March 24, 1959 H. R. DAMMOND 2,879,372

HEAT EXCHANGERS

Filed July 30, 1957

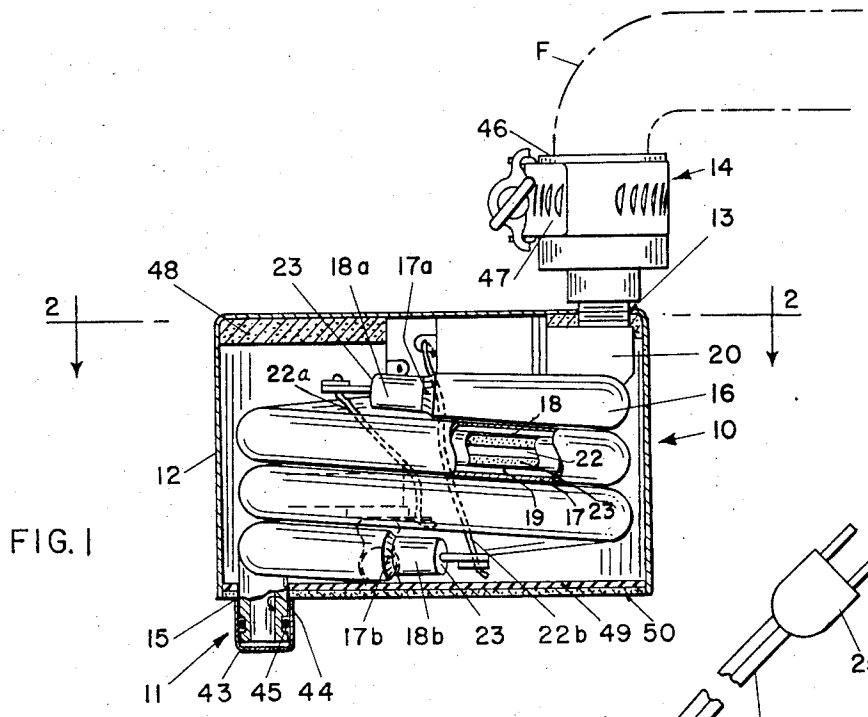


FIG. 1

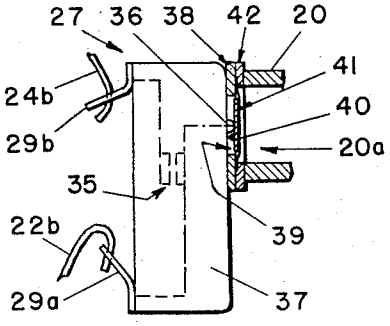


FIG. 3

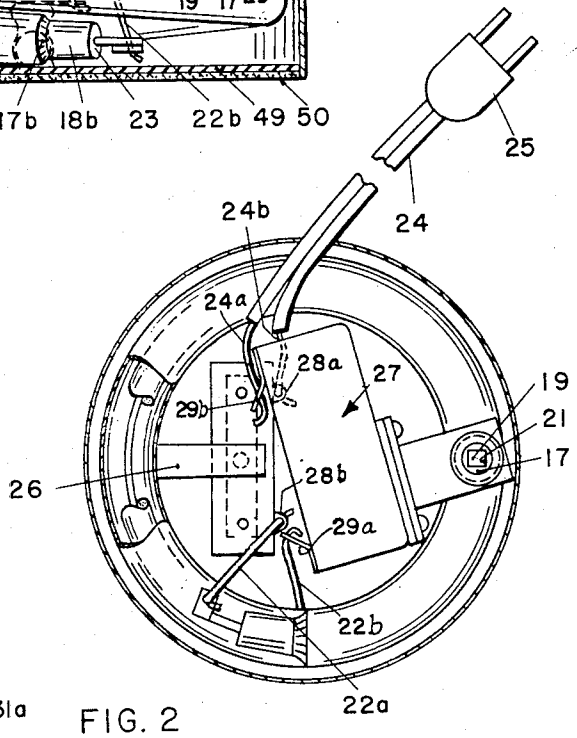


FIG. 2

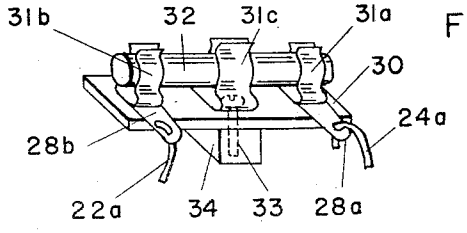


FIG. 4

INVENTOR.

Howard R. Dammond

BY

James C. Eisenman

attorney

United States Patent Office 2,879,372 Patented Mar. 24, 1959

2,879,372

HEAT EXCHANGERS

Howard R. Dammond, Great Neck, N.Y., assignor to Landam Products Corporation, Great Neck, N.Y., a corporation of New York

Application July 30, 1957, Serial No. 675,174

7 Claims. (Cl. 219—39)

This invention relates to heat exchangers and more particularly to electrically-energized liquid heaters of the through-flow or instantaneous type.

In the design of through-flow heaters for liquids, particularly faucet-type water heaters, in which the heating element takes the form of an electrical resistance, it is in most cases necessary for safety and simplicity to provide control action whereby current flows only when liquid is flowing in the unit. In order, however, to insure that there not be a significant time lag in the appearance of heated liquid at the output, the total volume of liquid in the unit at any given instant should be kept small. Also in those cases in which the heat exchanger is to be used as a faucet attachment for providing hot water at a cold water tap, weight, size and reliability of the unit are important factors, as is the ability of the unit to keep itself free of foreign matter over a long life.

Accordingly, it is one object of the present invention to provide an improved heat exchanger of the through-flow type for heating liquids. Other objects of the invention are to provide a through-flow type heat exchanger for liquids which is electrically efficient, self-purging, and safe for use on faucets.

