

[54] HEAT EXCHANGER

[72] Inventors: **Roger W. Hall**, 7008 Stafford Ave., Apt. G, Huntington Park, Calif. 90255; **John M. Spicer**, Mira Loma, Calif.

[73] Assignee: **said Hall, by said Spicer**

[22] Filed: **Feb. 5, 1970**

[21] Appl. No.: **8,811**

[52] U.S. Cl. **165/81, 165/154, 138/32, 285/41**

[51] Int. Cl. **F28f 7/00**

[58] Field of Search **165/143, 156, 81-83, 165/112, 51, 141, 46; 138/32, 114; 285/41, 133**

[56] References Cited

UNITED STATES PATENTS

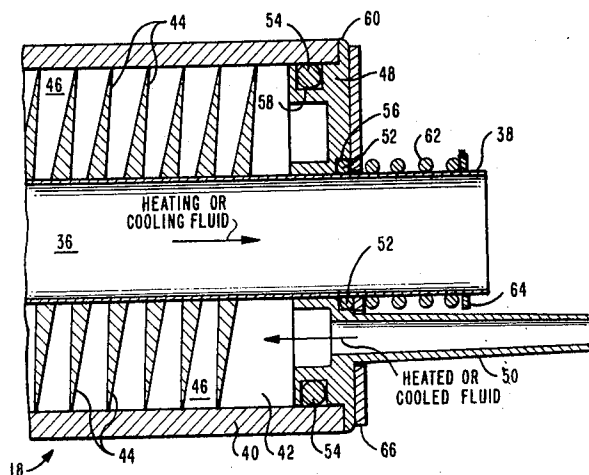
1,869,637	8/1932	Walworth	165/83
2,066,480	1/1937	McKerrall	165/156
3,346,042	10/1967	Seehausen	165/83

Primary Examiner—Charles Sukalo
Attorney—Fraser and Bogucki

[57] ABSTRACT

A heat exchanger in which fluid is passed through the inside of an inner tube to heat or cool fluid passing between the outside of the inner tube and the inside of an outer tube concentrically disposed about the inner tube accommodates substantial expansion and contraction of both the outer tube and the fluid to be heated or cooled without leakage or damage to the heat exchanger. The outer tube is made of resilient material so as to expand and contract in response to changes in the volume of the fluid to be heated or cooled, and the heat exchanger is provided with circular end bells between the inner and outer tubes at the opposite ends, one of the end bells being movable axially relative to the inner tube to allow for freezing of the fluid to be heated or cooled and to accommodate axial expansion and contraction of the outer tube. Each end bell includes a pair of elastomeric O-rings disposed between the end bell and different ones of the inner and outer tubes, and the axially movable end bell is restrained by a coil spring and included stop washer mounted on the inner tube adjacent the end bell.

