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(54) HEAT PUMP AND METHOD OF HEATING FLUID

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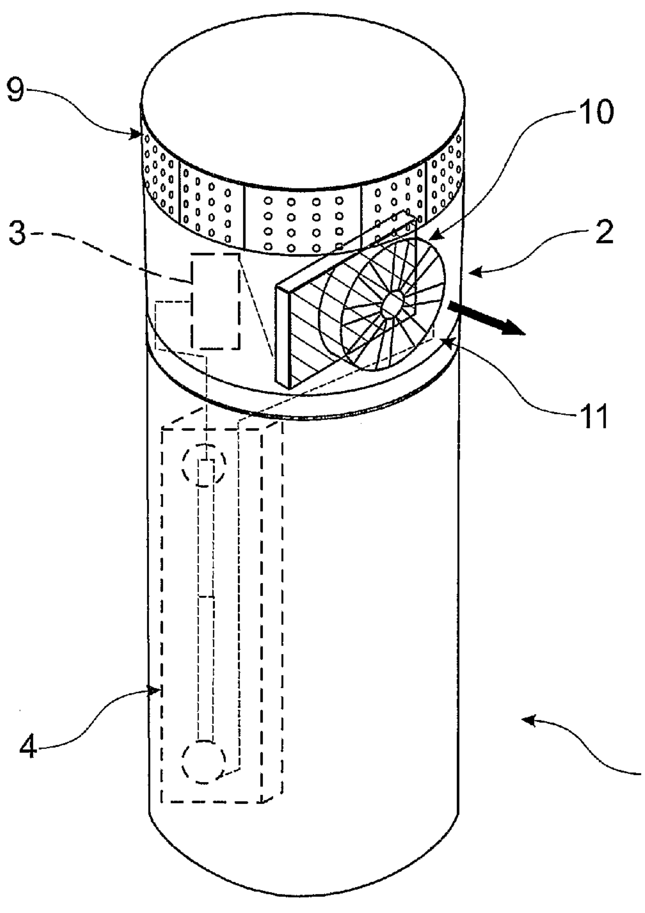
(57) ABSTRACT

A heat pump comprising an evaporator, a compressor and a heat exchanger is provided. The evaporator transfers heat from taken in air to a first fluid and expels the taken in air at a temperature cooler than ambient temperature. The compressor compresses and pumps the first fluid. The heat exchanger comprises a first passage for the heated compressed first fluid driven by the compressor and a second passage for a second fluid driven by thermal convection. A heat pump comprising a second heat exchanger that receives heated compressed first fluid from the compressor which heats compressed first fluid from the heat exchanger is also provided. Additionally, methods and systems for heating a fluid are also provided.