In accordance with the invention, a heat exchanger is provided with a liquid flow path in the form of a generally toroidal space between concentrically-arranged inner and outer tubes, the innermost tube of which carries internally any electrical resistance heater element. The tube assembly is preferably formed into coils, with the center area within the coils containing control elements. An inlet fitting is attached to the outer tubular member adjacent one end thereof and an outlet fitting to the member adjacent the other end, communication with the toroidal space being established through suitable apertures in the outer tube. Turbulent flow in the toroidal space is utilized to effect efficient heat transfer, to scavenge the heat-exchanging surfaces and to generate back pressure within the system.

The back pressure generated within the system by the passage of liquid therethrough is sensed adjacent the inlet end of the exchanger to operate a control element in the form of a pressure-responsive switch for closing the electrical power circuit to the heater element, the switch automatically opening to break the circuit when the source of liquid under pressure is cut off as by closing the water tap on the upstream end of the unit, for example. A thermal switch can be included in the unit in the form of a fuse assembly connected in series in the electrical circuit and physically joined in a thermal coupling to a section of the outer tube. The fuse assembly is preferably received within the coils for greater sensitivity. The coil assembly with its several control elements is mounted in a casing, preferably in an electrically insulating potting compound for protection against damage to the unit and shock to the users.

A representative embodiment of the invention is described below, having reference to the accompanying drawings, in which:

Figure 1 is a view in side elevation, partly in vertical section, of a heat exchanger unit of the type adapted to be attached to a water tap for instantaneous heating;

Figure 2 is a top view, partly in horizontal section, taken on the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is an enlarged view partly in section, of a control element in the heat exchanger for controlling the flow of electrical current; and

Figure 4 is an enlarged perspective view of a second control element comprising a fuse assembly normally mounted within the heating coils of the unit.