9 Claims, 3 Drawing Figures



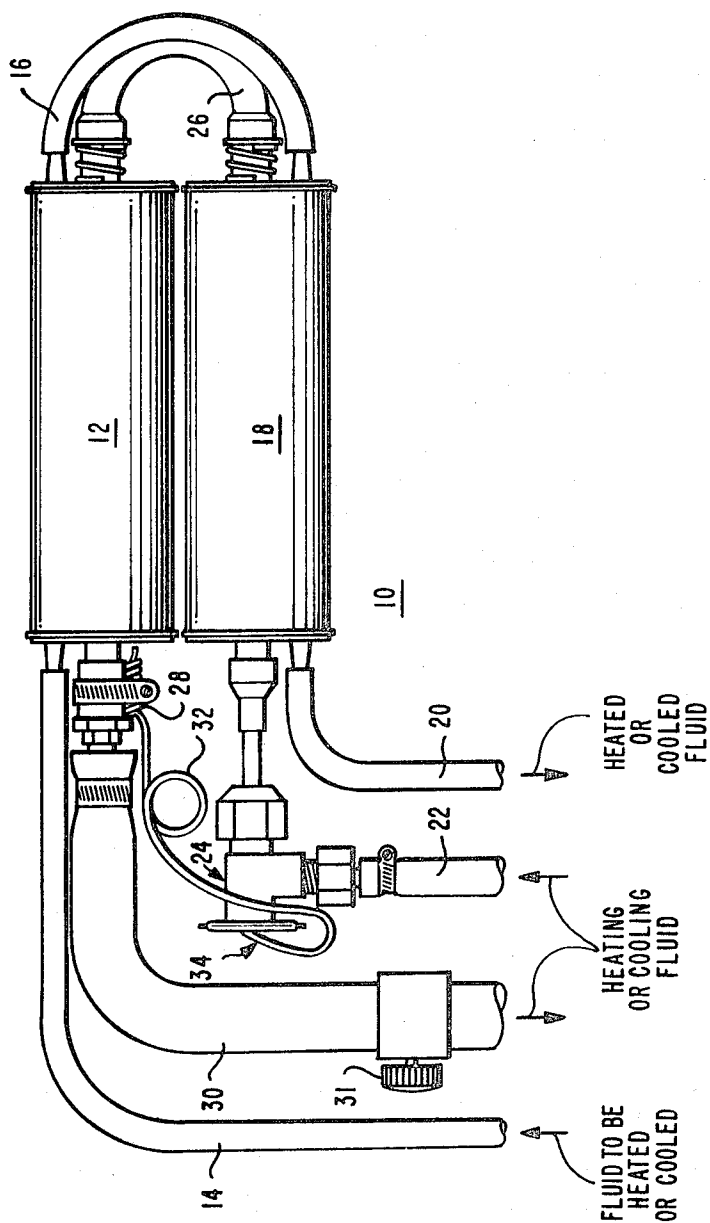


FIG. — 1

INVENTORS
 ROGER W. HALL
 JOHN M. SPICER

BY

Fraser and Boguecki
 ATTORNEYS

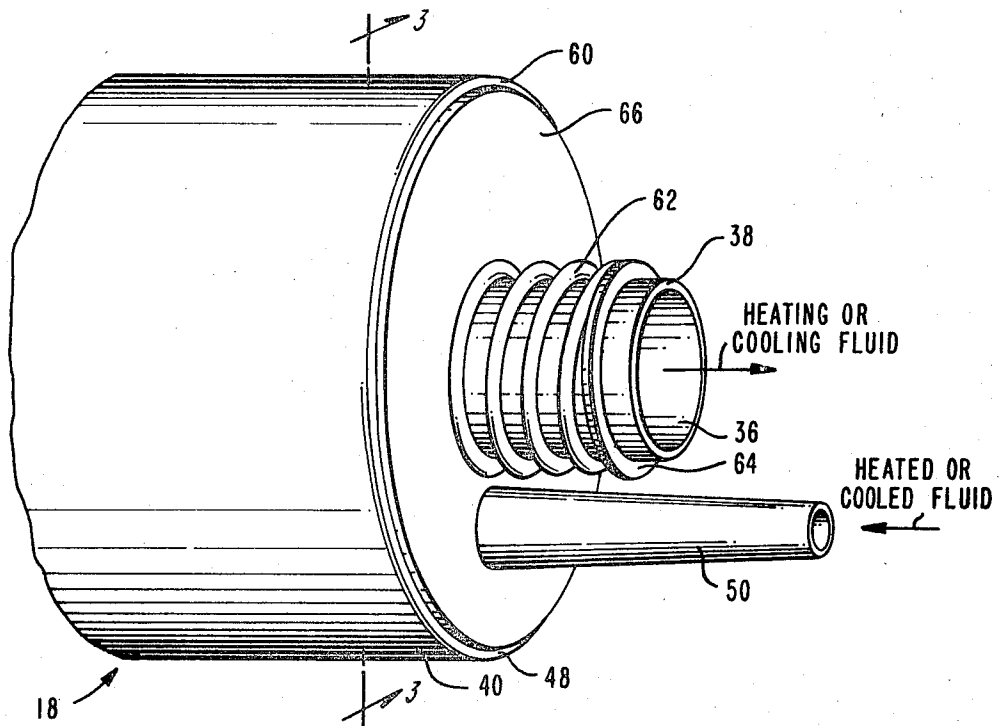


FIG. - 2

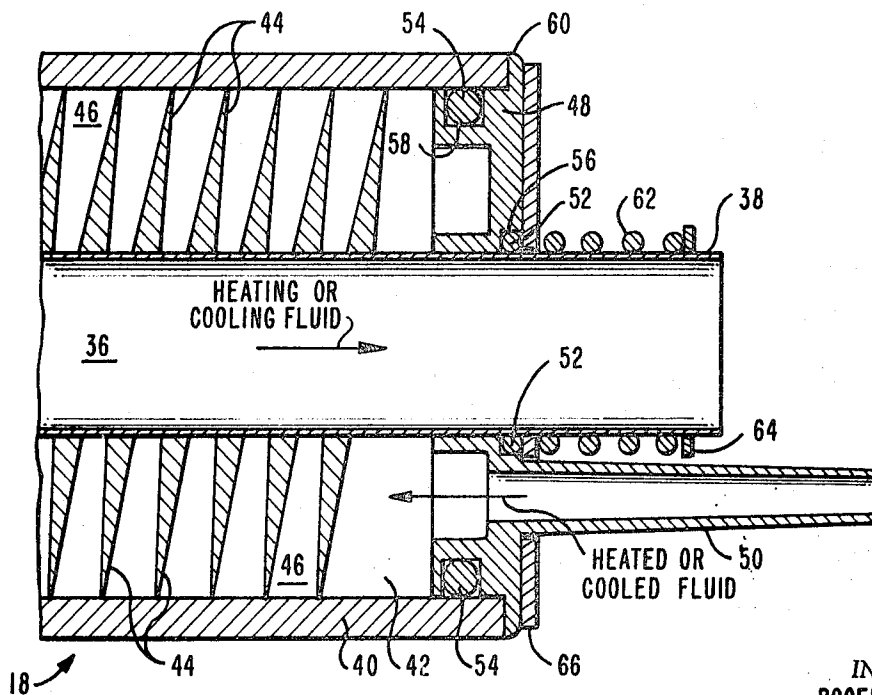


FIG. - 3

INVENTORS
ROGER W. HALL
JOHN M. SPICER

BY
Fraser and Buzucki
ATTORNEYS

HEAT EXCHANGER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to heat exchangers, and more particularly to heat exchangers of the type in which a heated or cooled liquid is employed to change the temperature of another liquid.

2. History of the Prior Art

Heat exchangers which employ a heated or cooled fluid to change the temperature of a second fluid are well known. In one relatively simple heat exchanger of this type two or more hollow cylindrical members or tubes are generally concentrically disposed relative to one another to define a plurality of fluid chambers or passageways. A plurality of fins may be employed to provide one of the chambers with a torroidal path to achieve greater rates of heat transfer.

In one arrangement well known in the art the hollow interior of an inner tubular member defines a first fluid chamber. The inner tubular member is surrounded by an outer tubular member, and a plurality of fins are arranged in the space therebetween to provide a torroidal path for a second fluid chamber. A generally circular member is disposed at each of the opposite ends of the inner and outer tubular members to enclose the second fluid chamber, and includes appropriate means for communicating between the second fluid chamber and the outside of the heat exchanger. Heated or cooled fluid is passed through one of the first and second fluid chambers to respectively heat or cool a fluid in the other one of the two chambers. Typically, the heated