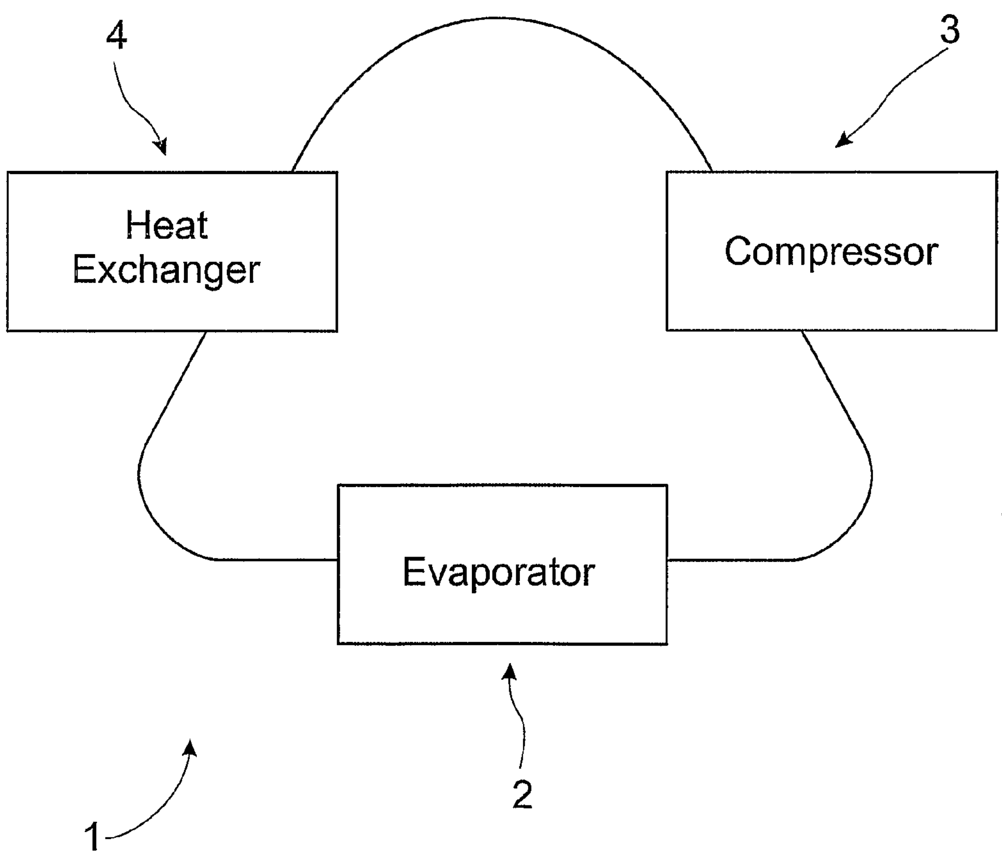


FIG. 1

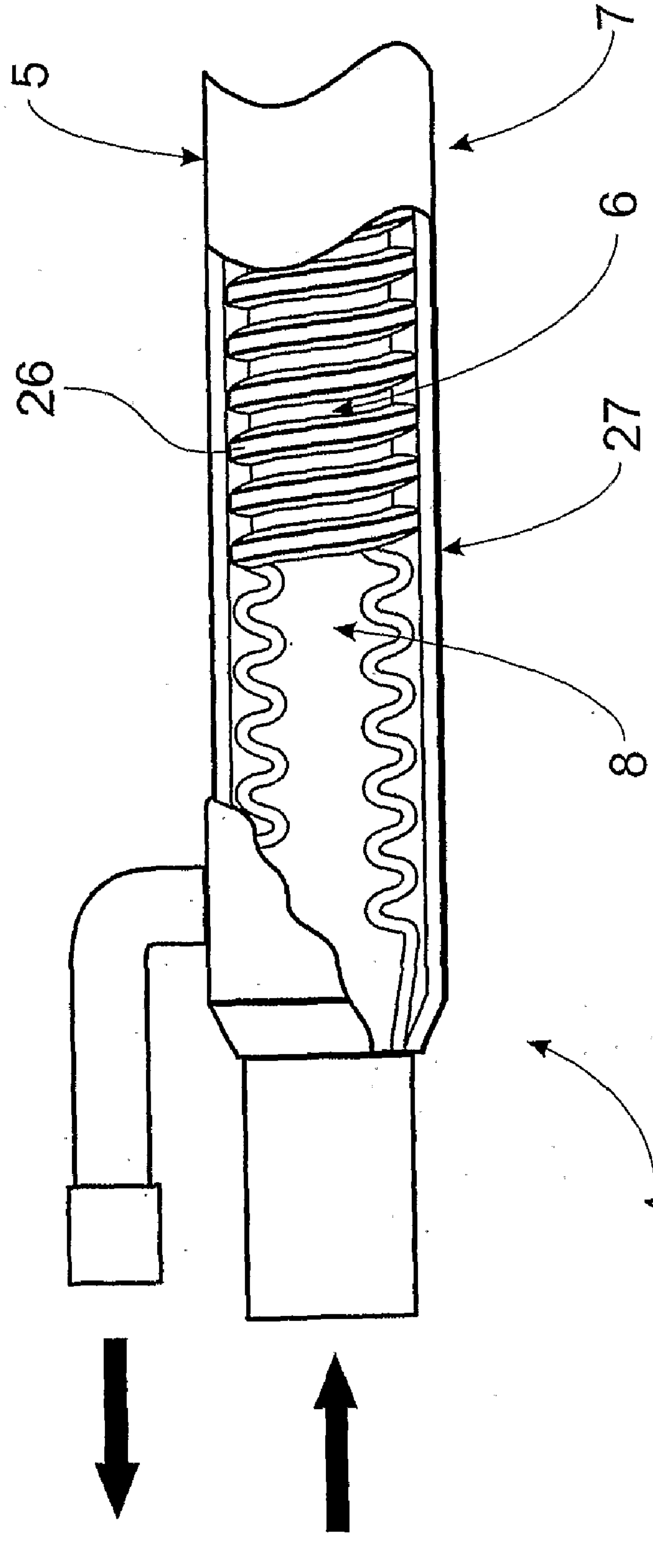


FIG. 2

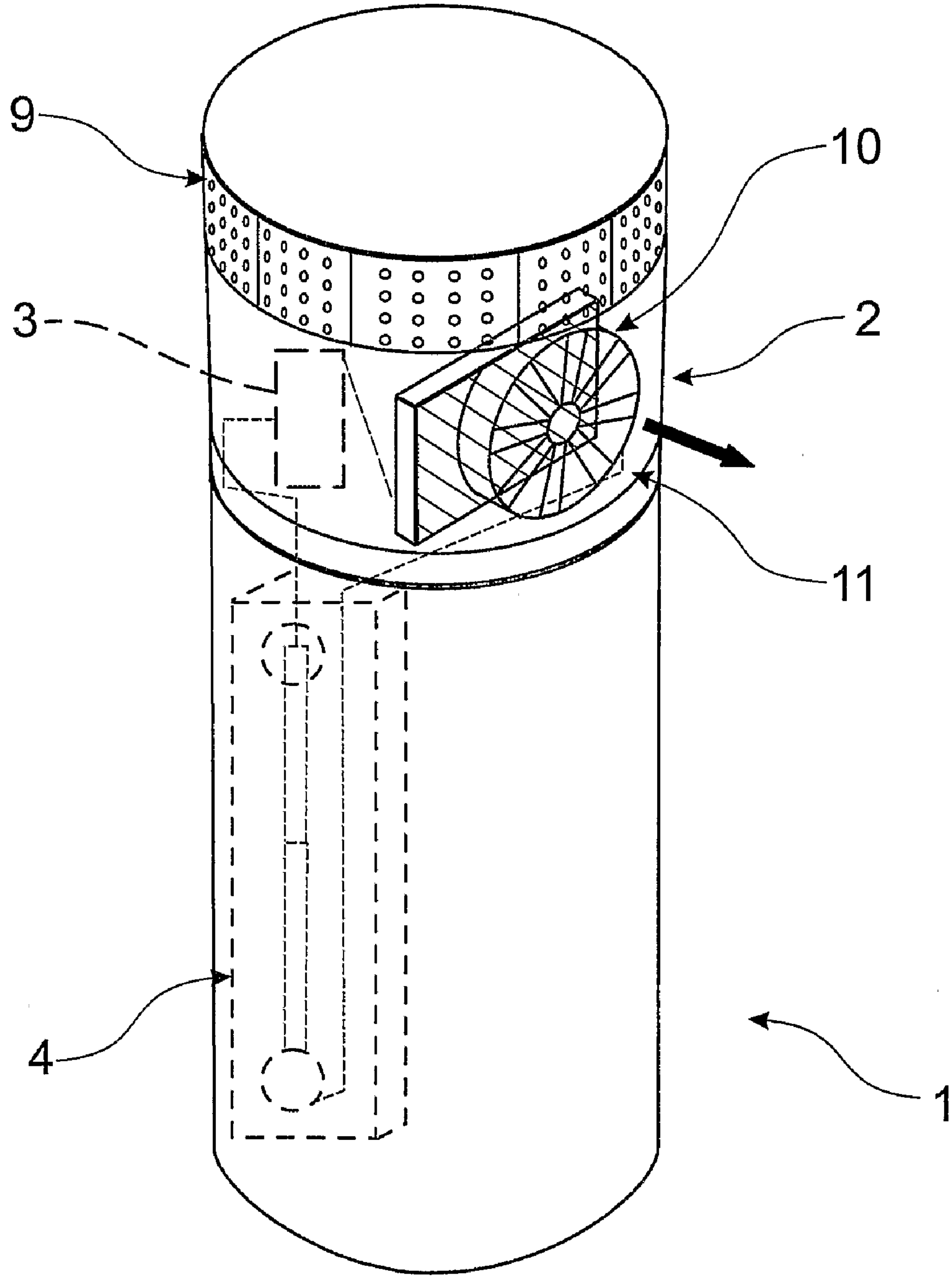


FIG. 3

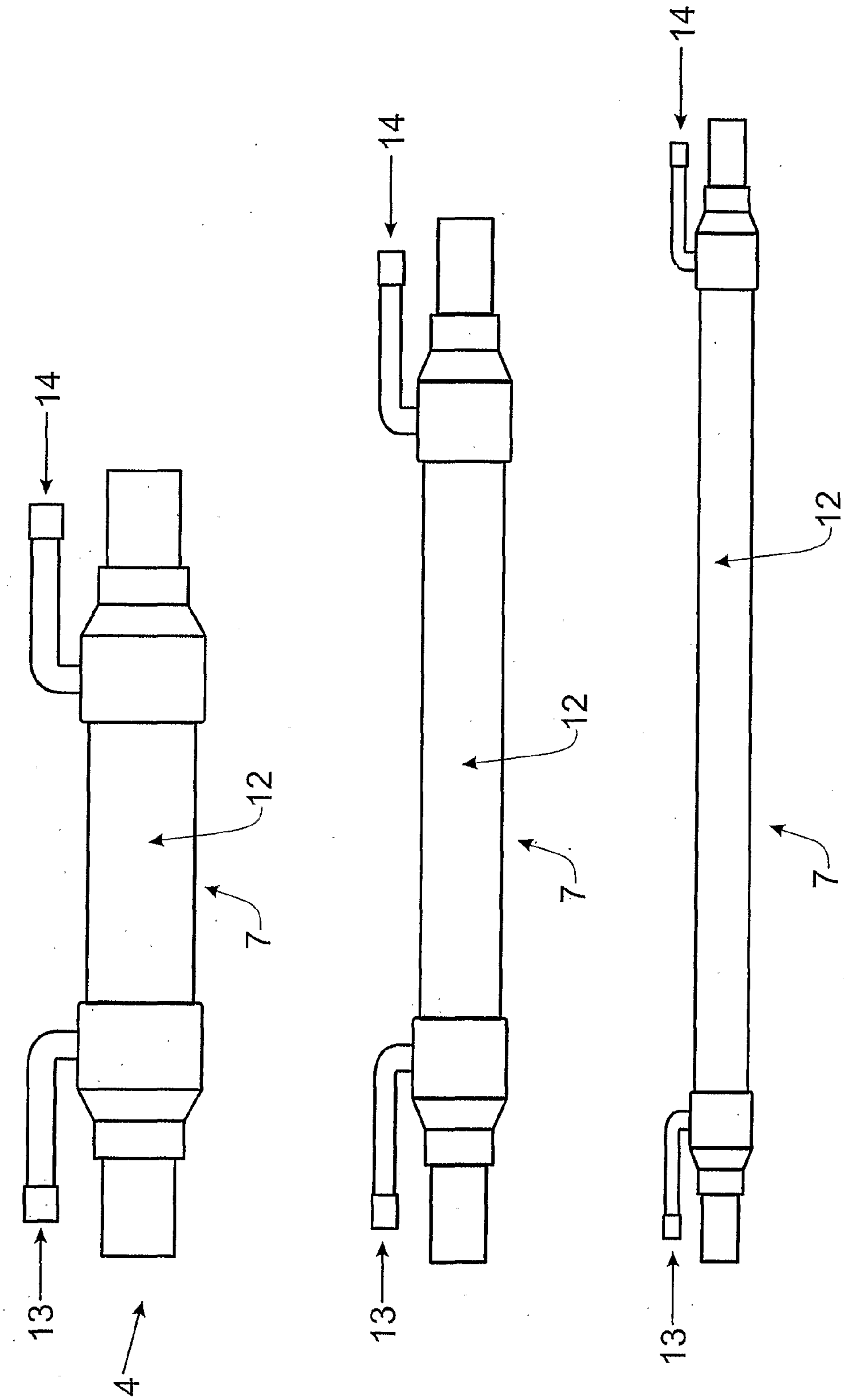


FIG. 4

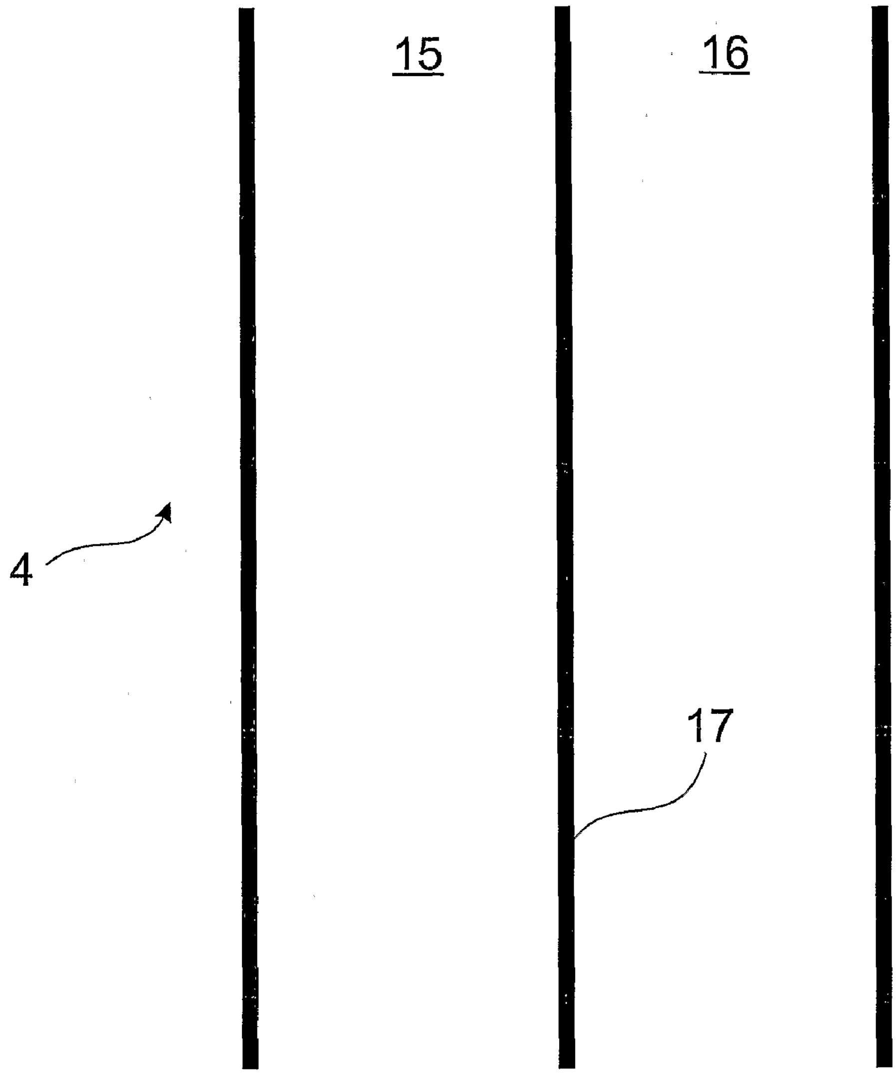


FIG. 5

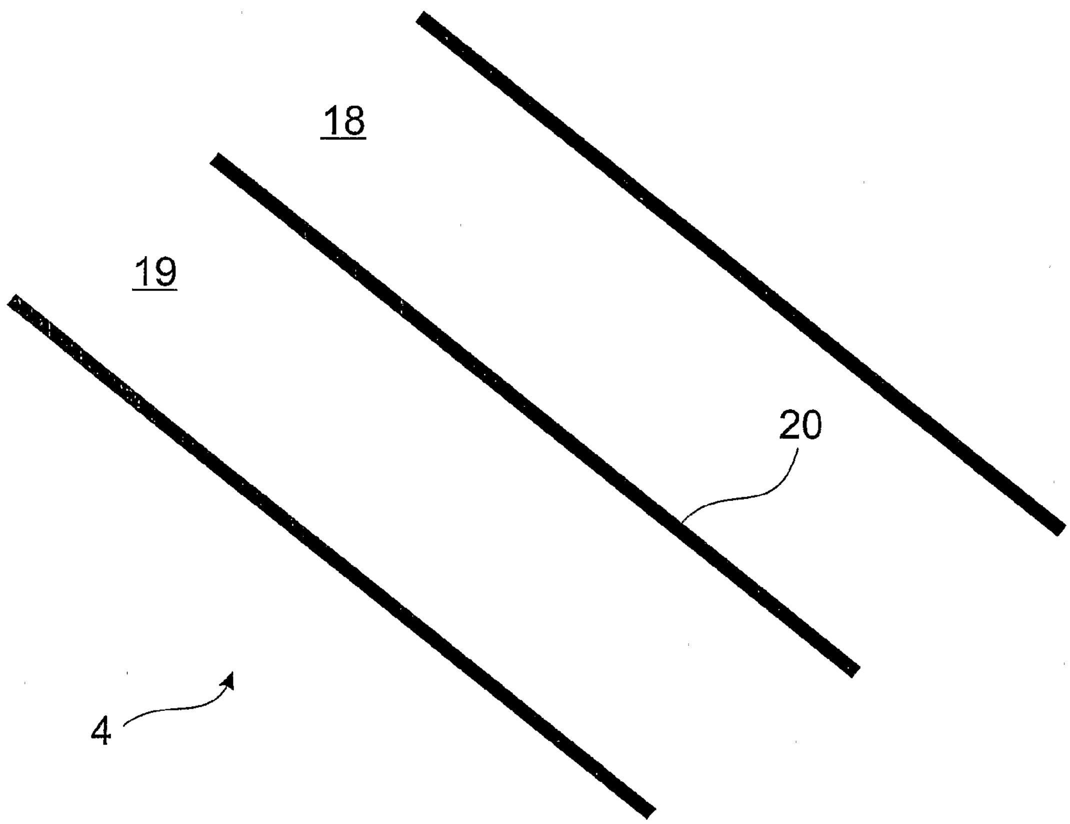


FIG. 6

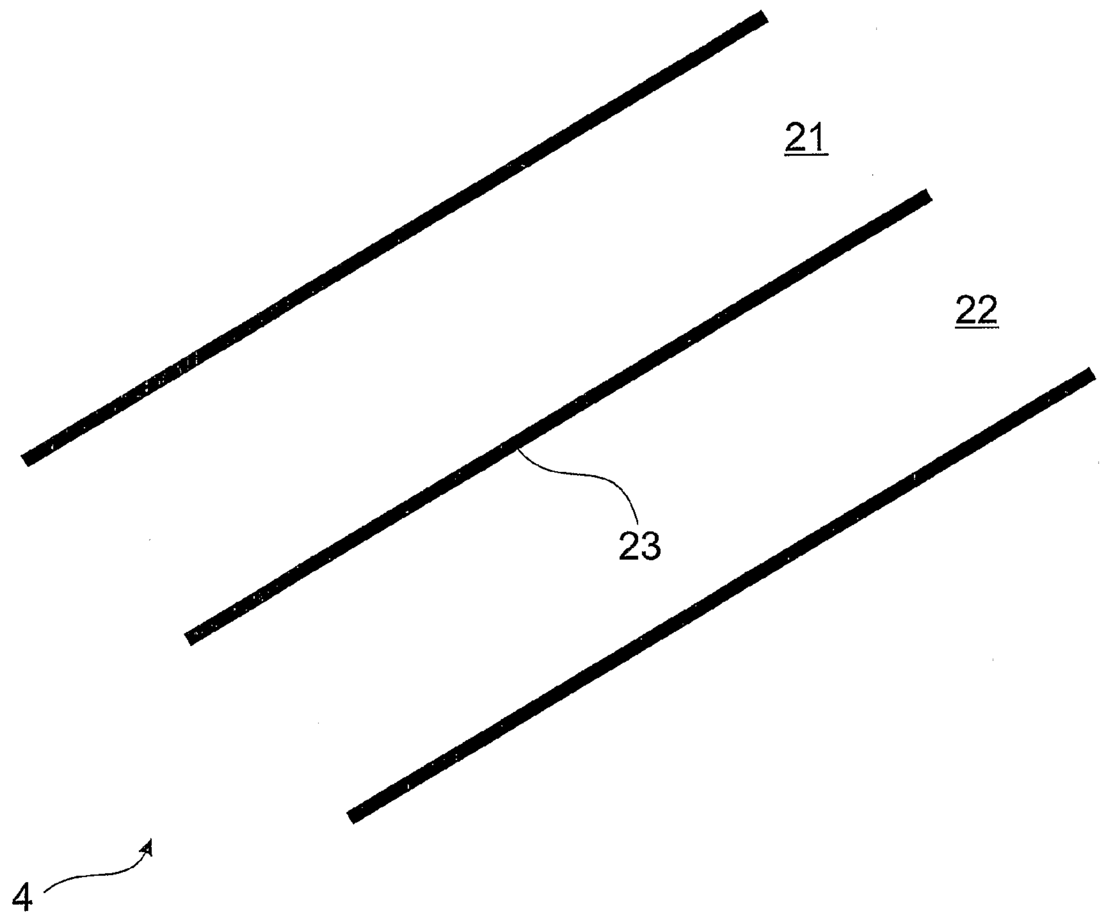


FIG. 7

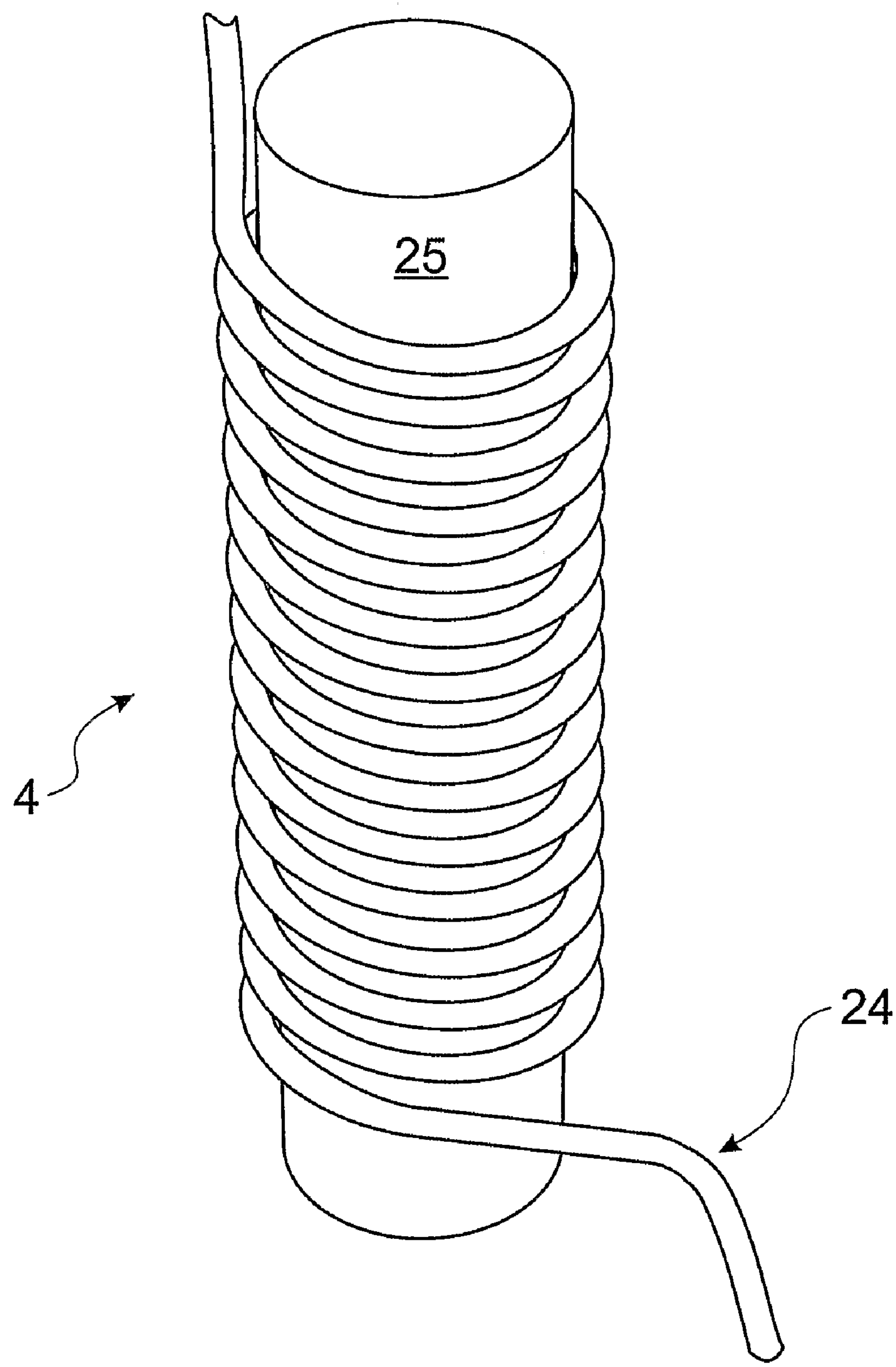