Referring to the drawing, the invention is illustrated as embodied in a heat exchanger unit indicated generally by the numeral **10** of the type adapted to be attached to the nozzle of a cold water faucet F for providing a flow of heated water from its outlet or discharge nozzle **11**, the heating of the water occurring automatically as a function of the water flow through the unit. The unit **10** includes a casing **12** formed in its upper surface with an opening **13** to accommodate a faucet adapter **14**. The lower surface consists of a thin disc **49** of insulating material, such as phenolic plastic, preferably coated with a sealing compound **50** and formed with an opening **15** to receive the discharge nozzle **11**.

Centered within the housing **10**, which can take the form of a plastic or metal casing, is a heat-exchanging coil **16** including an outer tubular member **17** containing an inner tubular member **18**. The outer surface of the inner tubular member and the inner surface of the outer tubular member define a generally toroidal space **19** representing the liquid flow path. The inner tubular member is not necessarily centered within the outer tubular member at any given point along the length of the coil. Thus, while the cross-sectional area of the flow path is constant along its length, the configuration varies randomly, thereby augmenting the desired turbulent flow therein. The tubular members **17** and **18** are preferably formed of metal tubing which is corrosion resistant. At the upper end of the coil **16** the inner tubular member extends beyond the end of the outer tubular member **18** in an extension **18***a*. Similarly, at the lower end **18***b* of the inner tubular member, there is a protrusion from the outer tubular member. At the upper and lower ends of the outer tubular member **17** seals **17***a* and **17***b*, preferably formed of silver solder, close the toroidal space **19**.

An inlet fitting **20**, including an internal chamber or conduit **20***a*, is secured to the coil **16** close to its upper end as by soldering or brazing, for example, and within the fitting the outer tubular member **17** is formed with a milled slot **21** (Figure 2) connecting the channel of inlet with the toroidal space **19**. The discharge nozzle or outlet **11** is similarly joined to the coil **16** adjacent its lower end, with communication between the outlet **11** and the toroidal space also occurring through an opening in the outer tubular member. In this fashion, water from the faucet F flows through the inlet fitting **20** into the toroidal space **19**, around the several coils of the unit **16** and out of the outlet **11**.

The liquid flowing through the toroidal path is heated by means of an electrical resistance heater element **22** passing through the center of the inner tubular member **18**, the heater element **22** being connected at its upper end to a conductor lead **22***a* and at its lower end to a conductor lead **22***b*. The space between the heater element **22** and the metal walls of the tubular member **18** is filled with a ceramic insulator **23** which affords a heat-conducting path to the metal walls which surround it.

The electrical circuit to energize the resistance heater **22** includes an electrical supply conduit or cord **24**,

terminating in a cord cap 25 to be plugged into the mains, and control elements including a fuse assembly 26 and a pressure-operated switch 27. The control elements are mounted within the coils of the heat exchanger unit 16.

One conductor 24*a* of the electrical supply cord 24 is connected to a terminal 29*b* of the control switch assembly 27, the other terminal 29*a* of which is connected to the conductor lead 22*b* of the resistance heater. The other conductor lead 22*a* of the resistance heater is connected to a terminal 28*b* of the fuse assembly 26, the other terminal 28*a* of which is connected to the conductor 24*b* of the electrical supply cord 24 to complete the circuit. The fuse assembly 26 includes, as best seen in Figure 4, an insulating plate 30 having mounted at its ends a pair of fuse clip elements 31*a* and 31*b* joined respectively to the terminals 28*a* and 28*b*. A cartridge fuse 32 is received in the clips 31*a* and 31*b*, the fuse preferably comprising a thermal fuse including a fuseable element under spring pressure to insure its parting to open the circuit at the time of melting. Between its ends the insulating plate 30 carries a third, relatively-wide clip element 31*c* which embraces the insulating glass center of the fuse 32. The clip element 31*c* is joined by a heavy metal screw 33 to a metal mounting block 34 which is in turn secured in thermal conducting relationship, as by brazing, to one of the inner coils of the heat-exchanging coil 16. In this fashion, the support for the fuse assembly 26 also forms a thermal conducting path by means of which heat from the coil is conducted to the fuse element 32. Heating in the coil beyond a predetermined value will therefore open the electrical circuit.