or cooled fluid is passed through the first fluid chamber defined by the interior of the inner tubular member, and the fluid to be heated or cooled is caused to flow through the torroidal path. Heat is directed through the inner tube and the fins between the two fluids, the direction of heat transfer being determined by whether the fluid in the torroidal path is to be heated or cooled. The two different fluids may be circulated in the same axial direction along the heat exchanger, but more typically are circulated in opposite directions to provide a countercurrent or counterflow.

Problems frequently arise in use of heat exchangers of the type just described in cases where the heat exchanger is subjected to substantial temperature changes or extremes. Thus, where the fluid chamber between the inner and outer tubular members contains a liquid which is heated to a relatively high temperature, the resulting expanding volume of the liquid places considerable pressure on the outer tubular member and the end members. If such pressure becomes sufficiently great the heat exchanger may leak or even burst. Likewise, considerable pressure may be placed on the outer tubular member and the end members if the fluid between the inner and outer tubular members freezes. Freezing may result where such fluid is being cooled without proper control over its temperature and pressure, but can occur in any heat exchanger application if the ambient temperature becomes low enough.

The problem may therefore be present both in heat exchangers designed to heat a fluid and in heat exchangers designed to cool a fluid. The problem becomes particularly critical in the case of heat exchangers designed for more universal use in which they may be required to both heat and cool a fluid for different applications thereof.