FIG. 8

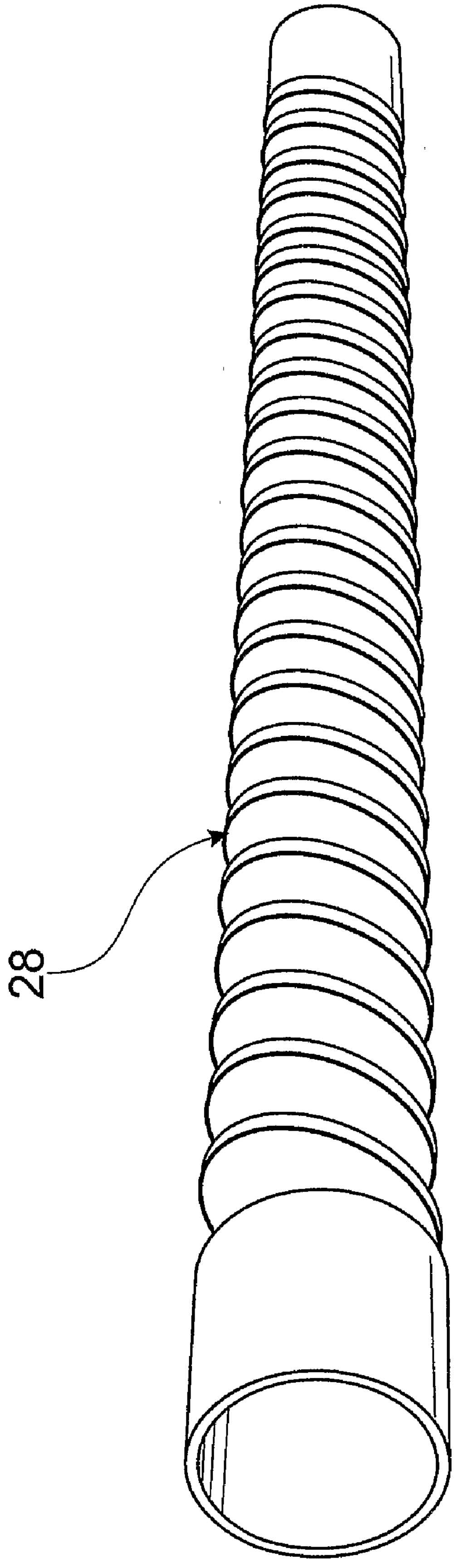


FIG. 9

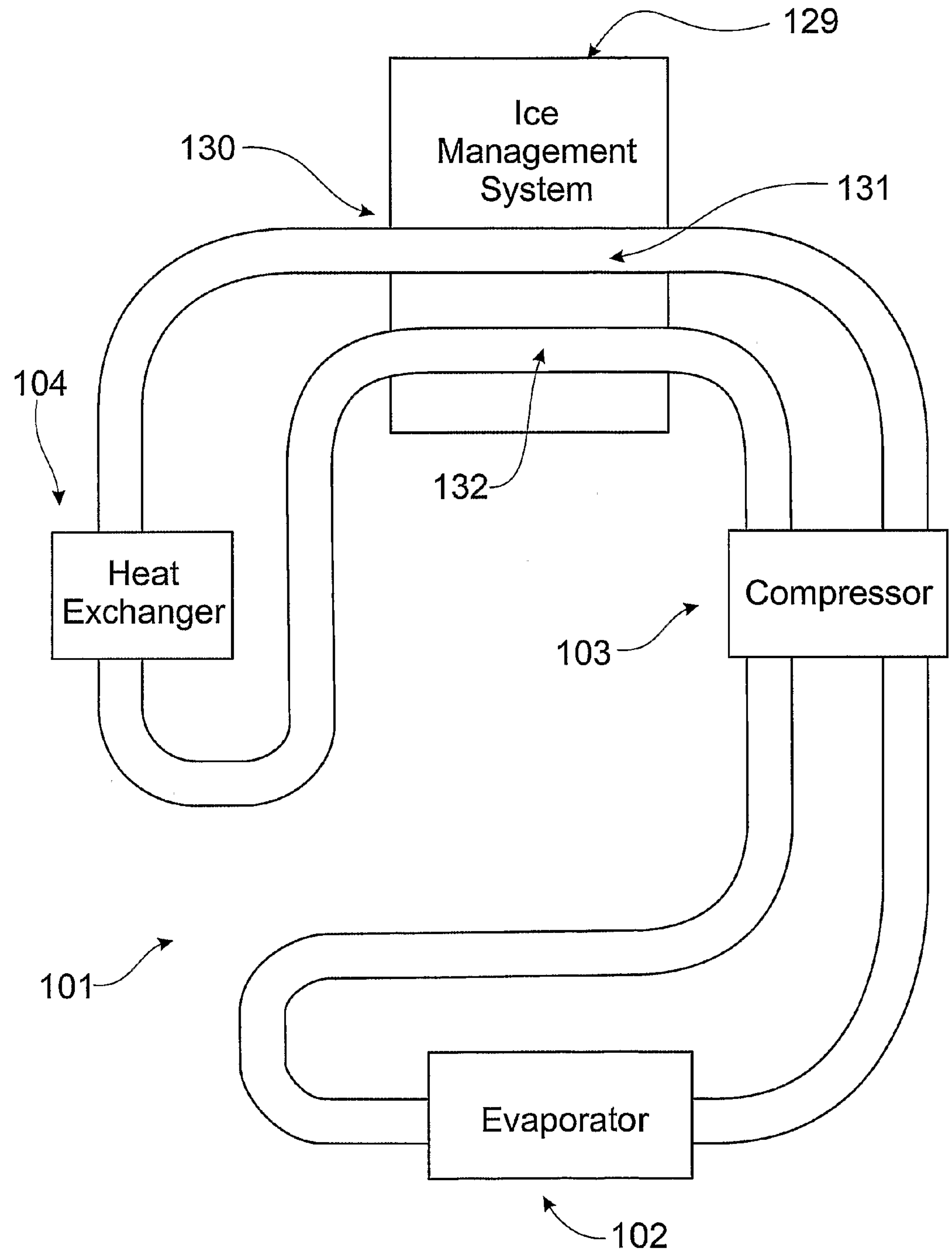

129
Ice
Management
System
130
131
104
132
Heat
Exchanger
Compressor
103
101
Evaporator
102

FIG. 10

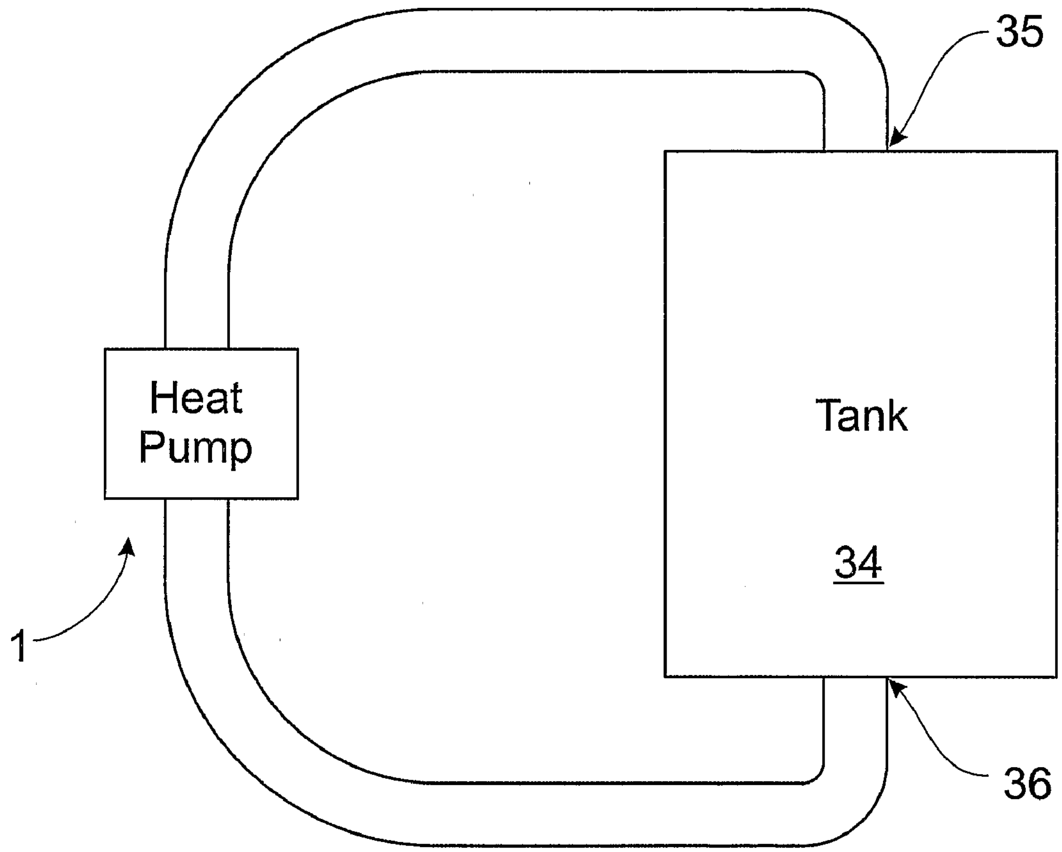


FIG. 11

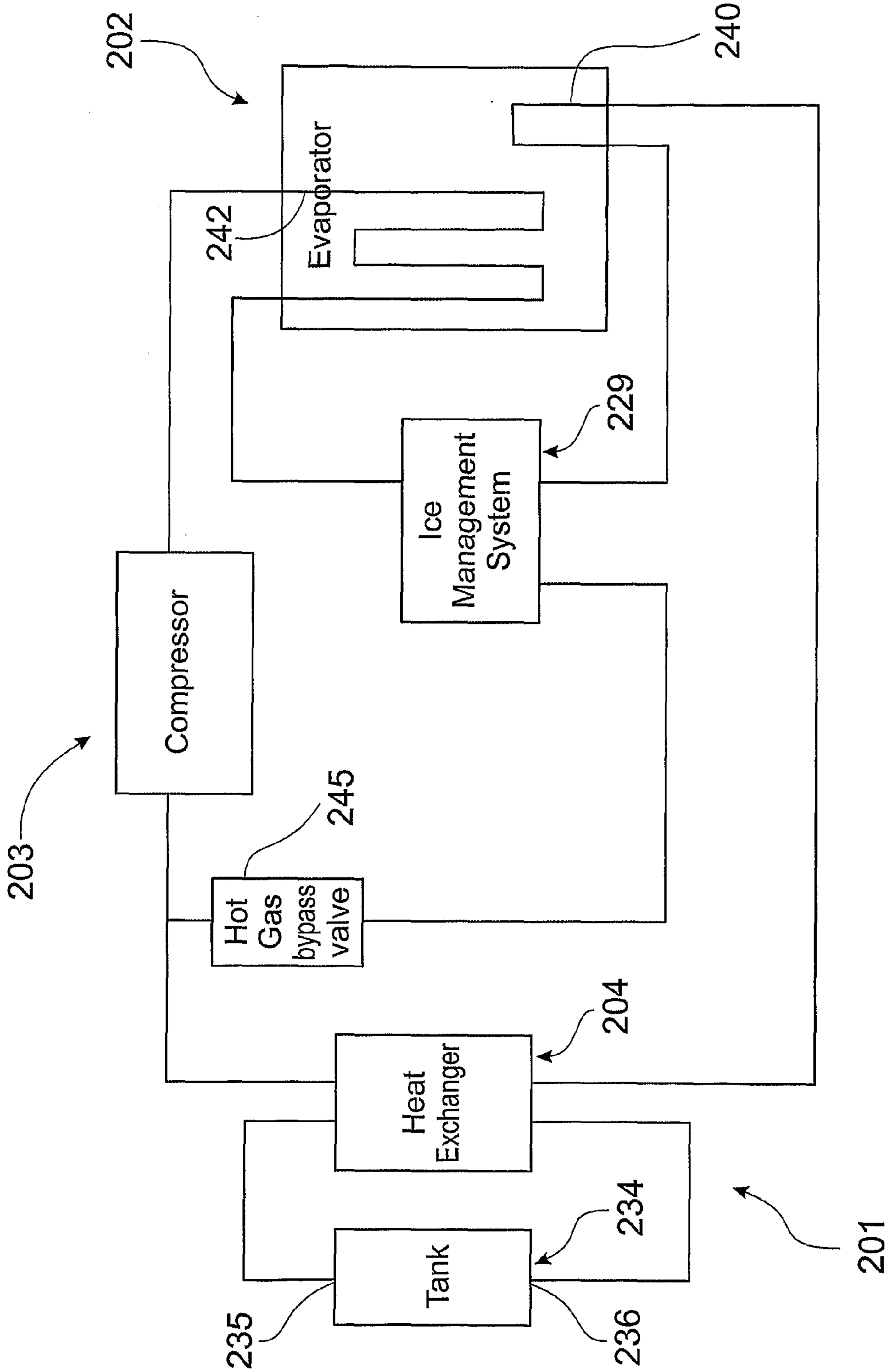

202
240
Evaporator
242
229
Ice Management System
Compressor
203
