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(54) WATER HEATER APPLIANCE

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventor: **Timothy Scott Shaffer**, La Grange, KY (US)

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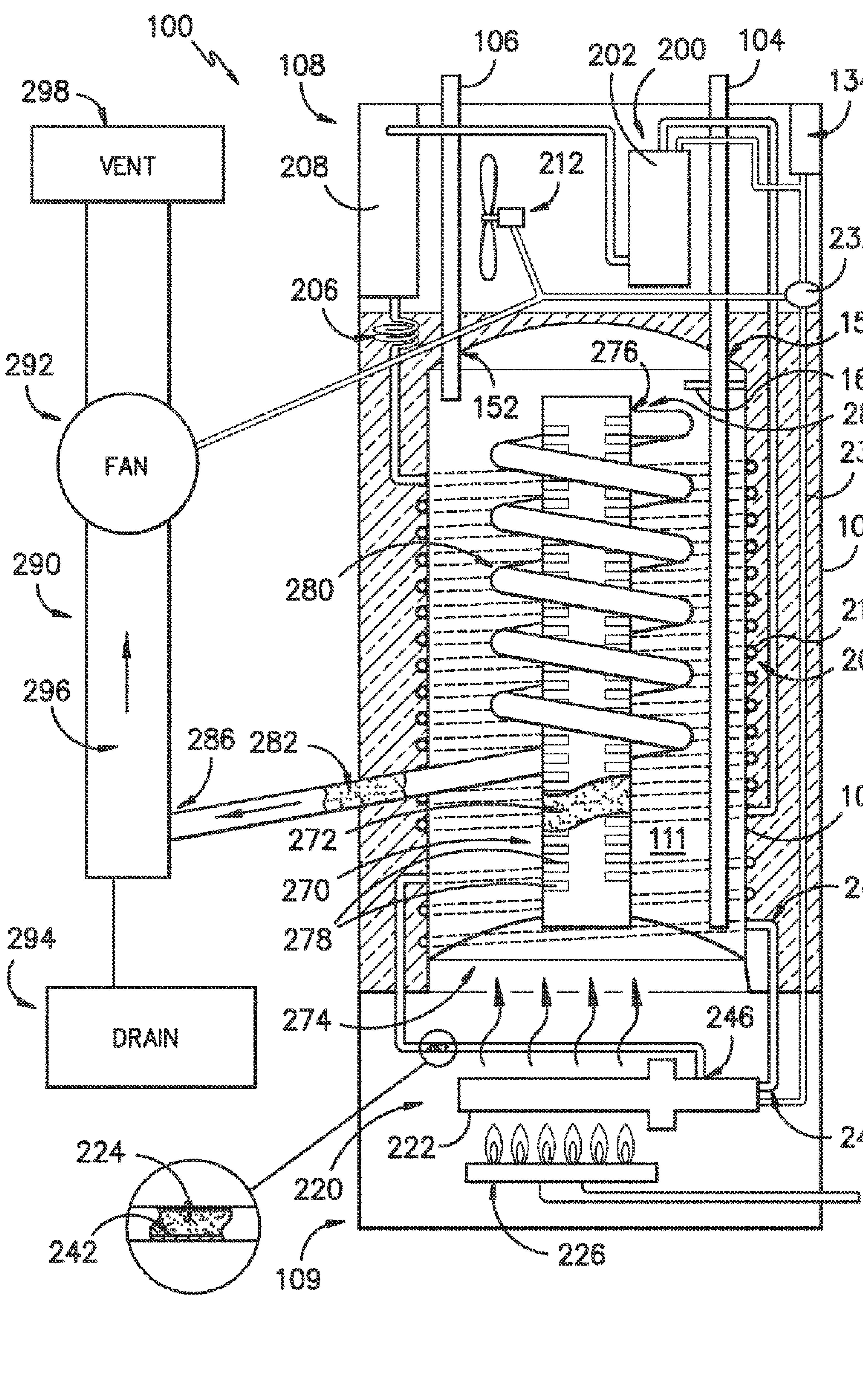
(57) **ABSTRACT**

Water heater appliances are provided. A water heater appliance includes a tank, a hot water conduit and a cold water conduit. The water heater appliance further includes a heat pump assembly configured to heat water within the chamber of the tank, and a thermo-electric assembly configured to generate an electrical current. The thermo-electric assembly includes a thermo-electric converter, a working fluid flowable through the thermo-electric converter, and a heat source configured to heat the working fluid within the thermo-electric converter. At least a portion of the electrical current generated by the thermo-electric assembly is flowed to the heat pump assembly to at least partially power the heat pump assembly.