One technique commonly employed in an effort to accommodate a wider range of fluid volumes within the heat exchanger comprises the fabrication of the outer tubular member of resilient or flexible material, with plasticlike substances commonly being employed for this purpose. Resilient outer tubular members accommodate some radially directed force, particularly at the center and away from the opposite ends thereof. Problems still exist, however, in the regions of the opposite ends of the outer tubular member and at the end members themselves. Thus where freezing occurs the central portion of the outer tubular member expands to accommodate some of the increase in volume, but the end members are still

frequently pushed away from the outer tubular member. Such problems, moreover, may be accentuated by the use of resilient material for the outer tubular member. For one thing such materials typically expand at a much greater rate than the inner tubular member and fins, when heated. This increased expansion frequently results in one or both of the end members being displaced axially along the inner tubular member. As the outer tubular member contracts in response to subsequent cooling, the opposite ends thereof pull away from the end members and leakage ensues. In instances where the end members are rigidly bonded to the inner tubular member, inner tubular members made of relatively rigid materials such as copper and aluminum have been known to undergo substantial stretching in response to the expanding outer tubular member. As the outer tubular member contracts, the inner tubular member remains stretched resulting in leakage and possible total loss of usefulness of the heat exchanger.

BRIEF DESCRIPTION OF THE INVENTION

Heat exchangers in accordance with the present invention are capable of expansion and contraction in both axial and radial directions to accommodate substantial expansion and contraction of fluids being heated or cooled therein. In one preferred embodiment an inner tubular member is generally concentrically disposed within an outer tubular member, and a circular end bell is concentrically disposed on the outside of the inner tubular member adjacent each of the opposite ends of the outer tubular member so as to extend between the inner and outer tubular members. The hollow interior of the inner tubular member defines a first fluid chamber or passageway for heating or cooling fluid. A plurality of fins extend between the outer surface of the inner tubular member and the inner surface of the outer tubular member to define a torroidal path for a second fluid chamber or passageway, the second chamber communicating with the outside of the heat exchanger via a tubular structure formed in each of the end bells.

In accordance with the invention, one of the end bells is made axially movable relative to the inner tubular member to accommodate radial forces within the heat exchanger. A pair of elastomeric O-rings are mounted between the end bell and different ones of the inner and outer tubular members to maintain a fluidtight seal between the end bell and the tubular members as the end bell undergoes axial movement. Such axial movement is restrained by the disposition of resilient means between the end bell and a fixed position on the inner tubular member. In the preferred embodiment hereafter described the resilient means comprises a coil spring slidably concentrically disposed on the outside of the inner tubular member between the end bell and a washer concentrically mounted on the outside of the inner tubular member, the washer defining the fixed position. The outer tubular member is made of resilient material so as to be able to expand in the radial direction when required.

If the fluid in the second chamber freezes, the outer tubular member expands radially outwardly and the movable end bell moves axially outwardly along the inner tubular member to accommodate the increase in volume. Upon thawing, the movable end bell slides axially inwardly under the urging of the coil spring to maintain the end bells sealed to the inner and outer tubular members. If the fluid in the second chamber is heated, the movable end bell moves axially outwardly to accommodate the accompanying expansion of the outer tubular member. Again the movable end bell slides axially inwardly under the urging of the coil spring to maintain the end bells sealed to the inner and outer tubular members as the outer tubular member contracts.

DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following more par-

ticular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings, in which:

FIG. 1 is a plan view of one preferred form of heat exchanger according to the invention;

FIG. 2 is a perspective view of a portion of the heat exchanger illustrated in FIG. 1; and

FIG. 3 is a sectional view of the heat exchanger portion of FIG. 2 taken along the line 3—3 thereof.

DETAILED DESCRIPTION

A preferred form of heat exchanger in accordance with the invention is illustrated in plan in FIG. 1. It should be understood by those skilled in the art, however, that the novel features of the invention hereafter described may be used with other types and configurations of heat exchangers, the particular arrangement of FIG. 1 being illustrated and described by way of example only.

In the heat exchanger 10 of FIG. 1 fluid to be heated or cooled or to otherwise have its temperature changed is fed to the interior of a first cylindrical tank 12 by way of an entry hose or conduit 14. The fluid is circulated through the first cylindrical tank 12 prior to its exiting at the opposite axial end via a hose or conduit 16. The hose 16 directs the fluid into a second cylindrical tank 18, the fluid circulating through the tank 18 to the opposite axial end where it leaves via an exit hose or conduit 20. The cylindrical tanks 12 and 18 are identical in construction and can be combined into a single tank, if desired, at the expense of an increase in the space required for the heat exchanger 10.