245
Hot Gas bypass valve
204
Heat Exchanger
201
234
Tank
235
236

FIG. 12

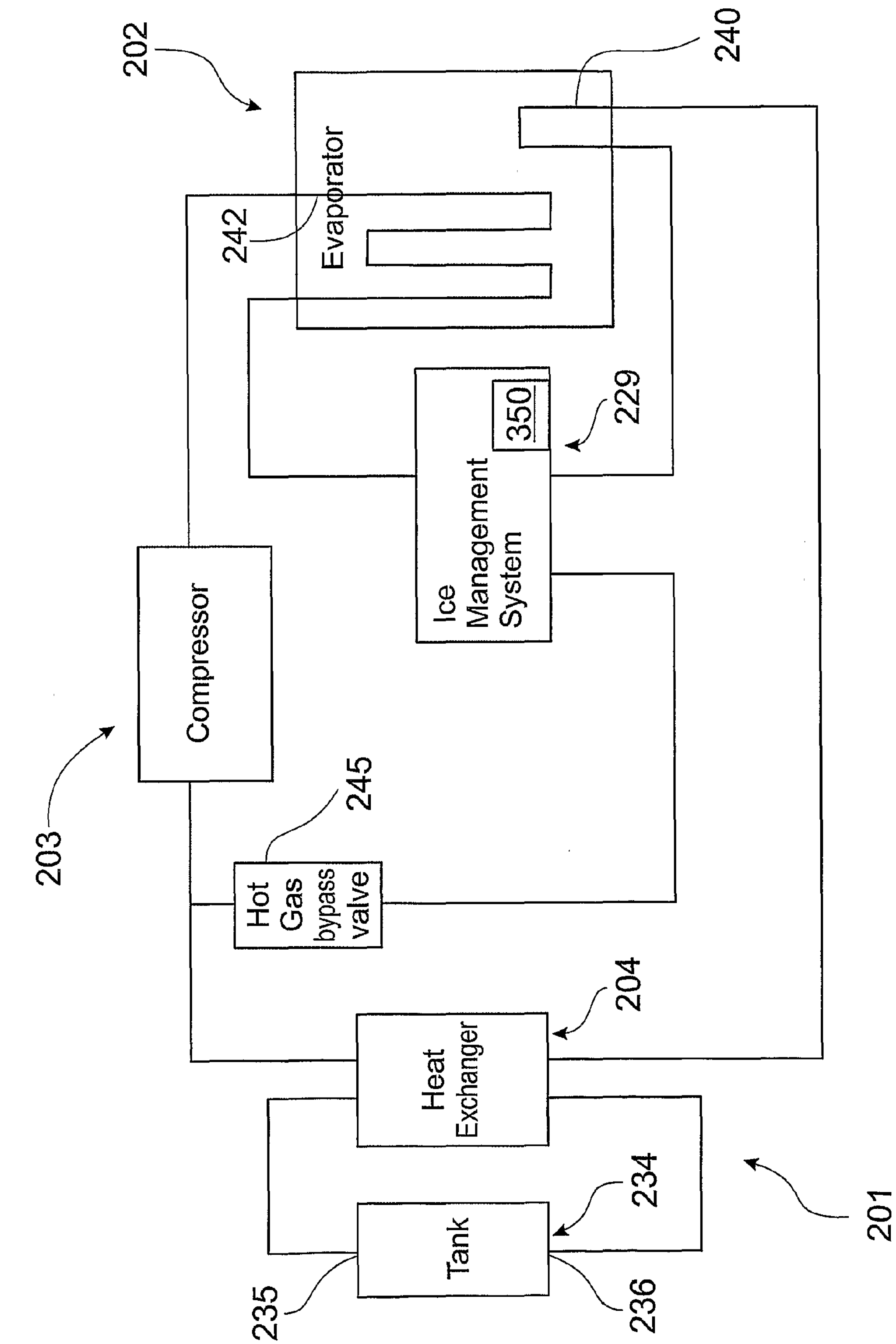

202
240
Evaporator
242
350
229
Ice
Management
System
Compressor
203
245
Hot
Gas
bypass
valve
204
Heat
Exchanger
234
Tank
201
235
236

FIG. 13

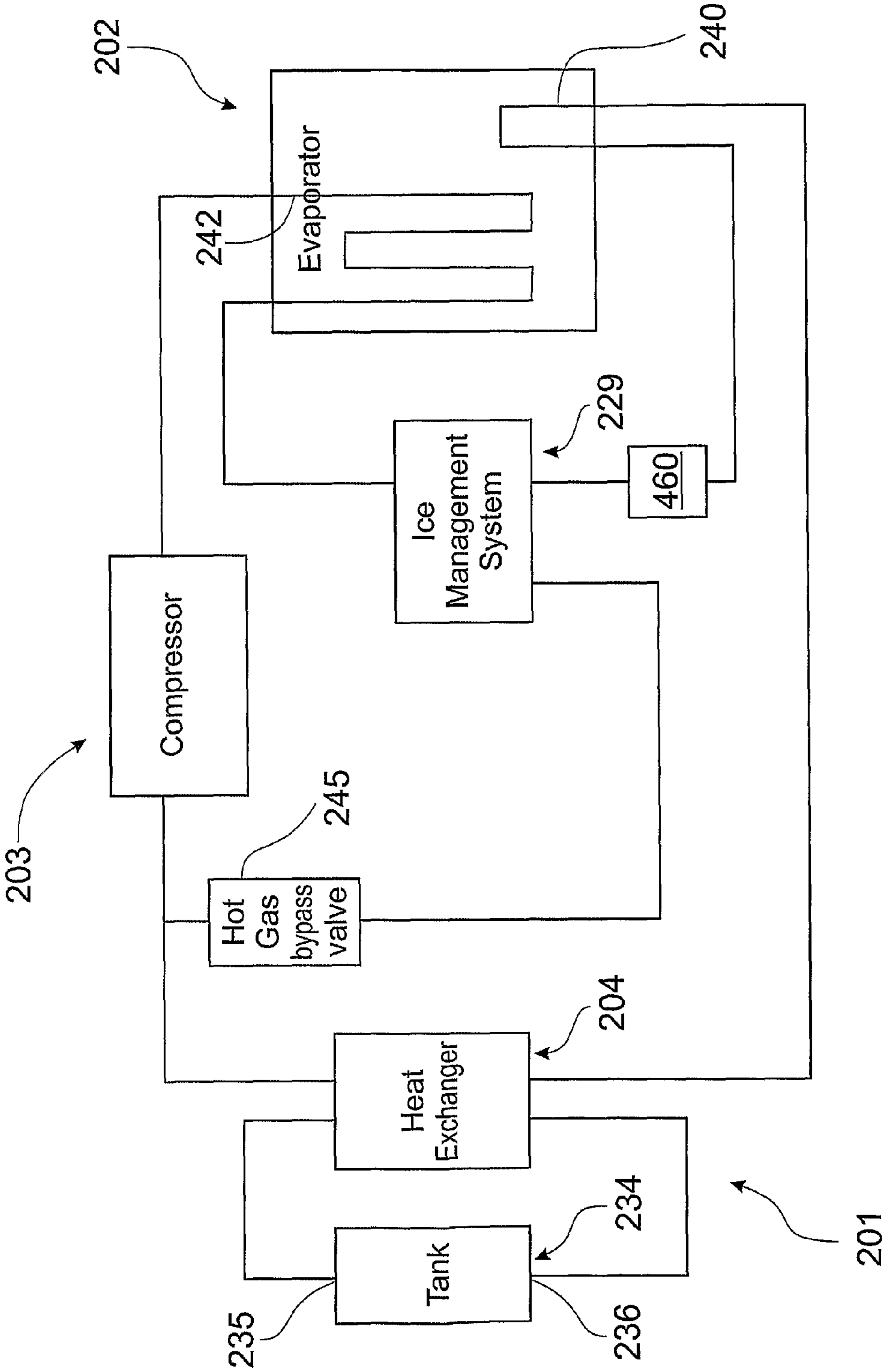

202
240
Evaporator
242
229
Ice Management System
460
Compressor
203
245
Hot Gas bypass valve
204
Heat Exchanger
234
201
Tank
235
236

FIG. 14

HEAT PUMP AND METHOD OF HEATING FLUID

FIELD OF THE INVENTION

[0001] The present invention relates to a heat pump and method of heating a fluid. In particular, but not exclusively, the present invention relates to a thermosiphonic heat pump and thermosiphonic method of heating water using heat from the atmosphere.

