US 20120102985A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2012/0102985 A1
(43) Pub. Date: May 3, 2012
Tafoya et al.

(54) **CONDUCTIVE SURFACE HEATER FOR A REFRIGERATOR**

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(21) Appl. No.: **12/912,920**

(22) Filed: **Oct. 27, 2010**

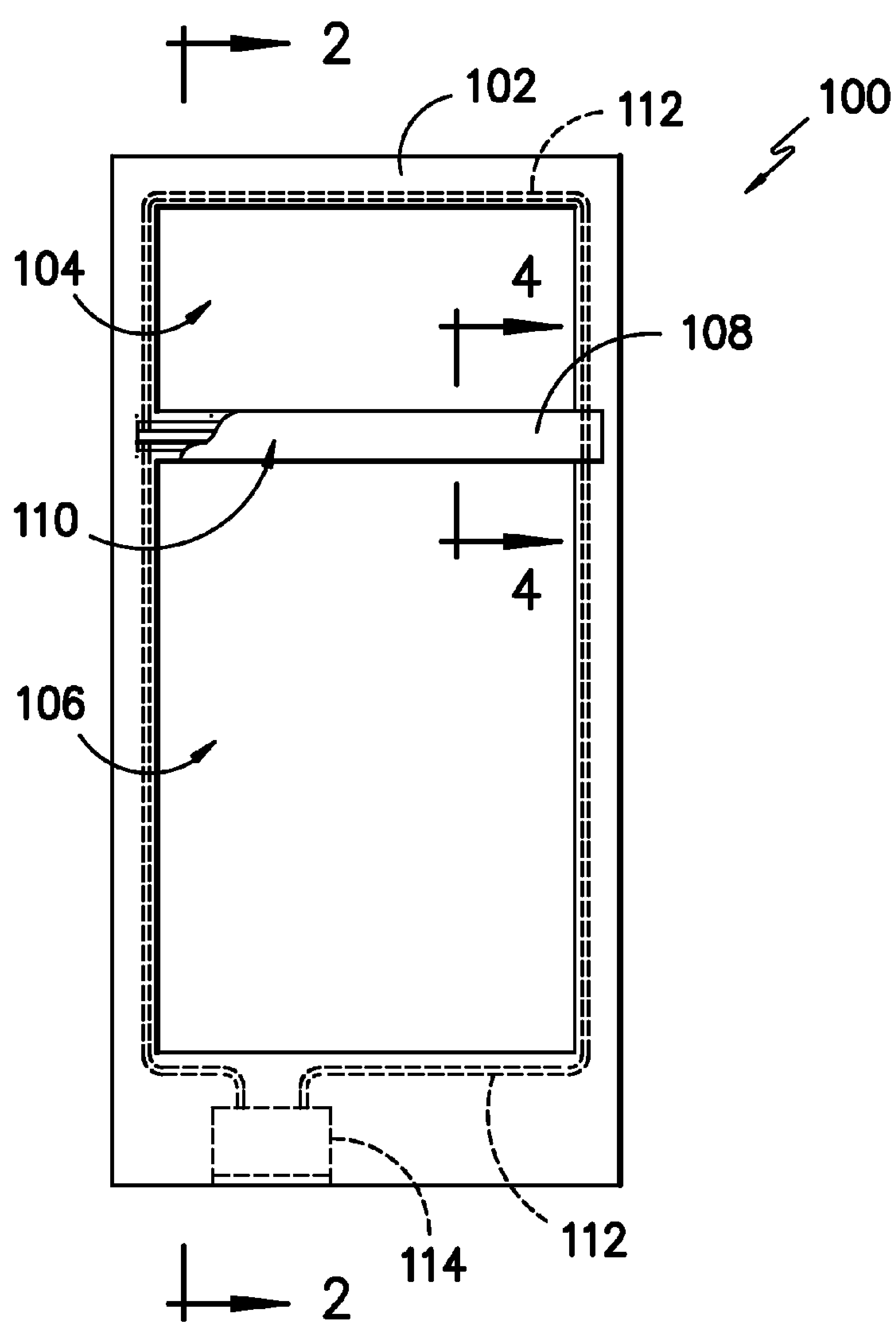
Publication Classification

(51) **Int. Cl.**
F25B 41/00 (2006.01)
F25D 21/00 (2006.01)

(52) **U.S. Cl.** **62/81**; 62/277

(57) **ABSTRACT**

A heater is provided for elevating the temperature of a surface of a refrigerator above the dew point of air surrounding the surface so as to avoid condensation. Heat energy is recovered from the refrigeration cycle of the refrigerator by using a portion of the appliance's refrigeration loop to provide heat to the desired surface. A conductive element is connected with the desired surface and also placed into contact with a heated portion of the refrigeration loop to conduct heat energy therebetween. The surface and conductive element may be selectively removed and replaced from the refrigerator without the use of electric heating elements as conventionally required for removable surfaces.