Fluid which is to be used to heat or cool the fluid circulating through hoses 14, 16 and 20 is passed to the interior of the second cylindrical tank 18 via an entry hose or conduit 22 and a temperature sensitive control valve 24. The valve 24 is useful when the heat exchanger 10 is being used to cool the fluid, but is preferably removed or disconnected for applications where the fluid is heated. The fluid from the hose 22 circulates through the second cylindrical tank 18 to a conduit 26 where it is directed into the first cylindrical tank 12 for circulation therethrough. As the fluid exits from the first cylindrical tank 12 it passes a temperature sensor 28 included with the control valve 24 prior to entering an exit hose or conduit 30. For applications where the fluid is being cooled by the heat exchanger 10, the hose 30 is preferably provided with a pressure sensitive control valve 31.

As will be described in detail hereafter the two different fluids flow through different chambers in each of the cylindrical tanks 12 and 18 in heat exchanging relation, the fluid from the hose 22 heating or cooling or otherwise changing the temperature of the fluid from the hose 14 as desired. The particular heat exchanger 10 so illustrated is designed so as to be capable of both heating fluid and cooling fluid depending upon its particular application, thereby making the particular features of the present invention even more useful because of the relatively wide range of temperatures which the heat exchanger must be capable of withstanding. Although the heat exchanger 10 may be used for any appropriate application in which fluid is to have its temperature raised or lowered, the particular exchanger so illustrated was designed for use in conjunction with automotive heating and cooling systems. In one particular application in which the heat exchanger 10 is employed to heat water or other liquid beverages to be dispensed at a unit conveniently located at the dashboard or other appropriate place within an automobile, the liquid beverage to be dispensed is fed from a storage container or reservoir through the entry conduit 14 to the first cylindrical tank 12, then via the hose 16 to the second cylindrical tank 18. Heated fluid from the radiator is passed to the interiors of the cylindrical tanks 18 and 12 via the conduits 22 and 26. Heat from the heated fluid is applied within the cylindrical tanks 12 and 18 to raise the temperature of the liquid beverage to a desired level prior to the dispensing of such beverage.

In a slightly different application where the heat exchanger 10 is employed to chill dispensable liquid beverages such as water the heat exchanger is coupled in parallel with an auto air conditioner so that the entry hose 22 receives part of the liquid refrigerant or coolant such as Freon being circulated by the air conditioner. The refrigerant is passed through the cylindrical tanks 18 and 12 to chill the liquid beverage prior to its being returned to the air conditioner via the exit hose 30. The control valve 24 proves useful for such applications by regulating the flow of refrigerant through the cylindrical tanks 18 and 12 in accordance with the temperature of the refrigerant as it exits the tank 12. The control valve 24 includes a sealed bulb 32 containing a temperature-sensitive variable pressure substance such as gaseous Freon and extending from a diaphragm 34 to the sensor 28. The diaphragm which is sensitive to the pressure within the bulb 32 is coupled through a needle seat (not shown) to open or close the valve 24. When the temperature of the exiting refrigerant at the sensor 28 decreases to a predetermined level signifying that there is excess heat absorption capacity within the tanks 18 and 12, the valve 24 closes stopping the flow of refrigerant into the tank 18. The valve 24 remains closed until such time as a rise in the temperature of the exiting refrigerant indicates that the heat absorption capacity of the refrigerant within the tanks 18 and 12 has been depleted, at which point the valve 24 opens allowing fresh refrigerant to flow into the tanks 18 and 12. The pressure sensitive control valve 31 prevents freezing of the chilled fluid by regulating the pressure of the refrigerant in the tanks 18 and 12. Thus, if the valve 24 is closed and the auto air conditioner is pumping refrigerant the pressure in the hose 30 decreases. For refrigerant pressures below a predetermined threshold value the valve 31 is closed. As the pressure falls below the threshold value, the valve 31 closes preventing the refrigerant from flowing out of the heat exchanger and thereby maintaining the temperature and pressure of the chilled fluid within the heat exchanger to prevent freezing thereof.