BACKGROUND TO THE INVENTION

[0002] Hot water is costly to produce, a cost compounded by the high cost of water heaters. Electric, solar, gas and heat pump water heaters all have disadvantages. Electric hot water systems are undesirable as they have a comparatively high cost of operation and generate considerable pollutants. Solar hot water heaters are expensive, heavily regulated in many countries and they are unable to be used in some sites, such as boutique housing developments, for aesthetic reasons. Solar water heaters usually require a booster energy source such as the non-renewable energy sources of electricity and natural gas which produce pollutants.

[0003] Natural gas is another alternative to electric water heaters however these systems also produce harmful greenhouse gases and use a non-renewable energy source.

[0004] Another method of providing hot water is heat pumps which extract heat from the surrounding atmosphere using a refrigerant gas and a compressor. Prior art heat pumps are expensive and rely on electricity to power a pump. Further the utility of prior art heat pumps is reduced as they are not capable of operating when the ambient temperature is below 10° C. which makes them unsuitable for many sites or increases their reliance on booster energy sources such as the above-mentioned non-renewable energy sources, electricity and natural gas.

[0005] Many of the water heaters in use in homes and other buildings are electric, gas or solar powered, or a combination of these. Replacing all existing hot water tanks would be an enormous cost and would take a long time to gain a favourable energy and pollution cost/benefit ratio. With this in mind it is highly desirable that any alternative for providing less costly hot water has the capacity of fitting to existing water tanks.

[0006] In this specification, the terms "comprises", "comprising" or similar terms are intended to mean a non-exclusive inclusion, such that an apparatus, method or system that comprises a list of elements does not include those elements solely, but may well include other elements not listed.

OBJECT OF THE INVENTION

[0007] It is an object of the present invention to provide a heat pump comprising a thermosiphon which is a useful commercial alternative to existing heat pumps. Further objects will be evident from the foregoing description.

SUMMARY OF THE INVENTION

[0008] In one form, although it need not be the only or indeed the broadest form, the invention resides in a heat pump comprising an evaporator that transfers heat from taken in air to a first fluid and expels the taken in air at a temperature cooler than ambient temperature, a compressor for compressing and pumping the first fluid and an improved heat exchanger, the improvement residing in the improved heat exchanger comprising a first passage for the heated compressed first fluid driven by the compressor and a second passage for a second fluid driven by thermal convection.

[0009] The inventors' novel utilization of thermosiphon technology to drive the passage of the second fluid eliminates the need for a pump to pump the second fluid which has the advantages of reducing cost, reducing energy usage and reducing both noise and green house gas pollution.

[0010] In one aspect the taken in air is heated above ambient temperature by heat generated by normal operation of the evaporator and heat is transferred from the heated taken in air to the first fluid.

[0011] In another aspect the heat pump also comprises a second heat exchanger comprising a third passage for heated compressed first fluid from the compressor and a fourth passage for compressed first fluid from the heat exchanger that has exchanged heat with the second fluid.

[0012] In still another aspect the invention further includes a storage tank filled with the second fluid.

[0013] Unlike prior art heat pumps the heat pump of the invention is capable of operating below 10° C. and even below 0° C.

[0014] In a second form the invention resides in a water heater comprising a tank and a heat pump, the heat pump comprising an evaporator that transfers heat from taken in air to a first fluid and expels the taken in air at a cooler temperature, a compressor for compressing and pumping the heated first fluid and an improved heat exchanger, the improvement residing in the heat exchanger comprising a first passage for the heated compressed first fluid driven by the compressor and a second passage for a second fluid driven by thermal convection.

[0015] In another form, the invention resides in a method of heating water including the steps of:

[0016] taking ambient air in through an evaporator;

[0017] heating a first fluid in the evaporator with the taken in air;

[0018] expelling the taken in air as relatively cool air;

[0019] compressing the heated first fluid;

[0020] pumping the heated compressed first fluid through a heat exchanger; and

[0021] heating water in the heat exchanger by exchanging heat from the heated compressed first fluid to the water whereby passage of the water is driven by thermal convection.

[0022] Further features of the present invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] By way of example only, preferred embodiments of the invention will be described more fully hereinafter with reference to the accompanying drawings in which like reference numerals refer to like elements, wherein:

[0024] FIG. **1** shows a schematic diagram of a heat pump in accordance with an embodiment of the invention;

[0025] FIG. **2** shows a schematic diagram of a portion of a heat exchanger in accordance with an embodiment of the invention;

[0026] FIG. **3** shows a cut away view of part of a heat exchanger in accordance with an embodiment of the invention;

[0027] FIG. **4** shows one embodiment of the heat exchanger of the invention illustrating the feature of different lengths and widths of the heat exchanger;

[0028] FIG. **5** shows a side by side arrangement for first and second passages in accordance with an embodiment of the heat exchanger of the invention;

[0029] FIG. **6** shows a top and bottom arrangement for first and second passages in accordance with an embodiment of the heat exchanger of the invention;

[0030] FIG. **7** shows another top and bottom arrangement for first and second passages in accordance with an embodiment of the heat exchanger of the invention;

[0031] FIG. **8** shows a coaxial arrangement for first passage and second passage of a heat exchanger in accordance with an embodiment of the invention;

[0032] FIG. **9** shows a perspective view of an inner tube of the heat exchanger in accordance with one embodiment of the invention;

[0033] FIG. **10** shows a schematic diagram of a heat pump comprising an ice management system in accordance with an embodiment of the invention;

[0034] FIG. **11** shows a schematic diagram of a heat pump fitted to a tank in accordance with an embodiment of the invention;

[0035] FIG. **12** shows a schematic diagram of a heat pump comprising an ice management system in accordance with another embodiment of the invention;

[0036] FIG. **13** shows a schematic diagram of a heat pump comprising an electrical element in accordance with another embodiment of the invention; and

[0037] FIG. **14** shows a schematic diagram of a heat pump comprising an expansion device in accordance with another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0038] Referring to FIG. **1**, there is provided a heat pump **1** comprising an evaporator **2**, a compressor **3** and a heat exchanger **4**. As best seen in FIG. **2** the heat exchanger **4** comprises a first passage **5** and a second passage **6**. A first fluid cycles through the first passage **5** and a second fluid passes through the second passage **6**. The heat exchanger **4** will be described with reference to the first passage **5** being an outer tube **7** and the second passage **6** being an inner tube **8**, however the invention is not limited to this embodiment.

[0039] FIG. **2** illustrates an embodiment of the improved heat exchanger **4** wherein the outer tube **7** and the inner tube **8** are coaxial. In this coaxial embodiment the inner tube **8** is a core and the outer tube **7** is a jacket enclosing the coaxial core.

[0040] The evaporator **2** as best seen in FIG. **3** comprises an air intake **9** and an air exhaust **10**. The embodiment depicted in FIG. **3** shows the air intake **9** additionally comprising a fan **11** which assists in the circulation of air through the heat pump **1**, however the fan **11** is not an essential element of the evaporator **2**. Air is drawn into the evaporator **2** through the air intake **9**. The taken in air is at ambient temperature and is used to heat the first fluid located inside the evaporator **2**. The heated first fluid is then pumped, by the compressor **3**, from evaporator **2** to the compressor **3**. The air that was taken into the evaporator **2** as ambient air having exchanged its heat with the first fluid is expelled from the evaporator **2** as relatively cooler air.

[0041] Advantageously, in one embodiment, like that shown in FIG. **3**, the evaporator **2** is configured so the air drawn into the evaporator **2** which is at ambient temperature passes over or through one or more area of the evaporator **2** that becomes heated during normal operation of the evaporator **2**. In this manner the drawn in ambient air becomes heated to a temperature above ambient temperature. This heating of the ambient air by operational heat occurs at no additional energy cost and further increases the efficiency and operable temperature range of the heat pump **1** over and above that of prior art heat pumps. The heated ambient air is used in the same manner as ambient air to heat the first fluid in the first passage **5**.

[0042] The compressor **3** compresses the heated first fluid which has the effect of further heating the first fluid. The heated compressed first fluid is then pumped, by compressor **3**, from the compressor **3** to the heat exchanger **4**.

[0043] It is understood that the first fluid may be gas or liquid and phase depends on pressure and temperature. Therefore the phase of the first fluid is dependent on the temperature and pressure at each point in the heat pump **1**. However, for ease of description, from exiting the compressor **3** until entering the evaporator **2** the first fluid will be referred to as "compressed first fluid" and from exiting the evaporator **2**, where it is decompressed, until entry into the compressor **3** the first fluid will be referred to as "first fluid". In a preferred embodiment the first fluid is a refrigerant.

[0044] The coaxial arrangement of the outer tube **7** and the inner tube **8** depicted in FIG. **2** allows efficient heat exchange between the first fluid and the second fluid. The hollow construction of the outer tube **7** allows the first fluid to pass therethrough, as driven by compressor **3**. The inner tube **8** is also of hollow construction and forms a convection path that allows the passage of the second fluid through the second passage **6** to be driven by thermal convection. The motion of the second fluid by thermal convection is termed thermosiphoning and is a consequence of the heat exchange between the heated compressed first fluid entering the outer tube **7** and the second fluid passaging through the inner tube **8**.

