FLOW THROUGH HEATER

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ABSTRACT
An improved construction for a flow-through heater for heating water or other liquid and/or generating steam is disclosed. The flow-through heater has a cylindrical member formed from an inner tubular portion and an outer tubular portion that extends over a portion of the exterior surface of the inner tubular portion. The outer tubular portion houses a plurality of heating elements, which can be electrically connected in series or in parallel, thus providing more control over the heat distribution from the heater to the fluid flowing through it.
FLOW THROUGH HEATER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/947,500, filed on Jul. 2, 2007. The disclosure of the above application is incorporated herein by reference.

FIELD

[0002] The present disclosure relates to a fluid heater for an appliance. In particular, the present disclosure relates to an improved construction for a flow-through heater for heating water or other liquids and/or generating steam.

BACKGROUND

[0003] The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

[0004] Appliances, such as dishwashers, clothes washers and water heaters, for example, employ a heater for heating water or other liquid that is used in the appliance. One type of heater that is well-known in such applications is a flow-through heater. One prior art flow-through heater is shown in FIG. 1. The flow-through heater 1 includes a hollow, metal, cylindrical member 24 having a passageway 22 extending along its longitudinal axis 20 through which water or other liquid to be heated flows. Located around the cylindrical member 24 in close proximity to its exterior surface is a tubular electric heating element 10. The heating element 10 is generally spirally-wrapped around the circumference of the cylindrical member 24 for a length along its longitudinal axis 20. Typically, the cylindrical member 24 is made from stainless steel and the tubular electric heating element 10 is brazed or crimped to the surface of the cylindrical member 24.

[0005] Mounted at locations on the exterior surface of the cylindrical member are one or more temperature sensor assemblies 44, 52. The temperature sensor assemblies 44, 52 can house a temperature sensor, like a thermostat device or NTC device. In the example shown in FIG. 1, one temperature sensor assembly 44 is mounted upstream of the heating element 10 in the direction of flow through the heater 1 and provides an electrical connection to a source of power for the heating element 10 at the connector and includes a thermostat. Another temperature sensor assembly 52, mounted downstream of the heating element 10, carries an NTC temperature sensor.

[0006] When the heater is powered ON, the heating element 10 generates heat that is transferred to the cylindrical member 24 and, ultimately, to the fluid passing through the heater 1. The temperature sensor assemblies 44, 52 can provide feedback to a control system regarding the temperature of the heating element 10 and/or fluid passing through the heater 1, and control or affect the interruption of power to the heating element 10.

[0007] A shroud 42 is located over the heating element 10 to cover and protect the heater 1 and shield the surrounding area from the heating element 10.

[0008] In water heating applications, a flow-through heater generally operates in a continuous flow mode; that is, water continuously passes through and recirculates through the heater under pressure where it is heated. When the heater is powered ON, heat generated by a heating element is transferred to the water from the heater as it flows. As the fluid continuously circulates through the heater, its temperature is raised. When a preset temperature is reached, for example, as determined by the temperature sensor assemblies, the heater is powered OFF.

[0009] Another known application for flow-through heaters is for steam generation. In such applications, the heater does not operate in a continuous flow mode. Instead the cylindrical member of the heater is filled to about half of its volume with water. The water then dwells in the heater until the powered ON heater converts the water to steam. Thereafter, the steam is released from the heater.

[0010] Conventional flow-through heaters like that shown in FIG. 1 have a single heating element which can be either powered ON or powered OFF. The spiral-wrapped configuration of the heater also means that the tube is always heated around its circumference when it is powered ON. As such, a conventional flow-through heater lacks the ability to control the location and amount of heat placed over the surface of the cylindrical member.

SUMMARY

[0011] The present disclosure is directed to a flow-through heater that generally comprises a cylindrical member extending generally along a longitudinal axis and a plurality of heating elements positioned around the cylindrical member. The cylindrical member comprises an inner tubular portion and an outer tubular portion that extends over a portion of the exterior surface of the inner tubular portion. The outer tubular portion contains the heating elements.