The present invention may be best understood by referring to FIGS. 2 and 3, FIG. 2 being a perspective view of the right-hand end of the second cylindrical tank 18 as viewed in FIG. 1, and FIG. 3 being a sectional view of the portion of the second cylindrical tank 18 shown in FIG. 2. The heating or cooling fluid from the entry hose or conduit 22 flows through a first fluid chamber or passageway 36 as defined by the hollow interior of an inner tube 38. An outer tube 40 is generally concentrically disposed about the inner tube 38 to define a space 42 between the outer surface of the inner tube 38 and the inner surface of the outer tube 40. The inner tube 38 is longer than the outer tube 40 such that the opposite ends thereof extend beyond the opposite ends of the outer tube 40. A plurality of fins 44 extend radially outwardly from the outer surface of the inner tube 38 and into contact with the inner surface of the outer tube 40 to define a torroidal path comprising a second fluid chamber or passageway 46. A circular end bell 48 is concentrically mounted on the outside of the inner tube 38 so as to extend between the inner tube 38 and the outer tube 40 and close off the second fluid chamber 46 from the outside of the heat exchanger. The end bell 48 includes a tubular portion 50 thereof for communicating between the second fluid chamber 46 and the outside of the heat exchanger. The tubular portion 50 is adapted to receive the hose or conduit 16 shown in FIG. 1 but omitted from FIGS. 2 and 3 for clarity.

Fluid to be heated or cooled flows through the tubular portion 50 of the end bell 48 and into the second fluid chamber 46 where it advances along the axial length of the cylindrical tank 18 by following the torroidal path defined by the fins 44. At the same time the heating or cooling fluid flows through the first chamber 36 in the direction shown in FIGS. 2 and 3 to impart the desired temperature change to the fluid within the second chamber 46.

The directions of fluid flow need not be opposite so as to effect a countercurrent or counterflow as shown and described,

but may be in the same direction as desired. For most applications of the heat exchanger 10 a countercurrent or counterflow has been found to provide the greatest efficiency of heat transfer. Counterflow is also generally preferred since it provides the hottest or coolest fluid at the dispensing location. Thus where the heat exchanger 10 is being used to cool water, the warm water in the hose 14 enters the heat exchanger at a point where the refrigerant is warmest and leaves the heat exchanger at a point where the refrigerant is coolest.

In the event the fluid to be heated or cooled freezes within the tanks 12 and 18, damage or destruction of the heat exchanger 10 will result unless the expansion of the fluid is provided for. Freezing may result where the fluid is being cooled without adequate control over its pressure or temperature. Freezing may also result from low ambient temperatures. Thus, even though the heat exchanger is installed within an automobile for the purpose of heating a fluid, the fluid may freeze within the heat exchanger during nonoperational periods when the auto is exposed to below freezing temperatures.

To partly compensate for the expansion which takes place in the event the fluid to be heated or cooled freezes, the outer tube 40 is made of a flexible, preferably resilient material. Although any suitable material such as polyethylene may be used, polypropylene is preferred for many applications of the heat exchanger because of its durability and resistance to deterioration over a relatively wide temperature range. As the fluid between the various fins 44 freezes and undergoes expansion, the outer tube 40 expands radially outwardly to accommodate some of the fluid volume increase. The problem still remains however that freezing of fluid adjacent the end bells 48 exerts considerable axial force on the end bells. Then too, if the outer tube 40 undergoes expansion as a result of high ambient temperature or the heating of fluid within the second chamber 46, considerable axial force will be placed on the end bells 48. Because of the difference in materials used to fabricate the outer tube 40 and the inner tube 38 and fins 44, the outer tube 40 being made of plasticlike material and the inner tube 38 and fins 44 being normally made of metal, the outer tube 40 normally undergoes a much greater expansion than the inner tube 38 and fins 44 for a given increase in temperature. The result is a greater increase in the length of the outer tube 40 than in the length of the inner tube 38, again resulting in considerable axial force on the end bells 48.

In accordance with the invention axial forces on the end bells 48 such as may be produced by freezing of the fluid or expansion of the outer tube 40 are easily accommodated by making one of the end bells axially movable relative to the inner tube 38 as shown in FIGS. 2 and 3. Although the inner diameter of the end bell 48 is very slightly larger than the outer diameter of the inner tube 38 and a portion of the outer periphery of the end bell 48 has a diameter very slightly smaller than the inner diameter of the outer tube 40, the fluid chamber 46 is sealed from the outside of the heat exchanger by inner and outer elastomeric O-rings 52 and 54. The inner O-ring 52 resides within an annular groove 56 in the end bell 48 and is compressed slightly against the outer surface of the inner tube 38. The outer O-ring 54 resides within an annular groove 58 in the end bell 48 and is compressed slightly against the inner surface of the outer tube 40. As the end bell 48 moves axially relative to the inner tube 38 the inner O-ring 52 rolls, slides or otherwise moves along the outer surface of the inner tube 38 to maintain the end bell 48 sealed against the inner tube 38. An outer lip 60 extends radially outwardly from the end bell 48 and over the end of the outer tube 40 to further enhance the sealing provided by the outer O-ring 54 and to minimize leakage in the event the outer tube 40 should expand sufficiently relative to the end bell 48 so as to break the seal between the outer O-ring 54 and the outer tube 40.