[0045] The heated compressed first fluid entering the outer tube **7** exchanges heat with the second fluid and exits the outer tube **7** as cool compressed first fluid. The second fluid enters the inner tube **8** as relatively cool second fluid and exits the inner tube **8** as heated second fluid.

[0046] The cool compressed first fluid is pumped out of the outer tube **7** and returns to the evaporator **2** where it is decompressed. After decompression the cool first fluid is again heated in the evaporator **2** by taken in air and the above-described heat-exchange process continues in a cycle with the cycling of the first fluid driven by the compressor **3** and the passage of the second fluid driven by convection.

[0047] Like the taken in air, any vapour produced during decompression of the heated relatively cool first fluid is expelled through the air exhaust **10**.

[0048] The heat pump **1** of the invention functions to heat a pump-driven first fluid, for example a refrigerant, through extracting heat from ambient air and in turn heating a thermosiphon-driven second fluid, for example water, by exchanging heat from the first fluid to the second fluid. In one form the heat pump **1** is a refrigerant heating system. The pumping force required to pump the first fluid through the heat pump **1** is provided by the compressor **3**. However, beneficially in one embodiment the heat pump **1** can also comprise a pump, not shown, to provide additional pumping force.

[0049] The coaxial arrangement of the first passage **5** and second passage **6** described above and illustrated in FIG. **2** is a particularly efficient arrangement for heat exchange from the first fluid to the second fluid. FIG. **4** illustrates another feature of the coaxial embodiment of the heat exchanger **4**

wherein the inner tube length **12** is located entirely within the outer tube **7**, while the inner tube inlet **13** and the inner tube outlet **14** are located external to the outer tube **7**.

[0050] The above refrigerant heating cycle has been described with reference to the first fluid being pumped through the first passage **5** of the heat exchanger **4** and the second fluid passing through the second passage **6** of the heat exchanger **4** driven by a thermosiphon. It is understood that the passage of the first and second fluids could be swapped, with the first fluid being pumped through the second passage **6** of the heat exchanger **4** and the second fluid passing through the first passage **5** of the heat exchanger **4** driven by thermal convection. In this alternate configuration the flow of the first fluid and second fluids must be designed with regard to the second fluid rising when heated as driven by thermal convection. Likewise, the alternate coaxial arrangement wherein the first passage **5** of the heat exchanger **4** is the inner tube **8** and the second passage **6** of the heat exchanger **4** is an outer tube **7** is also encompassed in coaxial embodiments of the heat exchanger **4**.

[0051] The coaxial arrangement of the outer tube **7** and the inner tube **8** depicted in FIG. **2** allows efficient heat exchange between the first fluid and the second fluid. It is not a requirement that the first passage **5** and the second passage **6** be arranged coaxially, any arrangement of the first passage **5** and second passage **6** allowing heat transfer from the first fluid to the second fluid and thermal convection of the second fluid (thermosiphoning) is encompassed. Illustrative further examples of adjacent or proximal first passage **5** and second passage **6** arrangements are shown in FIGS. **5-8**.

[0052] FIG. **5** shows a side-by-side embodiment of the heat exchanger **4** in which the first passage **5** comprises a left hand side tube **15** and the second passage **6** comprises a right hand side tube **16**. FIG. **6** shows another heat exchanger **4** embodiment in which the first passage **5** comprises a top tube **18** and the second passage **6** comprises a bottom tube **19**. FIG. **7** shows a similar top and bottom heat exchanger **4** arrangement in which the first passage **5** comprises a top tube **21** and the second passage **6** comprises a bottom tube **22**. The embodiments depicted in FIG. **6** and FIG. **7** differ in that FIG. **6** illustrates a top and bottom arrangement at an angle greater than 900 with respect to vertical and FIG. **7** illustrates a top and bottom arrangement at an angle less than 900 with respect to vertical.

[0053] Another suitable arrangement is depicted in FIG. **8** wherein the first passage **5** and second passage **6** are coaxial and the outer first passage comprises an encircling outer tube **24** forming a series of concentric rings wound around the second passage which comprises an inner core tube **25**.

[0054] To further increase the efficiency of heat exchange in some embodiments the surface(s) across which heat exchange takes place are in direct contact. Such an embodiment is shown in FIG. **8** wherein the surface of the encircling outer tube **24** is in direct contact with the surface of the inner core tube **25**.

[0055] To still further increase the efficiency of heat exchange the first passage **5** and second passage **6** in some embodiments share a wall, as depicted in FIGS. **2** and **5-7**. FIG. **2** shows a common wall **26** which forms the inner surface of the outer tube **7** and the outer surface of the inner tube **8**. Similarly, common wall **17**, common wall **20** and common wall **23** are depicted in FIGS. **5**, **6** and **7** respectively. The common walls **26**, **17**, **20** and **23** are walls across which heat exchange from the first fluid to the second fluid occurs. In the shared wall embodiment the first fluid and the second fluid pass across opposing surfaces of the common wall **26**, **17**, **20**, **23**. Advantageously, the efficient heat exchange of the common wall embodiment can also be achieved in the side-by-side arrangement as shown in FIG. **5** and in the top-and-bottom arrangement as shown in FIGS. **6** and **7**.

[0056] To still further increase the efficiency of heat exchange the first passage **5** and second passage **6** of the heat exchanger **4** are constructed in one-piece and the surfaces of the first passage **5** and the second passage **6** across which heat exchange occurs are constructed in a shape that increases the surface area of the surface(s) across which heat exchange takes place. Suitable shapes for increasing the surface area of the first passage **5** and the second passage **6** are the ribbed shape **27** depicted in FIG. **2** and the raised spiral shape **28** depicted in FIG. **9**.

[0057] For efficient thermosiphoning the second passage **6** is positioned so that the second passage **6** runs vertically, or close to vertical. Such a vertical embodiment is shown in FIG. **5**. In other embodiments the second passage **6** is positioned within ±45° from vertical. Embodiments wherein the second passage lies at an angle vertical ±45° from vertical are shown in FIGS. **6** and **7**.

[0058] In preferable embodiments to increase the heat exchange between the first fluid and the second fluid the fluids flow in opposite directions, i.e. the flows of the first and second fluid are counter-current. In this counter-current embodiment the second passage **6** must be positioned in an orientation that allows the second fluid to be driven by thermal convection alone.

[0059] A disadvantage of prior art heat pumps is that they cannot operate effectively below 10° C. where the heat pump evaporator develops ice. The conventional solution to eliminate ice, like that adopted in air conditioners, is to commence a reverse cycle. This however is undesirable in water heating as it would cool the water and in embodiments where the heat pump is fitted to a tank, such as described below, would cycle cold water into the water storage tank.

[0060] FIG. **10** shows heat pump **101**, which incorporates an ice management system **129**, that makes operation below 10° C. possible.

[0061] The ice management system **129** comprises a second heat exchanger **130** which comprises a third passage **131** through which heated compressed first fluid that has exited the compressor **103** passes as driven by the pumping action of the compressor **103**. The second heat exchanger **130** also comprises a fourth passage **132** through which cool compressed first fluid that has exited the heat exchanger **104** passes and is also pumped by compressor **103**.

[0062] In the second heat exchanger **130** the heated compressed first fluid exchanges heat with the cool compressed first fluid. Therefore the first fluid exiting the third passage **131** is relatively cool heated compressed first fluid and the first fluid exiting the fourth passage **132** is relatively warm cool compressed first fluid. It is to be understood that the relatively cool heated compressed first fluid is not cool per se and is only relatively cool compared to the heated compressed first fluid. The relatively cool heated compressed first fluid can function in the heat exchanger **104** to exchange heat with the second fluid to produce heated second fluid.

[0063] The heating in the third passage **131** of the cool compressed first fluid to relatively warm cool compressed first fluid reduces the incidence of ice production and has the significant effect of allowing the heat pump **101** to operate effectively at temperatures as low as 0° C. to 4° C.

[0064] In another embodiment the ice management system **129** further comprises a constant pressure/temperature valve (not shown) that detects the temperature of the first fluid at entry to the evaporator **102**. The constant pressure/temperature valve functions to operate the ice management system **129** when the temperature of the circulating first fluid entering the evaporator **102** falls below a set pressure/temperature. In one embodiment the constant pressure/temperature valve functions to operate the ice management system **129** when the compressed first fluid entering the evaporator **102** is at a pressure between about 300-25000 kpa. In another embodiment the constant pressure/temperature valve functions to operate the ice management system **129** when the compressed first fluid entering the evaporator **102** is at a temperature less than 10° C., or at a temperature between about 0 and 10° C.

[0065] The efficiency and the low temperature operability of the heat pump **1**, **101**, and heat pumps described below can be further increased by utilizing a low boiling point refrigerant as the first fluid. Prior art heat pumps use air conditioning refrigerant as the first fluid giving hot water at about 55° C. The heat pump **1**, **101** and heat pumps described below, are designed to use either conventional refrigerants, such as air conditioning refrigerants, or to use a lower boiling point refrigerant. Utilization of a lower boiling point refrigerant produces higher condensing temperatures and generates the benefit of hotter water.

[0066] The heat pump **1** has an expected average coefficient of performance (COP) at 55° C. of 3 to 3.2 which is equivalent to other domestic hot water heat pumps. At 65° C. the expected COP of the heat pump **1** is about 2.

[0067] A further important advance made by the present inventors is the circumvention of superheating of the first fluid which occurs in prior art heat pumps. Prior art heat pumps when fitted to a water tank return the first fluid from the heat exchanger to the compressor directly adjacent to the hottest second fluid which sends the first fluid to the evaporator hotter than is desirable and is inefficient. The inventors prevent superheating of the first fluid by advantageously locating the heat pump **1**, **101** and the heat pumps described below, external to the tank and by insulating the path of the first fluid. FIG. **11** depicts an embodiment of the heat pump **1** located external to the tank **34**.

[0068] A feature of the heat pump **1**, **101** and the heat pumps described below of great benefit is that they are suitable for easy retrofit installation on existing water storage tanks, such as domestic water tanks and including domestic water tanks with a capacity of, for example, 80, 125, 160, 180, and 250 litres or greater. The heat pump **1**, **101** and those described below are easily retrofitted, via for example T-pieces, to water tanks with a separate flow outlet and return inlets. Additionally, the heat pump **1**, **101** and those described below are suitable for installation onto existing water tanks that do not comprise a separate flow outlet and return inlet.