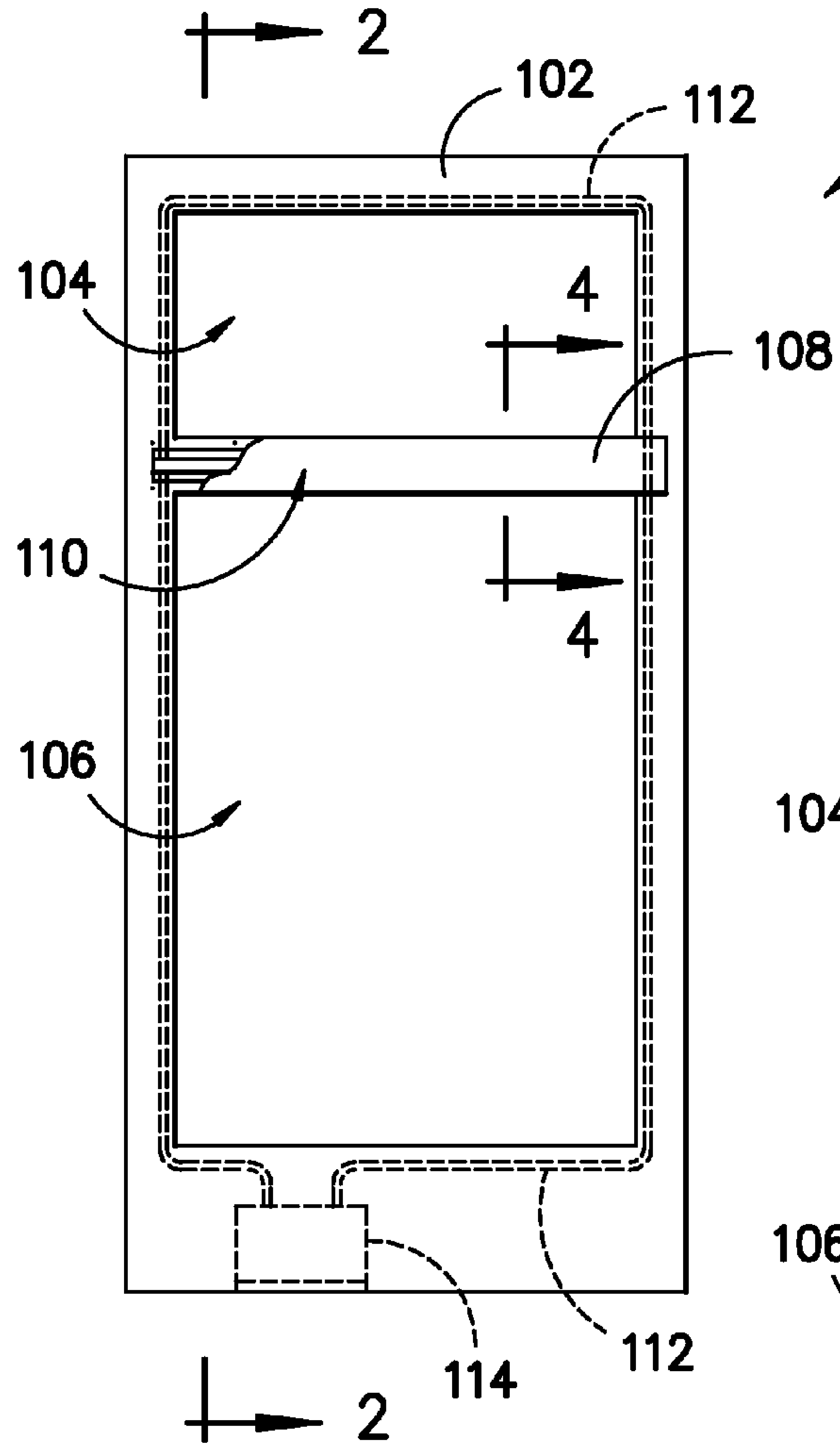

2
102
112
100
104
4
108
110
4
106
114
112
2

FIG. –1–

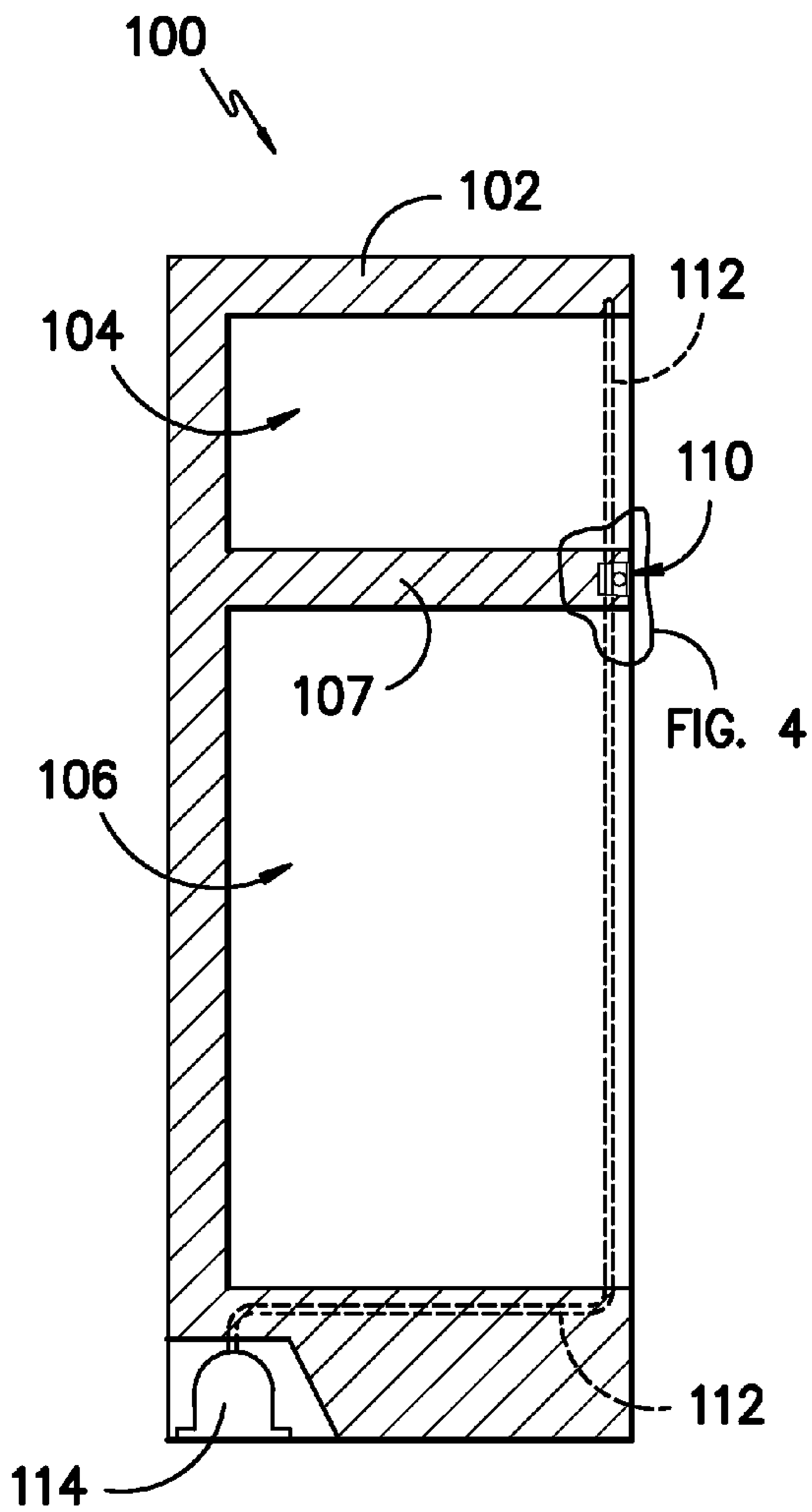

100
102
112
104
110
107
FIG. 4
106
112
114

FIG. –2–

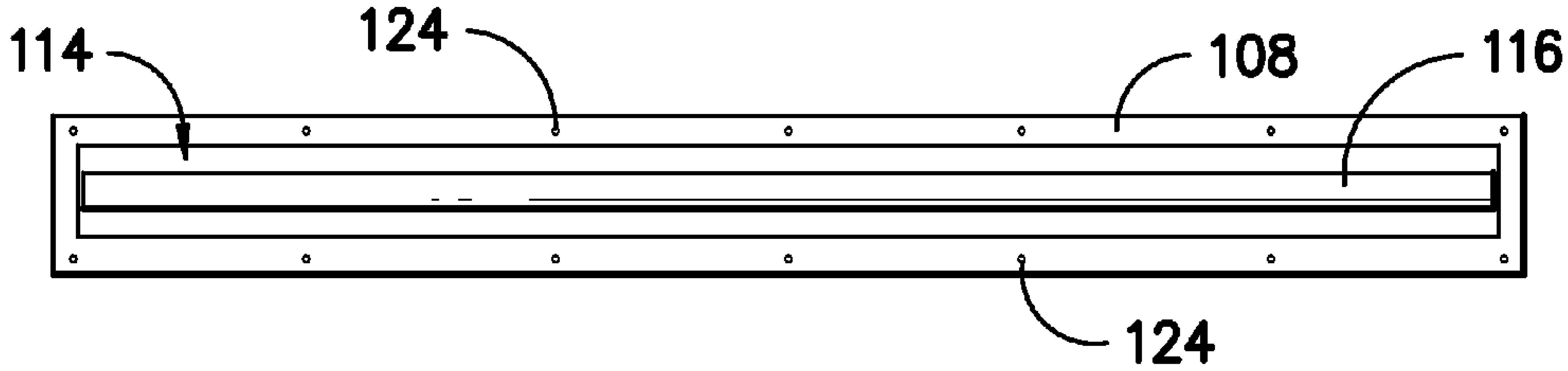

114
124
108
116
124

FIG. -3-

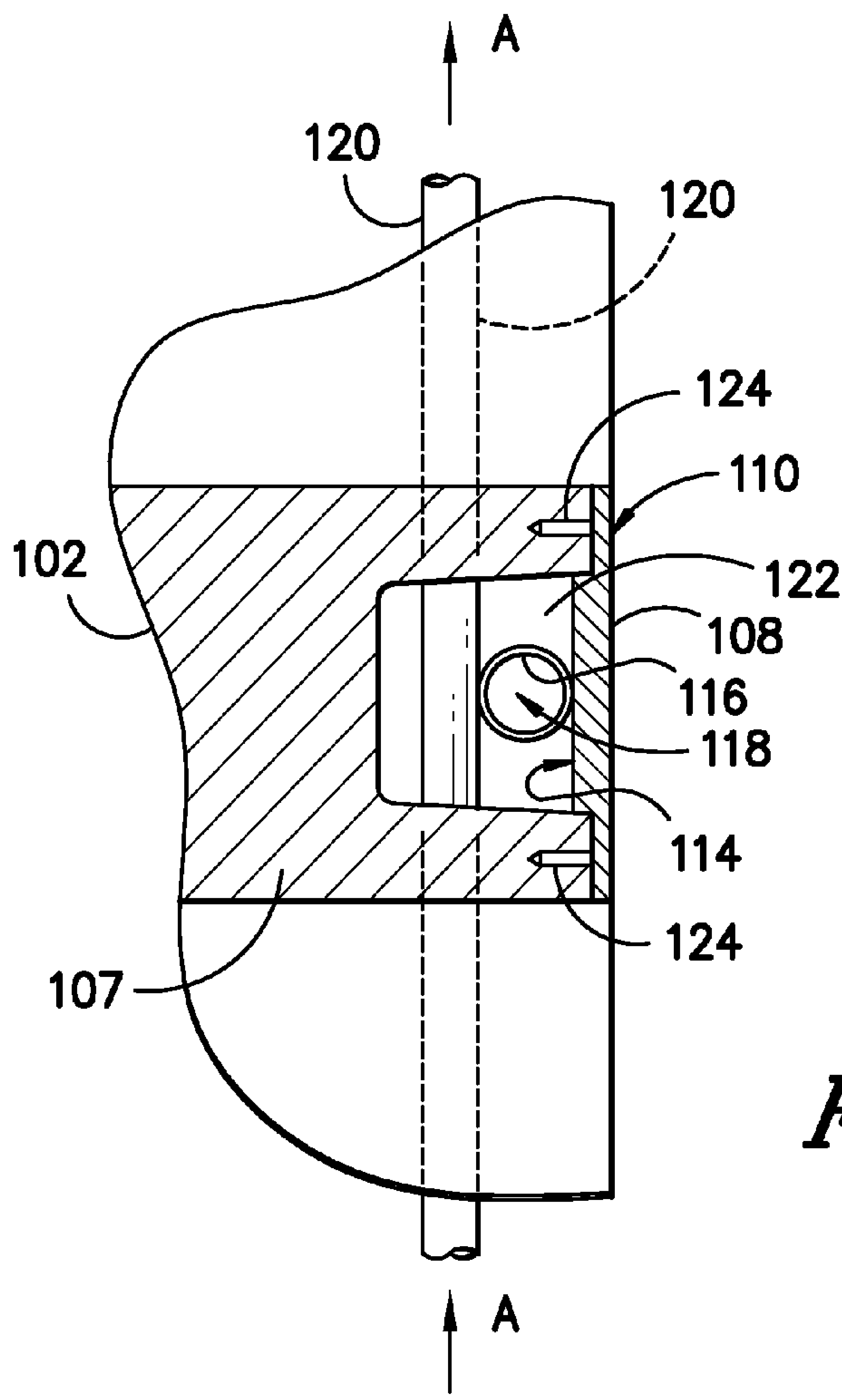

A
120
120
124
110
102
122
108
116
118
114
124
107
A

FIG. -4-

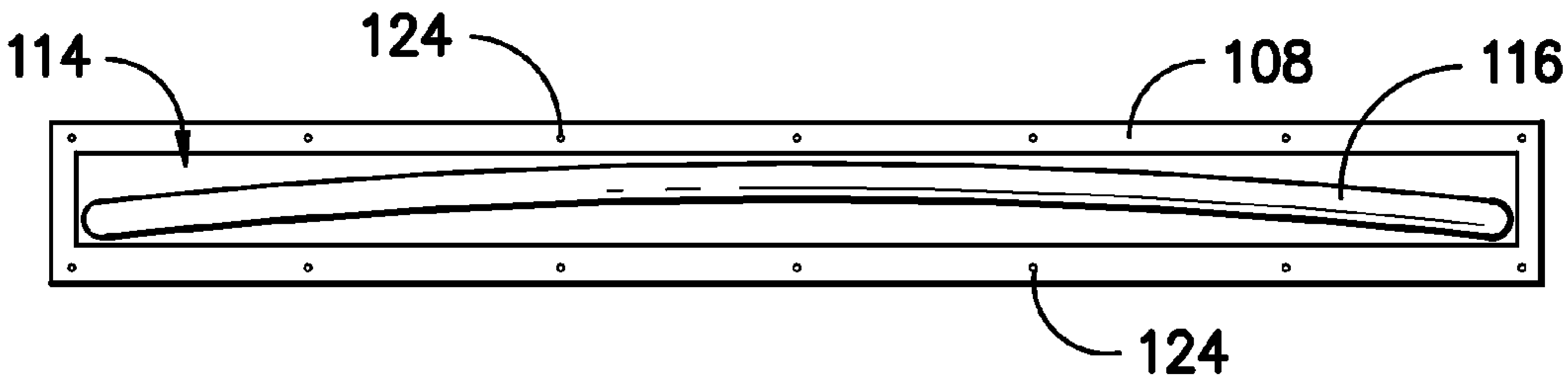

114
124
108
116
124

FIG. –5–

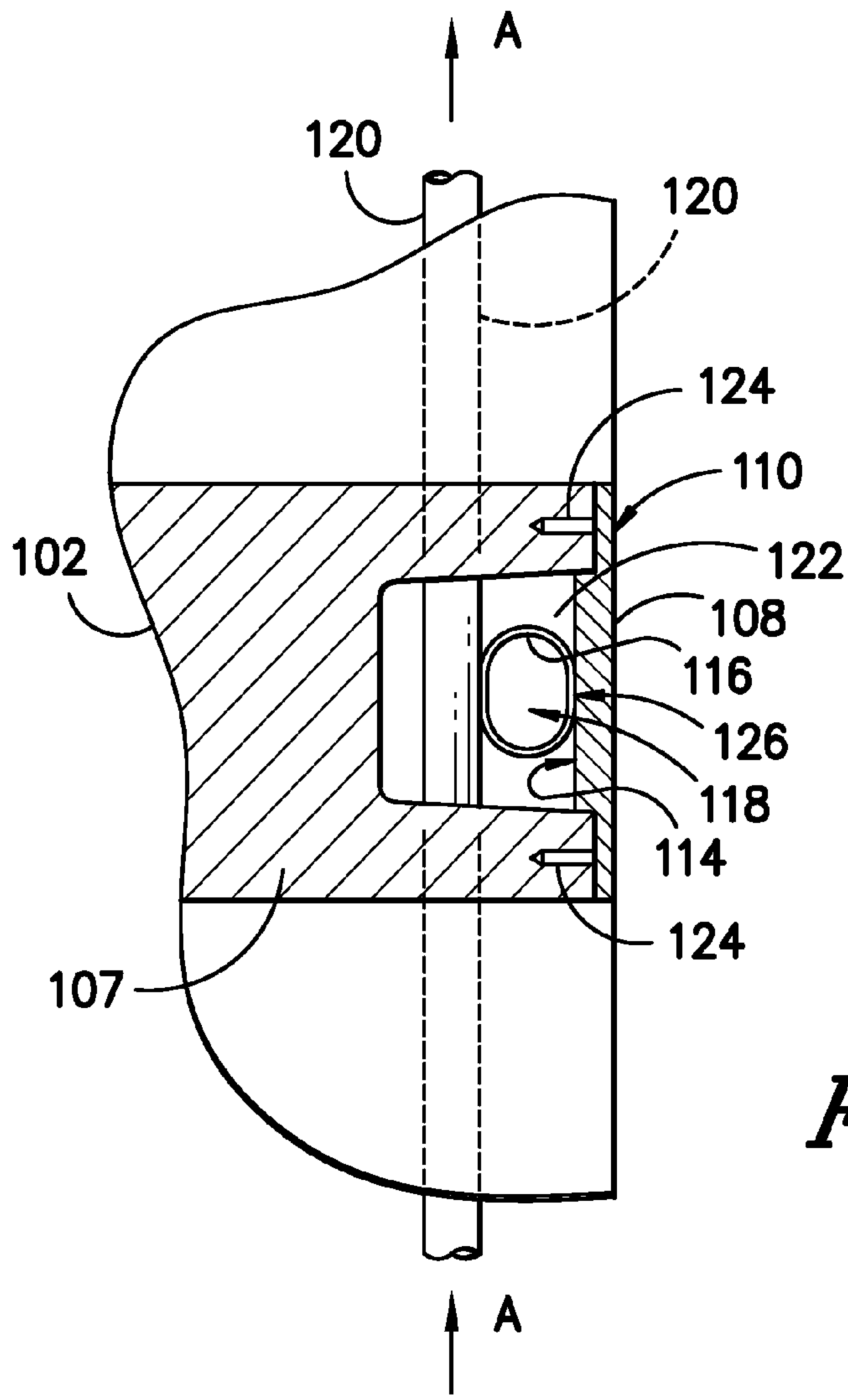

A
120
120
124
110
102
122
108
116
126
118
114