Axial movement of the end bells 48 is controlled in part by an arrangement including a coil spring 62 and stop washer 64. The washer 64 is concentrically disposed about and fixedly mounted, using an appropriate technique such as brazing, on

the outside of the inner tube 38 on the opposite side of the end bell 48 from the fluid chamber 46 to define a fixed reference point for the spring 62. The spring 62 is slidably concentrically disposed on the outside of the inner tube 38 between the washer 64 and a platelike retainer 66, the retainer 66 being generally coextensive with and disposed in contact with the end bell 48. The spring 62 is partially compressed during assembly of the heat exchanger. Thereafter, the spring 62 tends to resist or restrain axial movement of the end bell 48 in a direction away from the second fluid chamber 46 and the fins 44 while at the same time allowing some movement of the end bell 48 in that direction.

As discussed below the particular mounting arrangement including the spring 62 and washer 64 allows the end bell 48 to move in conjunction with the outer tube 40 so as to maintain the end bell sealed both to the outer tube 40 and the inner tube 38 as the outer tube 40 expands and contracts. Of equal importance, the mounting arrangement also allows movement of the end bell 48 away from the outer tube 40 in a manner such that the end bell 48 always tends to reengage the outer tube 40 and maintain the seal therebetween as well as in relation to the inner tube 38.

Under normal operation the inner and outer O-rings 52 and 54 maintain the end bell 48 sealed to the inner and outer tubes 38 and 40 respectively and the spring 62 allows axial movement of the end bell 48 so as to maintain the seal between the end bell and the outer tube 40 as the outer tube undergoes expansion and contraction due to temperature changes. In the event the fluid within the second chamber 46 freezes, the outer tube 40 expands radially outwardly as previously discussed. At the same time the end bell 48 may undergo axial movement against the resistance of the spring 62 to accommodate expansion of the fluid adjacent the end bell 48. In actual practice it has been found that if substantially all of the fluid within the chamber 46 freezes the end bell 48 may undergo sufficient axial movement so as to actually separate from the outer tube 40 breaking the seal therebetween. Since practically all of the fluid is frozen, however, little or none of it is lost. Upon subsequent thawing the end bell 48 moves axially under the urging of the spring 62 until it contacts the end of the outer tube 40 and forms a seal therewith via the outer O-ring 54. It will therefore be seen that heat exchangers in accordance with the present invention generally allow for freezing of the fluid therein without damage or destruction and with little or no loss in the fluid.

In the event the heat exchanger is subjected to relatively high temperatures such as may result from high ambient temperatures or when hot fluid is passed through the first chamber 36 to heat the fluid in the second chamber 46, the outer tube 40 tends to undergo greater expansion than the inner tube 38 and fins 44 as previously discussed. The outer tube 40 expands radially and may draw away from the outer peripheries of the fins 44 due to its greater rate of expansion. The outer tube 40 also tends to expand axially at a considerably greater rate than the inner tube 38 such that the end of the outer tube 40 moves relative to the length of the inner tube 38. This expansion is accommodated by the spring 62, the end bell 48 moving axially along the outer tube 38 while continuing to be sealed to the outer tube 40. When the temperature drops the end bell 48 follows the contracting outer tube 40 under the urging of the spring 62.

Under normal conditions the expansion in the fluid within the second chamber 46 which results from a rise in temperature is easily accommodated by the innerconnecting hoses 14 and 20 (FIG. 1) and the chamber or reservoir which supplies the fluid (not shown). The relatively great fluid pressure within the second chamber 46 which would otherwise result is thereby avoided. In a few situations the heat exchanger environment may not be capable of absorbing the increase in volume as the fluid is heated. In such situations the resulting pressure may overcome the seals provided by the inner and outer O-rings 52 and 54, thereby breaking the seals and allowing some of the fluid to escape. This result may generally be

avoided by fashioning the end bells 48 with a greater axial thickness and by using two or more sets of inner and outer O-rings. The inner tube 38 and fins 44 are made of an appropriate material such as copper having desirable heat transfer properties. The fins 44 need not be arranged to define a torroidal path for the second chamber 46 as shown and described so long as satisfactory heat transfer is taking place. In actual practice the fins 44 may be eliminated for certain applications and other finlike arrangements may be used depending upon application.