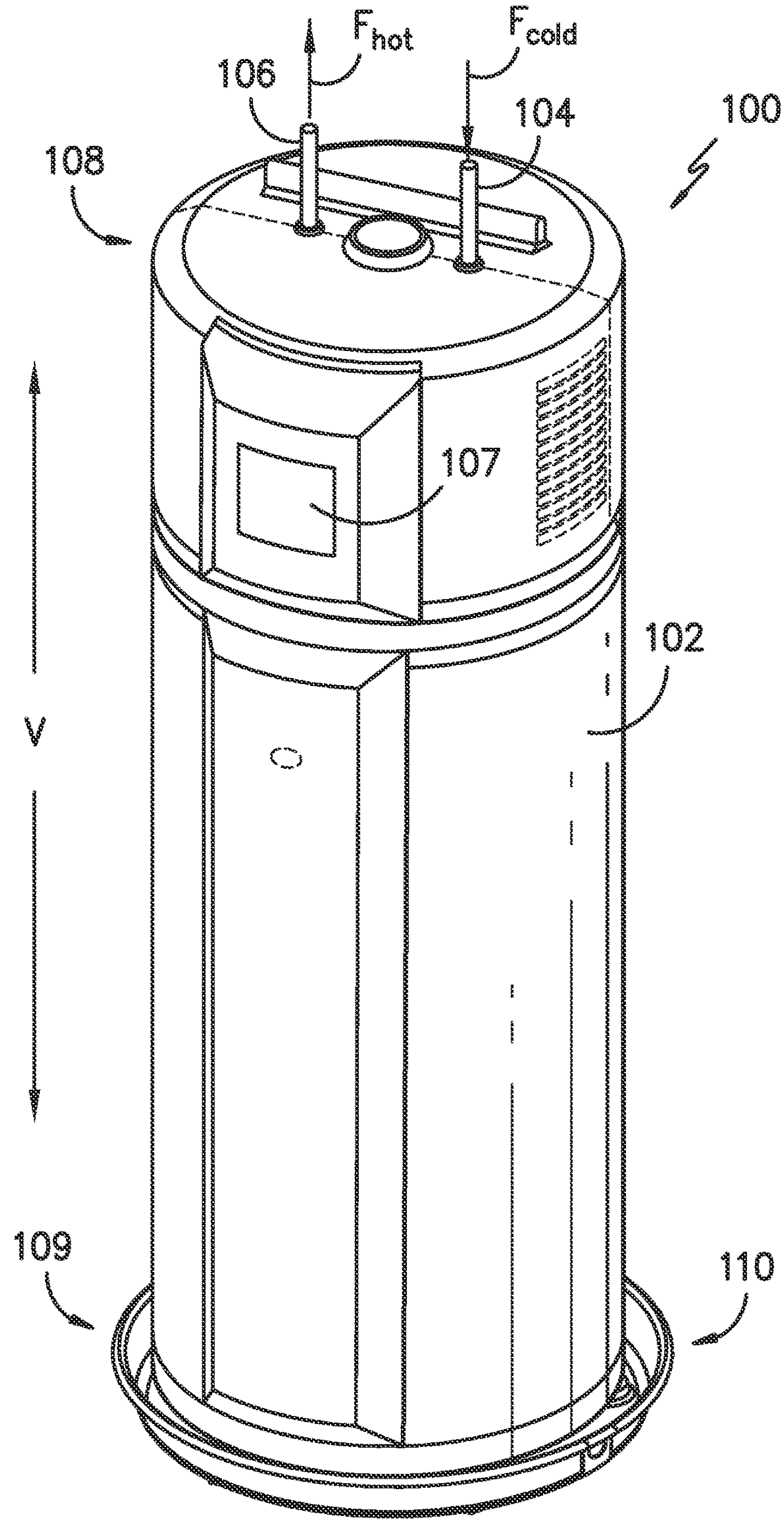


FIG. -1-

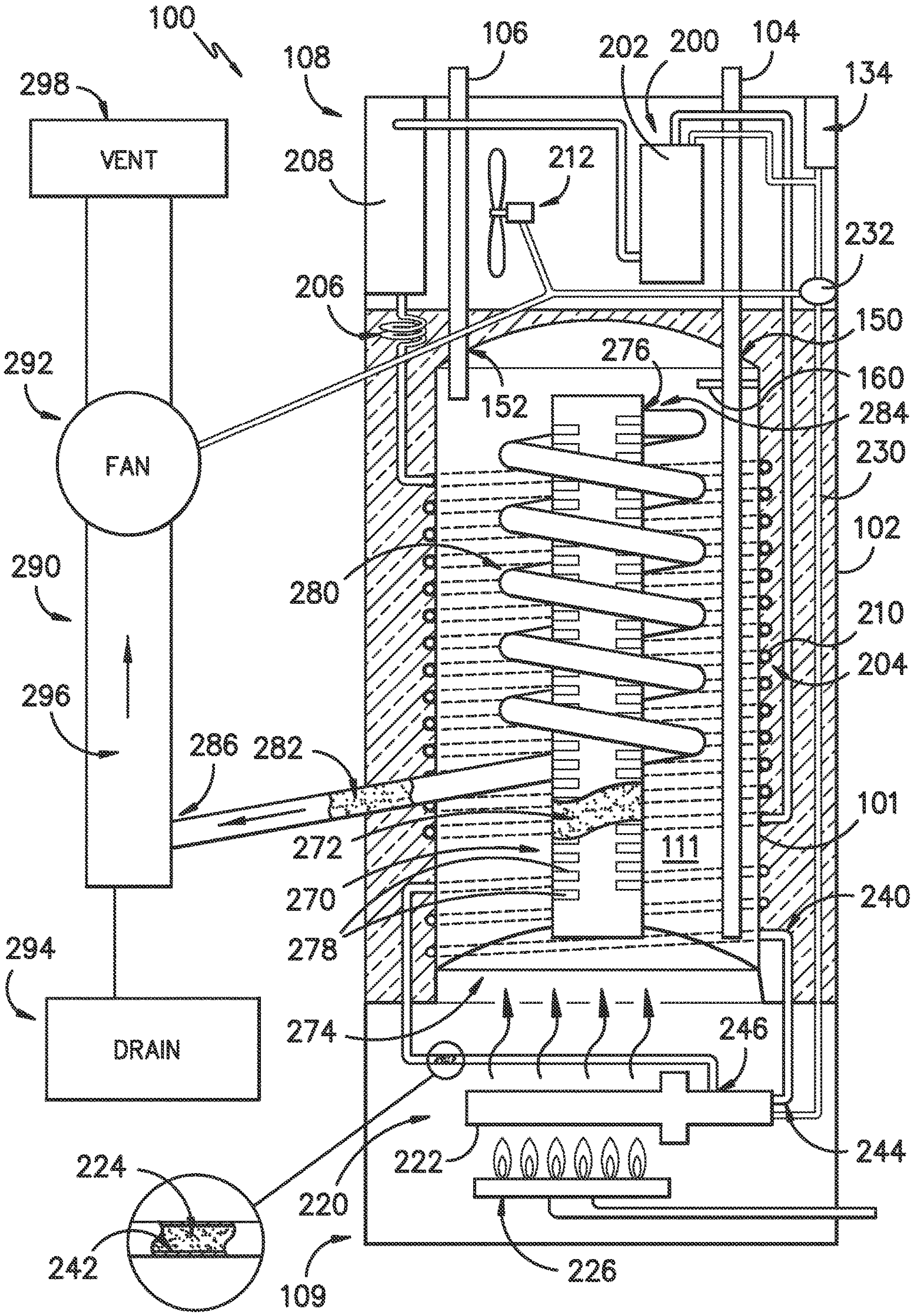

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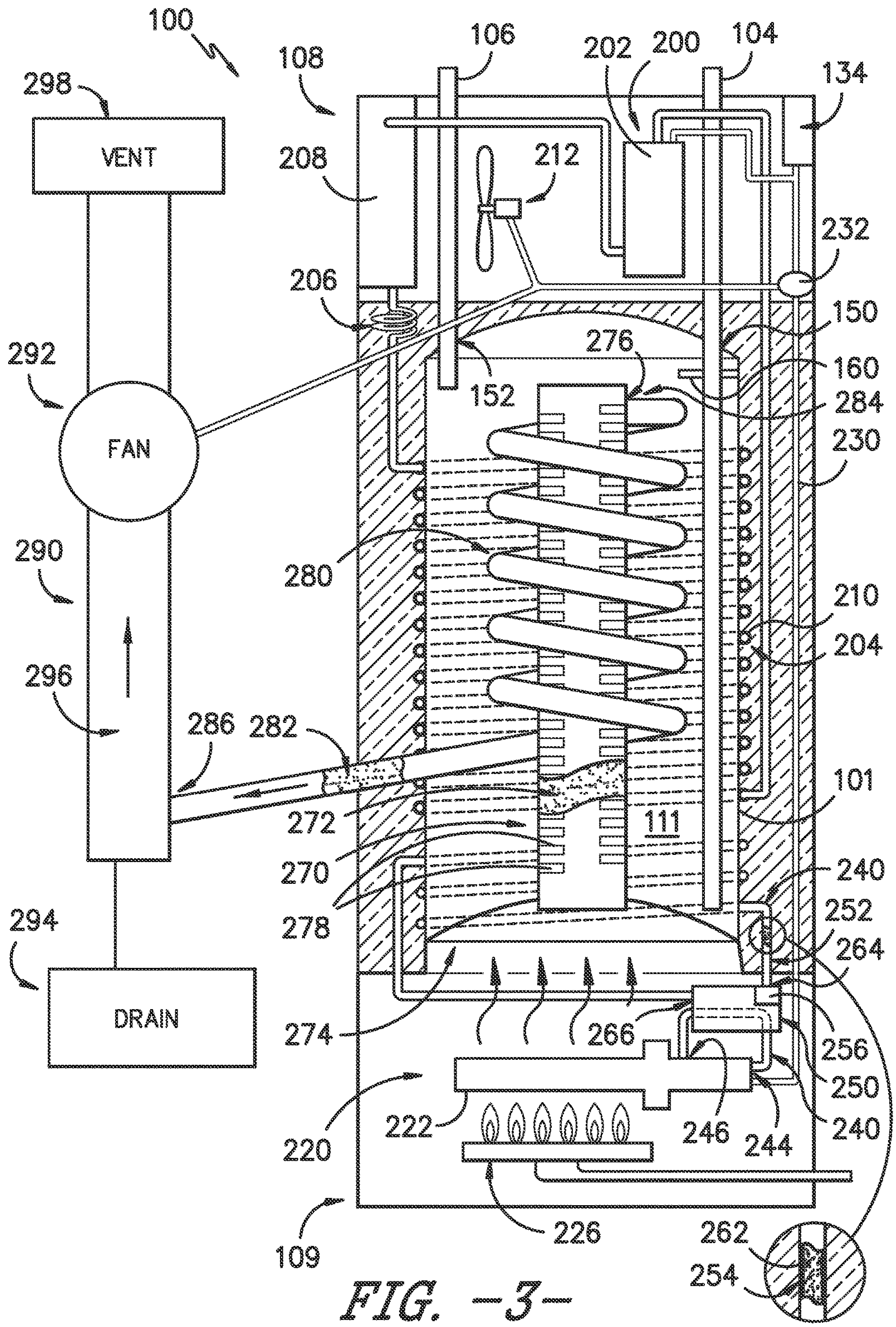
FIG. -2-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226
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FIG. -3-

WATER HEATER APPLIANCE

FIELD OF THE INVENTION

[0001] The present subject matter relates generally to water heater appliances, and more particularly to water heater appliances which utilized thermo-electric converters to improve water heater appliance efficiency.