124
107
A

FIG. –6–

CONDUCTIVE SURFACE HEATER FOR A REFRIGERATOR

FIELD OF THE INVENTION

[0001] The present invention provides a method and apparatus for heating a surface of a refrigerator, more particularly a removable surface of a refrigerator, in order to prevent condensation from forming on the surface.

BACKGROUND OF THE INVENTION

[0002] One problem frequently encountered with modern refrigerators is condensation on the outside of the cabinet or other surfaces of the refrigerator. Condensation occurs when a surface is at a temperature below the dew point temperature of the surrounding air. Once air contacts such surface, moisture in the air will condense on the surface. As such condensation accumulates, it may eventually drip or run onto the floor.

[0003] The lower temperature of these surfaces about the refrigerator is a result of the transfer of thermal energy between the refrigerator portions providing such surfaces and the refrigerated compartments as well as the movement of air across these surfaces when doors or compartments of the refrigerator are opened and shut. By way of example, surfaces on the mullion or divider between refrigerator doors, compartments, and drawers are prone to have condensation problems. Condensation can also occur, for example, on the front face of the refrigerator, the front portion of the outer case side and top walls adjacent the front edge of the case. By way of further example, such can also occur on the peripheral edges or walls of the doors, particularly the adjacent facing walls of the doors of multi-compartment units.