The end bells 48 may be fabricated of any appropriate material, but preferably are of the same material as the outer tube 40 to enhance the movement of the movable end bell 48 and the outer tube 40 in unison. The O-rings 52 and 54 may be of any appropriate elastomeric material such as rubber or neoprene. The coil spring 62 and stop washer 64 are typically fabricated of metal, and the retainer 66 is preferably made of a hard substance such as metal. The retainer 66 may be eliminated for certain applications, but is generally preferred as a means of engaging the spring 62 and distributing the force thereof over a substantial surface area portion of the end bell 48. In the particular embodiment illustrated in FIGS. 2 and 3 the retainer 66 also forms one of the walls of the annular groove 56 for the inner O-ring 52.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A heat exchanger comprising an inner member having a hollow interior defining a first fluid chamber, an outer member having a hollow interior and surrounding the inner member to define a second fluid chamber, and an end member extending between the inner and outer members to close off the second fluid chamber from the outside of the heat exchanger and including means for communicating between the second fluid chamber and the outside of the heat exchanger, said end member being movable relative to the inner member to accommodate expansion and contraction of the outer member and changes in the volume of fluid within the second fluid chamber.

2. A heat exchanger in accordance with claim 1, further including means disposed between the end member and the inner member for normally urging the end member relative to the inner member in a direction toward the second fluid chamber.

3. A heat exchanger comprising a generally cylindrical inner member having a hollow interior defining a first fluid chamber, a generally cylindrical outer member having a hollow interior and substantially concentrically disposed about the outside of the inner member, the space between the inside of the outer member and the outside of the inner member defining a second fluid chamber, a generally circular end member extending between and concentrically disposed relative to the inner and outer members and including means com-

municating between the second fluid chamber and the outside of the heat exchanger, said end member being movable axially relative to the inner member, and resilient means disposed between a fixed location on the outside of the inner member and the end member for restraining movement of the end member relative to the inner member in a direction away from the second fluid chamber.

4. A heat exchanger in accordance with claim 3, wherein the end member extends over and into contact with an end of the outer member, the outer member is comprised of resilient material, and further including a plurality of fins mounted on the outside of the inner member within the second fluid chamber and extending into contact with the outer member to define a torroidal path for the second fluid chamber.

5. A heat exchanger in accordance with claim 3, wherein the resilient means includes stop means fixedly mounted on the outside of the inner member on the opposite side of the end member from the second fluid chamber and a coil spring slidably concentrically disposed on the outside of the inner member between the stop means and the end member.

6. A heat exchanger in accordance with claim 5, wherein the stop means comprises a hollow, cylindrical member, and further including a circular retainer concentrically disposed on the outside of the inner member between the coil spring and the end member and substantially coextensive with the end member.

7. A heat exchanger in accordance with claim 3, further including sealing means separately disposed between each of the inner and outer members and the end member.

8. A heat exchanger in accordance with claim 7, wherein the sealing means comprises first and second resilient O-rings respectively concentrically disposed between the end member and the inner and outer members.

9. A heat exchanger comprising an inner tube having a hollow interior defining a flow passage for a temperature changing fluid, an outer tube having a hollow interior and an axial length which is less than the length of the inner tube, the outer tube being concentrically disposed on the outside of the inner tube along a portion of the axial length of the inner tube, a plurality of fins mounted on the outside of the inner tube and extending into at least close proximity to the outer tube to define a torroidal passage between the inner and outer tubes for a fluid which is to have its temperature changed, a pair of circular end bells concentrically mounted on the outside of the inner tube and extending into contact with different ones of the opposite ends of the outer tube to enclose the torroidal passage, each of the end bells including a tubular portion for communicating between the outside of the heat exchanger and the torroidal passage and one of the end bells being axially slidable relative to the inner tube, a coil spring concentrically slidably mounted on the outside of the inner tube on the opposite side of the axially slidable end bell from the torroidal passage, and means mounted on the outside of the inner tube adjacent the end of the coil spring opposite the axially slidable end bell for preventing movement of said end of the coil spring relative to the inner tube.

* * * * *

60

65

70

75