The control switch assembly 27, as best seen in Figure 3, includes normally-open, snap-type contacts 35 (indicated diagrammatically) and a push-type actuator 36 which extends out of the switch housing. Secured to the housing 37 around the actuator 36 is a plate 38 formed with a central aperture 39 in which is received a disc-shaped actuating element 40. Overlying the aperture 39 and the surface of the disc element 40 is an impervious, flexible diaphragm 41 which can take the form of a thin disc of heat and water-resistant Neoprene. The switch housing, together with the plate 38 and the diaphragm 41, is secured to a mounting plate 42 attached to the inlet fitting 20 to communicate with the chamber 20*a*. Thus, the inlet water path is placed in direct communication with the diaphragm 41. In operation, the pressure, representing the back pressure, of water in the chamber 20*a* works on the diaphragm 41 to depress the actuator 36 to close the contacts 35 to energize the heating element 22 of the heat exchanger unit 16.

The heat-exchanging coil 16, including the several control elements associated therewith, is preferably potted or sealed within the housing 12 by means of a water impervious electrical insulator such as epoxy plastic resin 48. The housing can be partially potted, as illustrated, or fully potted. The outlet 11 includes a diffuser 43 taking the form of a cup element having a series of holes in its underside to disperse the output flow and fitted over a depending tubular element 44 which connects to the toroidal flow path of the heat-exchanging coil. The diffuser 43 is slipped onto the element 44 over an O-ring 45 and operates to form the discharge of heater water into a plurality of streams while at the same time affording a pressure relief valve in the event of clogging by virtue of its ability to slide off of the fitting 44 under the controlled frictional force of the O-ring 45. The adapter 14 by means of which the unit attaches to a water faucet includes a rubber sleeve 46, water-tightly secured to a threaded bushing as by molding, for example. The threaded bushing is screwed onto the inlet fitting 20. In operation, the sleeve 46 is fitted over the nozzle of the faucet and tightened in place by a screw-operated tension band 47. It will be understood that other adapter fittings can be used in accordance with the requirements of particular units.

In a preferred embodiment of the invention the heat-exchanging coil 16 included an outer tubular member 17 of .375 inch outside diameter and a wall thickness of .02 inch, and an inner tubular member of .290 inch outside diameter. Both members were formed of type 321 stainless steel, and the length was about 26 inches formed into a coil of 2.375 inches inside diameter after the two straight lengths were joined one within the other. An electrical resistance heater of 8 ohms was used to provide a wattage of about 1700 to 1800 for heating the water. Using a switch in which the contacts are opened by a pressure on the actuator of 9 to 13 ozs., a .500 inch diameter opening was used for the aperture 39 in the plate 38 to achieve operation when the back pressure at the inlet was in the range of 3 to 6 p.s.i. The unit will operate with conventional pressures in the supply line of 30 to 70 p.s.i., with the faucet valve being used to control the flow, as described below.

In operation, with the unit mounted on a closed water faucet, electricity does not flow in the heating element. When the water is turned on at the faucet, the water flows into the toroidal space 19 of the coil 16 and around the coils to the outlet 11. The relatively small clearances between the inner and outer tubular members 17 and 18 results in a back pressure at the inlet fitting 20 which closes the contacts 35 of the control switch assembly 27 to energize the electrical resistance heater 22, the element remaining energized as long as the flow of water continues above a predetermined minimum. By controlling the flow of water at the faucet, the temperature of the outlet water can be controlled, higher pressures or a wide-open faucet providing a rapid flow of warm water and lower pressures arising from a partially closed faucet providing a slower flow of hot water. As the temperature approaches critically hot values, however, the back pressure drops below the minimum value to operate the control switch and the power is cut off. The water passing through the toroidal space in intimate contact with the metal surface of the inner tubular member 18 will be heated. Because of the relatively small volume of water in the unit at any given time, heated water is obtained quickly. The efficiency of the heat transfer to the flowing water is augmented by the turbulent flow therein. The turbulence of the flow and the high velocity has a scavenging effect which serves to purge the critical space of scale impurities or the like. To achieve the desired flow characteristics in the toroidal space 19, it is not necessary that the inner tubular member be centered within the outer tubular member. Rather, the random spacing of the two members serves to achieve increased turbulence which improves the heating efficiency. Overheating will melt the fuse to open the circuit.