[0012] The heating elements are shown to be connected electrically in series, though the heating elements can also be connected in parallel groups (see, e.g., FIG. 6) or individually, as desired. When the heating elements are connected in series, all of the heating elements are powered ON and OFF simultaneously. If connected in parallel, groups of heating elements, or individual heating elements, can be powered ON and OFF independently, enabling greater control over the selective heating about the circumference of the inner tubular portion of the heater. Thus, the flow-through heater of the present disclosure offers more control over the heat distribution from the heater to the fluid flowing through it.

[0013] Both the inner tubular portion and the outer tubular portion can be made of aluminum or copper, both of which exhibit very good thermal conductivity and heat transfer characteristics. Moreover, the cylindrical member can comprise a unitary construction where both the inner tubular portion and the outer tubular portion are made from a single piece of material. Alternatively, the cylindrical member can comprise a two-component construction where the inner tubular portion and the outer tubular portion are separate components.

[0014] The heater of the present disclosure can be configured as a heater (e.g., to heat water or another fluid to a desired temperature), or as a steam generator, depending on its application.

[0015] Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0016] The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.
heating elements 110 include a coiled resistance wire extending coaxially along the length of an elongate metal sheath. An electrically insulating material having a relatively high thermal conductivity is used to fill the space between the coil and the inner wall of the sheath. The resistance wire is commonly made from metals such as Fe/Cr/AI or Ni/Cr. Granulated magnesium oxide (MgO) is one substance known to be suitable for serving as the filler material.

The heating elements 110 can be of any wattage suitable for operation of the heater 100. In addition, the heating elements 110 can be designed to vary their wattage over their lengths. In particular, a heating element 110 can be designed to have a first wattage in its curved section 112, and a second (e.g., increased) wattage in its leg sections 111, if desired. This design feature can be accomplished by varying the pitch of heating element’s coiled resistance wire along the length of the heating element 110. Increasing the pitch at a location on the heating element 110 decreases the wattage of the heating element 110 at that location, while decreasing the pitch has the opposite effect of increasing the wattage. Decreasing the wattage of the heating element 110 at the location of its curved section 112 can reduce or eliminate the need for including a shroud around that location of the heating elements 110.

Adjacent heating elements 110 of the heater are shown in FIGS. 2-5 to be connected in series, in a daisy-chain manner by connecting wires 130. Electrical connectors 126 provide a location at which power can be applied to the heating elements 110. Although the heating elements 110 are shown to be connected electrically in series, the heating elements 110 can also be connected in parallel groups (see e.g., FIG. 6) or individually, or in any combination as desired. When the heating elements 110 are connected in series, all of the heating elements 110 are powered ON and OFF simultaneously. If connected in parallel, groups of heating elements 110, or individual heating elements 110, can be powered ON and OFF independently of others, enabling the greater control over the selective heating about the circumference of the inner tubular portion 118.

The fins 114 of the outer tubular portion 116 can be configured, for example, to receive the leg portions 111 of the heating elements 110 in a “snap-fit” manner. Alternatively, the fins 114 can be mechanically cramped, pinched or staked in order to secure the heating elements 110 in position on the outer tubular portion 116. Additionally, or in yet another alternative, the heating elements 110 can be adhered to the outer tubular portion 116 with a thermally conductive glue or epoxy.

Both the inner tubular portion 118 and the outer tubular portion 116 can be made of metal. Aluminum or copper, both of which exhibit very good thermal conductivity, are particularly suited for the application. In addition, the inner tubular portion 118 can also be made from stainless steel.

It is contemplated that the inner tubular portion 118 and outer tubular portion 116 can be extruded or machined from stock, though other known manufacturing methods and techniques may be used.