[0004] Conventionally, the condensation problem is solved by applying additional heat to a particular surface—thereby raising the temperature above the dew point of the surrounding air to prevent condensation. In some refrigerators this is accomplished by placement of an electric heater into a component of the refrigerator at a position adjacent and along the inside of the problematic surface. Other refrigerators may use heated refrigerant in a loop from the refrigeration cycle to heat the problematic surface by routing the loop through the component and placing the loop against such surface. However, in certain applications, the component having a condensation prone surface must also be removable, e.g., maintenance, cleaning, or repair. In such applications, use of a hot refrigerant loop is not practical because the integrity of the loop and containment of the refrigerant must be maintained. In such case, electric heaters can be used but are not as efficient as a heated refrigerant loop. Electric heaters must be separately powered whereas use of a heated refrigerant loop effectively captures heat produced by the refrigeration cycle that must otherwise be removed from the refrigerator. In addition, electric heaters are typically based on the use of a resistive element, which may have a shorter life span than the rest of the refrigerator.

[0005] Accordingly, an improved system for heating a surface of a refrigerator to avoid condensation problems is needed. More particularly, a system for heating a surface of a removable component of a refrigerator would be useful. A system that also recaptures energy from a heated refrigerant loop of the refrigeration cycle of the appliance would be particularly useful and efficient.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention. In one exemplary embodiment of the present invention, a conductive heater for increasing the temperature of a surface of a refrigerator is provided. The conductive heater includes a refrigeration loop providing the heat source for the conductive heater. A conductive element is attached along the inside of a component bearing the surface to be heated. The conductive element extends along at least part of the length of the component and in thermal communication therewith. The conductive element is also positioned into contact with the heat source of the refrigeration loop such that heat from the heat source may be transferred to the conductive element and to the surface of the component.

[0007] In another exemplary aspect of the present invention, a method for heating a surface of a refrigerator is provided. The method includes the steps of heating a refrigerant; circulating the refrigerant within a conduit in the refrigerator, the conduit having at least a portion that is placed in proximity to the surface to be heated; attaching a conductive element to a component of the refrigerator, the component bearing the surface to be heated; placing the conductive element into contact with the conduit; transferring heat from the refrigerant and conduit, through the conductive element, and to the surface to be heated; and raising the temperature of the surface above the dew point of air to which the surface is exposed.

[0008] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0010] FIG. **1** illustrates a front view of a refrigerator cabinet constructed according to an exemplary embodiment of the present invention. A partial cross-sectional view of a portion of the front is also included to show features located behind a surface that is to be heated above the dew point of the surrounding air as described more fully below. For clarity, exterior doors, internal drawers, and other features that might be included with the refrigerator are not shown as such can vary and will be well understood by one of skill in the art.

[0011] FIG. **2** illustrates a cross-sectional side view of the exemplary refrigerator cabinet of FIG. **1**.

[0012] FIG. **3** is a perspective view of the inside surface of removable component or part that is heated according to an exemplary embodiment of the present invention.

[0013] FIG. **4** is a cross-sectional view, taken along lines **4-4** of FIG. **1**, of the removable component that is heated according to an exemplary embodiment of the present invention.

[0014] FIG. **5** is a perspective view of the inside surface of another removable component or part that is heated according to an exemplary embodiment of the present invention.

[0015] FIG. **6** is a cross-sectional view, taken along lines **4-4** of FIG. **1**, of another removable component that is heated according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The present invention provides for heating a surface of a refrigerator above the dew point of air surrounding the surface so that condensation does not occur. Heat energy is recovered from a heat source within the refrigerator such as e.g., the refrigeration cycle of the refrigerator by using a portion of the appliance's refrigeration loop to provide heat to the desired surface. The present invention allows for the surface to be selectively removed and replaced from the refrigerator without the use of electric heating elements as conventionally required for removable surfaces. Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0017] FIG. **1** provides a front view of a refrigerator **100** having a cabinet **102** constructed according to an exemplary embodiment of the present invention. Cabinet **102** includes a freezer compartment **104** and fresh food compartment **106** arranged in an over-under configuration. Doors, drawers, and additional compartments as might otherwise be provided with refrigerator **100** are not shown as such can vary in style and location between different refrigerators and will be understood by one of skill in the art. In addition, the present invention can be used with different cabinet **102** constructions such as e.g., both top and bottom mount refrigerators.

[0018] Cabinet **102** includes what can be referred to as a mullion or partition **107**, along with a removable covering **108**, which divides compartments **104** and **106**. Covering **108** includes a surface **110** for which heating is needed in order to prevent condensation. For example, surface **110** may be one that is exposed to cold air from the inside compartments **104** and/or **106** when doors to these compartments are opened. As such, surface **110** is cooled to a temperature below that of the ambient air surrounding refrigerator **100**, and condensation will form on surface **110** upon exposure to such air. The heating of surface **110** or covering **108** is provided by way of example only. The present invention may be used to heat other surfaces (interior or exterior) of the refrigerator as well including, for example, along doors, drawers, flanges, and other components.

[0019] As will be understood by one of skill in the art, refrigerator **100** includes a refrigerant based cooling system that uses compression and vaporization of the refrigerant to remove heat (i.e. cool) from the inside compartments **104** and **106** of the refrigerator. As part of this conventional refrigeration cycle, the refrigerant is necessarily compressed to a higher pressure, which in turn heats up the refrigerant. This refrigerant must be further cooled and liquified before it can be vaporized to remove heat from the contents of the inside compartments **104** and **106** of the refrigerator **100**. Typically, this cooling is accomplished by circulating the refrigerant after compression through coils (e.g., condenser coils) located on the rear of the refrigerator where heat can be exchanged with ambient air. The present invention efficiently uses at least a portion of the heat present in the refrigerant at this stage of the cycle to provide heat to the surface **110** for which raising the temperature is desired. Accordingly, the present invention efficiently recovers energy imparted to the refrigerant by compression so as provide heating for the desired surface **110**.