[0069] When used in conjunction with a tank the heat pump **1**, **101** and those described below, will draw the second fluid, for example water, from the tank. As shown in FIG. **11** the tank **34** comprises a tank inlet **35** and a tank outlet **36**. The tank inlet **35** and the tank outlet **36** are connected to the second passage **6** of the heat exchanger **4**. The second fluid, for example water, stored in the tank **34** exits the tank **34** through the tank outlet **36**, enters the second passage **6** of the heat exchanger **4** where it is heated and is returned to the tank **34** as heated second fluid through the tank inlet **35**. As described above, when the second fluid passes through the second passage **6** it is heated by heated compressed first fluid cycling through the first passage **5** of the heat exchanger **4** and the passage of the second fluid is driven by convection. Therefore the second fluid that returns to the tank **34** has been heated by heat from the first fluid.

[0070] The circular heating motion of the second fluid from the tank **34** through the heat exchanger **4** and back to the tank **34** is driven by thermal convection so that the greater the difference in temperature between the water in the heat exchanger **4** and the water in the storage tank **34**, the faster the flow between them.

[0071] As shown in FIG. **11**, to maximise efficiency of the thermosiphon the tank **34** preferably has the tank outlet **36** located at the bottom of the tank **34** and the tank inlet **35** located at the top of tank **34**. In this arrangement the heat exchanger **4** can be conveniently mounted onto the side of the tank **34** with the second passage **6** positioned vertically, or close to vertically, i.e. within ±45° of vertical.

[0072] FIG. **12** shows another embodiment of a heat pump **201** that comprises an ice management system **229**. As with the heat pumps **1**, **101** described above, the passage of the first fluid in heat pump **201** is cyclical. The cycle of the first fluid in heat pump **201** is described below.

[0073] After exchanging heat with the second fluid in heat exchanger **204**, the first fluid is cooled in a cooling loop **240** of evaporator **202**. To efficiently cool the second fluid the cooling loop **240** may be positioned so that the relatively cooler air that has exchanged its heat with the first fluid flows over it. This cooling of the first gas draws heat out of heat pump **201** and increases the efficiency of the heating of the first fluid in the evaporator **202**.

[0074] After exiting the evaporator **202** the first fluid passes through ice management system **229**, which functions similarly to ice management system **29** and can also be turned on and off with fluctuations in ambient temperature. When ice management system **229** is functioning the first fluid that has exited the evaporator **202** will be heated in the ice management system **229** by the first fluid that has exited compressor **203**.

[0075] The first fluid exits the ice management system **229**, is heated in heating loop **242** of evaporator **202** by taken in ambient air and is then pumped through compressor **203**.

[0076] Next if the ice management system is operating hot gas bypass valve **245** will direct a portion of the heated compressed first fluid through the ice management system **229** to mix with and heat the first fluid that has exited the cooling loop **240**. The heated mixed first fluid then proceeds into the heating loop **242**. A person of skill in the art is readily able to select an appropriate portion of the heated compressed first fluid to direct through the ice management system **229**. The portion may be, for example, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, 20%, 30%, 40% or 50% In one embodiment the portion is up to 20% is used.

[0077] The heated compressed first fluid that is not directed by the valve **245** to the ice management system **229** passes through the heat exchanger **204** where it heats the second fluid from tank **234**.

[0078] The cooling loop **240** and heating loop **242** are shown to comprise two and four longitudinal segments respectively. A person of skill in the art is readily able to choose an appropriate number of longitudinal and lateral segments.

[0079] The ice management system **329** shown in FIG. **13** comprises a low wattage electrical element **350** that is switched on and heats up when the ambient air temperature is ≦5° C. The switching on and off of the electrical element **350** may be controlled electronically and automatically using a temperature sensor to detect the ambient air temperature. The heating of the electrical element **350** heats the first fluid in the ice management system **329**.

[0080] In one embodiment the presence of electrical element **350** allows the elimination of bypass valve **245**.

[0081] At temperatures ≦5° C. the speed of the fan (not shown) in the evaporator **302** may also be increased.

[0082] The heat pump **201** shown in FIG. **14** comprises an expansion device **460** which operates to reduce the pressure of the first fluid which thereby cools the first fluid. This cooling of the first gas draws heat out the heat pump **401** and increases the efficiency of the heating of the first fluid in the evaporator **442**. In one embodiment the expansion device **460** is a Tx valve and in another embodiment is a capillary tube.

[0083] The inventors have shown that heat pump **201** operates effectively at −1° C.

[0084] Other tests by the inventors have also shown that an electrical element **350** drawing only 300 watts operates effectively in heat pump **301**. This compares favourably with prior art heat pumps which require 3 000-3 600 watts to operate.

[0085] The invention also encompasses a method of heating water using the heat pump **1**, **101**, **201** described above to heat water.

[0086] In addition to encompassing a method of heating water the invention encompasses a system for heating water comprising a means for taking in ambient air, heating a first fluid with the taken in air and expelling the taken in air as relatively cooler air, a means for compressing the heated first fluid and for pumping the heated compressed first fluid through a heat exchanger, and an improved means for heating water wherein the improvement resides in the water being propelled through the improved heat exchanger by thermal convection and the water is heated by the heated compressed first fluid.

[0087] Hence, the heat pump **1**, **101**, **201**, method and system of using the heat pump **1**, **101**, **201** provide a solution to the problems of reducing reliance on non-renewable energy resources, reducing pollution and providing low cost hot water by virtue of the inventors novel utilization of the natural thermal convection of thermosiphon technology to passage fluids such as water.

[0088] Further, the heat pump **1**, **101**, **201** and method and system of the invention are operable at lower temperatures than prior art heat pumps which extends the use of heat pumps into hitherto unworkable locations.

[0089] The retrofittable aspect of the invention has the further advantages of reducing cost of replacement as storage tanks are not required to be replaced and space is saved as the heat pump **1**, **101**, **201** of the invention can be mounted on existing tanks.

[0090] Throughout the specification the aim has been to describe the invention without limiting the invention to any one embodiment or specific collection of features. Persons skilled in the relevant art may realize variations from the specific embodiments that will nonetheless fall within the scope of the invention.

1. A heat pump comprising an evaporator that transfers heat from taken in air to a first fluid and expels the taken in air that has exchanged heat at a temperature cooler than ambient temperature, a compressor for compressing and pumping the first fluid and an improved heat exchanger, the improvement residing in the improved heat exchanger comprising a first passage for the heated compressed first fluid driven by the compressor and a second passage for a second fluid driven by thermal convection.

2. The heat pump according to claim **1** wherein the taken in air is heated above ambient temperature by heat generated by normal operation of the evaporator and heat is transferred from the heated taken in air to the first fluid.

3. The heat pump according to claim **1** wherein the first passage and second passage are coaxial.

4. The heat pump according to claim **1** wherein the first passage and second passage are side by side.

5. The heat pump according to claim **1** wherein the first passage and second passage share a common wall.

6. The heat pump according to claim **5** wherein the common wall is ribbed.

7. The heat pump according to claim **5** wherein the common wall comprises a raised spiral.

8. The heat pump according to claim **1** wherein the evaporator further comprises a cooling loop.

9. The heat pump according to claim **8** wherein the cooling loop is positioned to be exposed to the air that has exchanged heat.

10. The heat pump according to claim **1** further comprising a second heat exchanger that receives heated compressed first fluid from the compressor and compressed first fluid from the heat exchanger.

11. The heat pump according to claim **10** wherein a valve controls flow of the first fluid from the compressor to the second heat exchanger.

12. The heat pump according to claim **10** wherein the second heat exchanger further comprises a third passage for heated compressed first fluid from the compressor and a fourth passage for compressed first fluid from the heat exchanger that has exchanged heat with the second fluid.

13. The heat pump according to claim **10** wherein the heated compressed first fluid from the compressor and the compressed first fluid from the heat exchanger mix in the second heat exchanger.

14. The heat pump according to claim **10** wherein the second heat exchanger further comprises an electrical element.

15. The heat pump according to claim **10** wherein a valve is positioned between the first heat exchanger and the evaporator to allow pressure of the first fluid to be reduced.

16. The heat pump according to claim **15** wherein the valve is a Tx valve.

17. The heat pump according to claim **10** wherein a capillary tube is positioned between the first heat exchanger and the evaporator to allow pressure of the first fluid to be reduce.

18. The heat pump according to claim **1** further comprising a storage tank filled with the second fluid.

19. A water heater comprising a tank and a heat pump, the heat pump comprising an evaporator that transfers heat from taken in air to a first fluid and expels the taken in air that has exchanged heat at a cooler temperature, a compressor for compressing and pumping the heated first fluid and an improved heat exchanger, the improvement residing in the heat exchanger comprising a first passage for the heated compressed first fluid driven by the compressor and a second passage for a second fluid driven by thermal convection.

20. A method of heating water including the steps of:
- taking ambient air in through an evaporator;
- heating a first fluid in the evaporator with the taken in air;
- expelling the taken in air as relatively cool air;
- compressing the heated first fluid;
- pumping the heated compressed first fluid through a heat exchanger; and
- heating the water in the heat exchanger by exchanging heat from the heated compressed first fluid to the water whereby passage of the water is driven by thermal convection.

21. The method of claim **20** further including the step of heating the first fluid with the heated compressed first fluid.

22. The method of claim **21** further comprising reducing the pressure of the first fluid.

23. A system for heating water comprising:
- a means for taking in ambient air, heating a first fluid with the taken in air and expelling the taken in air as relatively cooler air;
- a means for compressing the heated first fluid and for pumping the heated compressed first fluid through a heat exchanger; and
- a means for heating water;

wherein the water is heated by the heated compressed first fluid and the water is propelled by thermal convection.

24. The system of claim **23** further comprising a means for heating the first fluid with the heated compressed first fluid.

25. The system of claim **23** further comprising a means for reducing the pressure of the first fluid.

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