The cylindrical member 124 can comprise a unitary construction where both the inner tubular portion 116 and the outer tubular portion 118 are made from a single piece of material. Alternatively, the cylindrical member 124 can comprise a two-component construction where the inner tubular portion 118 and the outer tubular portion 116 are separate
components (see, e.g., FIGS. 7 and 9, for example). In such a construction, the outer tubular portion 116 can be mechanically attached to the inner tubular portion 118 such as with a taper fit, an interference fit, or a wedge (not shown) which can be lodged between the inner diameter of the outer tubular portion 116 and the outer diameter of the inner tubular portion 118. Alternatively, or in addition, the inner and outer tubular portions 118, 116 can be fastened together by brazing or with a thermal epoxy. Preferably, any method of connecting the two components would avoid creating an air gap between the components, although a minimal air gap between the components can still be acceptable.

Another exemplary flow through heater 200 of the present disclosure is shown in FIGS. 6 and 7. In this embodiment, a shroud 242 is incorporated into the heater's design. The shroud 242 is positioned around the heating elements 210 and serves as a protective cover for the heater 200. The shroud 242 serves to protect other components of the appliance from the heat generated by the heater 200. In addition, in the unlikely event of a catastrophic failure of a heating element 210, the shield serves to contain debris and reduce the potential for damage to other components of the appliance.

In addition, one or more temperature sensor assemblies 244 can be included in the heater 200 and are shown in FIGS. 6 and 7. A temperature sensor assembly 244 can comprise a temperature sensing device, such as a thermistor or a NTC device. In addition, the temperature sensor assembly 244 can include an electrical connector 226 which connects, at one side, to the heating elements 210 and, at the other side, to a power source for the heater 200. As shown in FIGS. 6 and 7, a single temperature sensor assembly 242 is installed.

The outer surface of the inner tubular portion 218 includes one or more areas or “flats” 240 that can accommodate the mounting of a temperature sensor assembly 244.

The heating elements 210 of the heater shown in FIGS. 6 and 7 are connected electrically in parallel. One group of heating elements 210 extend along the upper side of the heater and are electrically in parallel with another group of heating elements 210 that extend along the lower side of the heater. In this configuration, adjacent heating elements 210 of a group are electrically connected by terminal pins 228. A “hot” terminal connector 232, 234 for each group is paired with a “neutral” terminal connector 236 to create the electrically parallel relationship. Connecting wires like those shown in FIG. 1 connect each group of heating elements 210 to the temperature sensor assembly 244.

As seen in FIG. 7, the heater’s cylindrical member 224 is of a two-piece construction, with the inner tubular portion 218 and the outer tubular portion 216 comprising separate components. The construction of the cylindrical member 224, however, may be one-piece as well. Also the materials and manufacturing techniques previously described are equally applicable to the heater 200 shown in FIGS. 6 and 7.

Yet another exemplary flow through heater 300 of the present disclosure is shown in FIGS. 8 and 9. In this example, the cylindrical outer tubular portion 316 receives a plurality of heating elements 310 in receptacles 346 (e.g., holes) into which the heating elements 310 can be inserted. The heating elements 310 can be secured mechanically or adhered, as already described.

The outer tubular portion 316 in the heater of FIGS. 8 and 9 doubles as a protective shroud around the heating elements 310.

FIG. 10 shows still another exemplary flow through heater 400 of the present disclosure. Similar to that shown in FIGS. 8 and 9, the heating elements 410 can be inserted into and secured in receptacles 446 in the outer tubular portion 416, which again serves to shroud the heating elements 410.

The flow-through heater of the present disclosure can be configured as a heater (e.g., to heat water to a desired temperature), or as a steam generator, depending on its application. The heater of the present disclosure offers more control over the heat distribution from the heater to the fluid flowing through it.