[0020] More specifically, FIGS. **1** and **2** shows a loop **112** containing refrigerant that has been heated from being pressurized by compressor **114**. Loop **112** may form the exothermic, condenser portion of the refrigeration cycle for refrigerator **100** or may be a sub-portion or a smaller loop thereof. Regardless, as the refrigerant flows out of compressor **114**, it is at a higher temperature than the ambient air and/or casing of the refrigerator. Accordingly, as the refrigerant circulates about loop **112**, heat is released and is available for exchange with air and/or components in contact with loop **112**. By selecting a particular routing for loop **112** within cabinet **102**, this heat may be made available at various locations in the refrigerator as needed for the heating of surfaces such as surface **110**. For simplicity in explanation, other portions of a conventional refrigeration loop such as the evaporator, expander, and others are not shown in FIGS. **1** and **2** but will be understood by one of skill in the art.

[0021] FIG. **3** illustrates a rear view of covering **108** with an inside surface **114**. FIG. **4** illustrates a cross-sectional view covering **108** installed on refrigerator **100**. As shown, covering **108** includes a conductive element **116** positioned along the length of covering **108** and in thermal communication with covering **108** through e.g., contact with inside surface **110**. Conductive element **116** is also in thermal communication with a conduit **120**, through which heated refrigerant is flowing as described more fully below. For this exemplary embodiment, conductive element **116** is constructed as a round tube or heat pipe that extends along nearly the entire length of covering **108**. However, longer or shorter configurations of element **116** may be used depending upon, for example, the amount of heat transfer needed or the extent of surface **110** over which temperature elevation is needed.

[0022] In a preferred embodiment, conductive element **116** forms a sealed interior **118** and includes a fluid that facilitates heat transfer. More particularly, by choosing a fluid with a relatively low boiling point, the fluid can operate as a thermosyphon within conductive element **116** to further effectuate the transfer of heat. By way of example, the fluid within conductive element **116** may be water or an alcohol such as methanol.

[0023] As used herein, thermosyphon refers to a method of heat exchange that uses natural convection to circulate a fluid without the use of a pump. Convective movement of the fluid within conductive element **116** starts when a portion of the fluid is heated by conduction of heat from the refrigerant in conduit **120**. This heat causes a portion of the fluid to expand and become less dense, which in turn makes the heated portion of the fluid more buoyant than cooler portions of the fluid in conductive element **116**. As a result, convection moves the heated portions of the fluid upward within the conductive element **116**, which in turn is simultaneously replaced by cooler fluid under the effect of gravity. Accordingly, a circulation of fluid will occur within conductive element **116** that further facilitates heat transfer from conduit **120** to covering **108** such that conductive element **116** operates as a heat pipe supplying heat to raise the temperature of covering **108**.

[0024] Using the teachings disclosed herein, one of skill in the art will understand that other constructions may be used for conductive element **116**. FIG. **5**, for example, provides another exemplary embodiment of conductive element **116** that has been formed with an arcuate shape. The arcuate shape enhances the thermosyphon effect for the fluid within conductive element **116** by providing height differences along its length. These differences in height will promote the flow of less buoyant, cooler fluid by operation of gravity to the lower portions of conductive element **116**. In turn, by placing these lower portions into contact with conduit **120**, this same fluid will then be heated and rise to the higher portions of conductive element **116** as circulation of the fluid occurs from natural convection.

[0025] By way of further example, conductive element **116** could be constructed without an interior fluid and could even be a solid piece of conductive material with interior **118**. Regardless, conductive element **116** is constructed preferably from a thermally conductive material such as a metal. Conductive element **116** can also be formed with one or more flat surfaces to improve thermal contact and, therefore, the conduction of heat between conduit **120** and covering **108**. For example, in FIG. **6**, conduit **120** includes flat sides **126** in contact with conduit **120** and covering **108**. These flats sides **126** increase the amount of surface area for contact thereby improving conductive heat transfer.

[0026] Referring to FIGS. **4** and **6**, cabinet **102** and covering **108** form an interior space **122** through which conduit **120** passes. Conductive element **116** is also received into such interior space **122**. A plurality of connectors **124** allow covering **108** to be removed or replaced onto cabinet **102** as needed. The ability to selectively remove covering **108** may be necessary, for example, so that maintenance, cleaning, repair, other functions may be performed.

[0027] Referring now more particularly to FIGS. **4** and **6**, conductive element **116** is placed into thermal communication with conduit **120**, through which refrigerant is flowing as indicated by arrows A. More particularly, conductive element **116** and conduit **120** preferably contact each other to facilitate effective heat transfer between the two. Although shown as contacting at right angles to one another in FIG. **4**, other orientations including parallel, zig-zag, and numerous others may be applied so as to increase the amount of contact between conduit **120** and conductive element **116** and thereby improve heat transfer. Conduit **120** may be a portion of loop **112** or may be connected to or within loop **112** such that it is in receipt of the heated refrigerant flowing within loop **112**.