While the invention has been described above having reference to a preferred embodiment thereof, it will be understood that it can take various other forms and arrangements and should not, therefore, be regarded as limited except as defined by the following claims.

I claim:

1. In a water heater, an outer tubular member, an inner tubular member mounted in the outer member to define a generally toroidal space therebetween, liquid inlet means adjacent one end of the toroidal space, outlet means adjacent the other end, said toroidal space affording an impedance to water passage therethrough to establish turbulent flow and to generate a back pressure therein, electrical resistance heater means in the inner tubular member, whereby the inner tubular member becomes a heat exchanging surface enveloped by water on all sides, switch means connected in series with the resistance heater, and means responsive to liquid pressure in the toroidal space generated by the flow of water therethrough to actuate said switch to energize the resistance heater, whereby the impedance to flow established by the presence of the exchanging surface within

the outer member both generates back pressure to effect energization of said resistance heater and establishes turbulent flow to enhance the transfer of heat from the heat exchanging surface to the water.

2. In a water heater, an outer tubular member, an inner tubular member mounted in the outer member to define a generally toroidal space therebetween, liquid inlet means adjacent one end of the toroidal space, outlet means adjacent the other end, said toroidal space affording an impedance to water passage therethrough to establish turbulent flow and to generate a back pressure therein, electrical resistance heater means in the inner tubular member, switch means connected in series with the resistance heater, means responsive to the liquid pressure in the toroidal space generated by the flow of water therethrough to actuate the switch to energize the resistance heater, and thermal-responsive means thermally coupled to the outer tubular member and connected in series in the electrical circuit to the resistance heater, the thermal-responsive means opening the electrical circuit when the temperature of the tubular member exceeds a predetermined value.

3. A heater as set forth in claim 1, said outlet means comprising a depending tubular discharge conduit communicating with the toroidal space, a cup-shaped cap fitted on the conduit and including a plurality of water-dispersing openings therein, and a resilient O-ring interposed between the conduit and the cup to impose a predetermined frictional holding force thereon.

4. A heater as set forth in claim 1, said means responsive to pressure in the toroidal space being in communication with the toroidal space adjacent the inlet means.

5. A heater as set forth in claim 1, said means responsive to pressure in the toroidal space comprising a flexible, impervious diaphragm in communication on one side with the toroidal space, a support member movably mounted beneath the diaphragm to urge the diaphragm out of its normal plane toward the source of pressure, and a switch actuator interposed between the support member and said switch means.

6. A heater as set forth in claim 2, said inner and outer tubular members comprising metal tubes taking the configuration of a helical coil, said thermal-responsive means comprising a metal block affixed to the outer tubular member and extending in cantilever fashion into the center of the coil, a metal clip member attached to the block, and an electrical fuse element having a pair of terminals and an insulating body portion, the body portion being received in said clip member.

7. A heater as set forth in claim 6, including a casing for the coiled tubular members, and an electrically insulating potting compound filling the spaces among the coils and between the coils and the casing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,438,445	Loubiere	Dec. 12, 1922
1,759,774	Andriulli	May 20, 1930
1,920,284	Wells	Aug. 1, 1933
2,588,314	Wicks	Mar. 4, 1952