What is claimed is:

1. A flow-through heater comprising:
an inner tubular portion extending along a longitudinal axis and including an exterior surface;
an outer tubular portion extending over the exterior surface of the inner tubular portion;
a plurality of heating elements contained in the outer tubular portion and extending generally longitudinally along the exterior surface of the inner tubular portion, the plurality of heating elements forming part of an electric circuit;
each heating element comprising an elongated metal sheath, a coiled resistance wire extending coaxially along the length of the elongated metal sheath, and an electrically insulating material disposed between the elongated metal sheath and the coiled resistance wire; and

wherein each heating element is configured to form an intermediate section and a pair of leg sections extending from opposite ends of the intermediate section; and

wherein the exterior surface of the inner tubular portion is selectively heated by powering at least a portion of the plurality of the heating elements ON and OFF.

2. The flow-through heater of claim 1 wherein the outer tubular portion includes at least one of receptacles and fins for receiving the plurality of heating elements, wherein the receptacles and fins extend longitudinally and the fins project radially outwardly from the longitudinal axis.

3. The flow-through heater of claim 1 wherein the coiled resistance wire has a pitch that varies along the length of the heating element.

4. The flow-through heater of claim 1 wherein at least a portion of the plurality of heating elements are powered ON and OFF separately from the remainder of the plurality of heating elements.

5. The flow-through heater of claim 1 wherein the plurality of heating elements are electrically connected in parallel.

6. The flow-through heater of claim 1 wherein the plurality of heating elements are electrically connected in series.

7. A flow-through heater comprising:
a cylindrical member extending generally along a longitudinal axis and comprising an inner tubular portion and an outer tubular portion that extends over an exterior surface of the inner tubular portion; and

a plurality of heating elements positioned at locations around the circumference of the outer tubular portion and extending generally longitudinally along the exterior surface of the inner tubular portion, the plurality of heating elements being electrically connected to one another.

8. The flow-through heater of claim 7 wherein the cylindrical member comprises a single-component construction,
the inner tubular portion and the outer tubular portion being constructed from a single piece of material.

9. The flow-through heater of claim 7 wherein the cylindrical member comprises a two-component construction, the outer tubular portion being attached to the inner tubular portion by at least one of a taper fit, an interference fit, a wedge, brazing or a thermal epoxy.

10. The flow-through heater of claim 7 wherein the outer tubular portion comprises a plurality of receptacles for receiving the plurality of heating elements.

11. The flow-through heater of claim 7 wherein the outer tubular portion comprises a plurality of fins extending radially and outwardly from the longitudinal axis, and wherein the plurality of heating elements are located between adjacent fins.

12. The flow-through heater of claim 11 wherein the plurality of heating elements are attached to the plurality of fins.

13. The flow-through heater of claim 7 wherein the plurality of heating elements each have a U-shaped construction and include a pair of leg sections and an intermediate curved section.

14. The flow-through heater of claim 13 wherein at least some of the plurality of heating elements have a wattage that varies along its length.

15. A flow-through heater comprising:

- a cylindrical member extending generally along a longitudinal axis, the cylindrical member comprising an inner tubular portion and an outer tubular portion that extends over a portion of the exterior surface of the inner tubular portion; and
- a plurality of heating elements attached to the outer tubular portion and positioned around the exterior surface of the inner tubular portion, wherein at least a portion of the plurality heating elements are electrically connected in parallel.

16. The flow-through heater of claim 15 wherein the cylindrical member comprises a single-component construction, the inner tubular portion and the outer tubular portion being constructed from a single piece of material.

17. The flow-through heater of claim 15 wherein the cylindrical member comprises a two-component construction, the outer tubular portion being attached to the inner tubular portion by at least one of a taper fit, an interference fit, a wedge, brazing or a thermal epoxy.

18. The flow-through heater of claim 15 wherein the outer tubular portion comprises a plurality of receptacles for receiving the plurality of heating elements.

19. The flow-through heater of claim 15 wherein the outer tubular portion comprises a plurality of fins extending in a longitudinal direction and projecting radially outwardly from the longitudinal axis, and wherein the plurality of heating elements are located between adjacent fins.

20. The flow-through heater of claim 15 wherein at least some of the plurality of heating elements have a wattage that varies along its length.

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