[0028] Accordingly, during operation of refrigerator **100**, refrigerant in loop **112** is heated by pressurization from pump or compressor **114**. This refrigerant is circulated about loop **112**. As shown in FIGS. **1**, **2**, **4** and **6**, loop **112** is routed in proximity to covering **108** having surface **110** for which it is desired to raise its temperature to avoid condensation.

[0029] As the heated refrigerant passes around loop **112** and eventually travels within conduit **120**, heat is transferred from the refrigerant, through conduit **120**, and into and through conductive element **116**. As a result, covering **108** is heated by contact of its rear surface **114** with conductive element **116**. Eventually, as this heating continues, the temperature of surface **110** of covering **108** will be raised. By routing sufficiently heated refrigerant through conduit **120**, the temperature of surface **110** can be raised to a level sufficient to remain above the dew point of air contacting or surrounding surface **110** while at the same time avoiding a surface too hot for human contact or the materials used for construction.

[0030] Accordingly, the present invention avoids electrical heating elements such as resistive wires in covering **108** by efficiently recovering heat energy from loop **112**. In addition, covering **108** remains readily removable from cabinet **102**.

[0031] It should be understood the present invention may be used with a variety of different appliance configurations including, for example, side-by-side fresh food and freezer compartments or all freezer or all fresh food appliances as well. In addition, the present invention may be applied to any refrigerator surface where condensation may present a problem provided heat from the refrigerant loop is available. More particularly, components other than covering **108** may also be heated using the present invention. Where needed, it should also be understood that multiple different surfaces of a refrigerator may also be heated using the present invention whereby condensation at multiple different locations may be avoided.

[0032] The exemplary embodiments of FIGS. **1** through **6** have been described using the exothermic portion of refrigeration loop **112** as a heat source. However, the present invention is not limited to the exothermic portion of refrigeration loop **112** and other warm sections of refrigerator loop **112** that are capable of providing heat energy for conductive element **116** may be used as a heat source as well.

[0033] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A conductive heater for increasing the temperature of a surface of a refrigerator, comprising:

a refrigeration loop providing the heat source for the conductive heater; and

a conductive element attached along the inside of a component bearing the surface to be heated, said conductive element extending along at least part of the length of said component and in thermal communication therewith, said conductive element also positioned into contact with the heat source of said refrigeration loop such that heat from the heat source may be transferred to said conductive element and to the surface.

2. A conductive heater for a surface of a refrigerator as in claim **1**, wherein the heat source of said refrigeration loop comprises an exothermic portion of said refrigeration loop, and further comprising a conduit connected with the exothermic portion of said refrigeration loop and configured for transporting refrigerant, said conductive element positioned into contact with said conduit.

3. A conductive heater for a surface of a refrigerator as in claim **1**, further comprising a fluid placed within said conductive element, and wherein said conductive element is sealed so as to contain such fluid.

4. A conductive heater for a surface of a refrigerator as in claim **3**, wherein said fluid has a low boiling point such that a thermosyphon is created in said conductive element during operation of the refrigerator.

5. A conductive heater for a surface of a refrigerator as in claim **3**, wherein said fluid comprises water.

6. A conductive heater for a surface of a refrigerator as in claim **3**, wherein said fluid comprises an alcohol.

7. A conductive heater for a surface of a refrigerator as in claim **6**, wherein said fluid comprises methanol.

8. A conductive heater for a surface of a refrigerator as in claim **1**, wherein said component, along with said conductive element, is selectively removable from the refrigerator.

9. A conductive heater for a surface of a refrigerator as in claim **8**, wherein the refrigerator and said component define an interior space through which said conduit passes, the interior space also configured for receipt of said conductive element.

10. A conductive heater for a surface of a refrigerator as in claim **1**, wherein said conductive element comprises metal tubing filled with a fluid.

11. A conductive heater for a surface of a refrigerator as in claim **10**, wherein said metal tubing has an arcuate shape extending along at least a portion of the surface.

12. A conductive heater for a surface of a refrigerator as in claim **1**, wherein the surface comprises a mullion of the refrigerator.

13. A refrigerator that includes the conductive heater of claim **1**.

14. A method for heating a surface of a refrigerator, comprising the steps of:

heating a refrigerant;

circulating the refrigerant within a conduit in the refrigerator, the conduit having at least a portion that is placed in proximity to the surface to be heated;

attaching a conductive element to a component of the refrigerator, the component bearing the surface to be heated;

placing the conductive element into contact with the conduit;

transferring heat from the refrigerant and conduit, through the conductive element, and to the surface to be heated; and

raising the temperature of the surface above the dew point of air to which the surface is exposed.

15. A method for heating a surface of a refrigerator as in claim **14**, wherein the conductive element and the component are selectively removable from the refrigerator.

16. A method for heating a surface of a refrigerator as in claim **14**, wherein the conductive element contains a fluid that is sealed within the conductive element.

17. A method for heating a surface of a refrigerator as in claim **16**, wherein the fluid is water.

18. A method for heating a surface of a refrigerator as in claim **16**, wherein the fluid is methanol.

19. A method for heating a surface of a refrigerator as in claim **14**, further comprising the step of providing an interior space in the refrigerator through which the conduit passes, the interior space also being configured for receipt of the conductive element.

* * * * *