BACKGROUND OF THE INVENTION

[0002] Certain water heater appliances include a tank therein. Heating elements, such as gas burners, electric resistance elements, or induction elements, heat water within the tank during operation of such water heater appliances. In particular embodiments, heat pump assemblies are utilized in water heater appliances, with the condenser of the heat pump acting as the heating element. The heating elements generally heat water within the tank to a predetermined temperature. The predetermined temperature is generally selected such that heated water within the tank is suitable for showering, washing hands, etc.

[0003] One goal in water heater appliance design is increasing the energy factor for the water heater appliance. Energy factor is generally utilized to compare the energy conversion efficiency of an appliance, such as a water heater appliance. Many typical water heater appliances have energy factors of less than 0.90. In conventional gas water heaters, the energy factors are commonly less than 0.60. Recently developed gas sorption cycle based water heater appliances, which utilize for example ammonia-water solutions or lithium bromide-water solutions as a working absorption refrigerant media, generate increased energy factors. However, these systems are expensive and complicated, and require an electrical current to maintain operation. In many cases, consumers are reluctant to convert to such systems due to the potential loss of ability to generate hot water during and due to power losses.

[0004] Accordingly, improved water heater appliances are desired. In particular, water heater appliances which provide improved energy factors, and which are not dependent upon mainline electricity for operation, would be advantageous.

BRIEF DESCRIPTION OF THE INVENTION

[0005] In accordance with one embodiment, a water heater appliance is disclosed. The water heater appliance includes a tank defining a chamber, the tank further defining an inlet aperture and an outlet aperture. The water heater appliance further includes a hot water conduit extending through the outlet aperture and in fluid communication with the chamber of the tank, the hot water conduit configured for directing a flow of water out of the chamber of the tank, and a cold water conduit extending through the inlet aperture and in fluid communication with the chamber of the tank, the cold water conduit configured for directing a flow of water into the chamber of the tank. The water heater appliance further includes a heat pump assembly configured to heat water within the chamber of the tank, and a thermo-electric assembly configured to generate an electrical current. The thermo-electric assembly includes a thermo-electric converter, a working fluid flowable through the thermo-electric converter, and a heat source configured to heat the working fluid within the thermo-electric converter. At least a portion of the electrical current generated by the thermo-electric assembly is flowed to the heat pump assembly to at least partially power the heat pump assembly.

[0006] In accordance with another embodiment, a water heater appliance is disclosed. The water heater appliance includes a tank defining a chamber, the tank further defining an inlet aperture and an outlet aperture. The water heater appliance further includes a hot water conduit extending through the outlet aperture and in fluid communication with the chamber of the tank, the hot water conduit configured for directing a flow of water out of the chamber of the tank, and a cold water conduit extending through the inlet aperture and in fluid communication with the chamber of the tank, the cold water conduit configured for directing a flow of water into the chamber of the tank. The water heater appliance further includes a heat pump assembly configured to heat water within the chamber of the tank, and a thermo-electric assembly configured to generate an electrical current. The thermo-electric assembly includes a thermo-electric converter, a working fluid flowable through the thermo-electric converter, and a heat source configured to heat the working fluid within the thermo-electric converter. The water heater appliance further includes a heat recovery vessel disposed at least partially within the chamber, the heat recovery vessel defining a passage extending between an inlet and an outlet, the inlet configured to receive exhaust fluid from the heat source therethrough. The water heater appliance further includes a condensing conduit connected at an inlet to the outlet of the heat recovery vessel, and an exhaust assembly exterior to the tank, the exhaust assembly connected to an outlet of the condensing conduit. At least a portion of the electrical current generated by the thermo-electric assembly is flowed to the heat pump assembly to at least partially power the heat pump assembly.

[0007] 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

[0008] 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.

[0009] FIG. **1** provides a perspective view of a water heater appliance in accordance with one embodiment of the present disclosure.

[0010] FIG. **2** provides a side cross-sectional view of a water heater appliance in accordance with one embodiment of the present disclosure.

[0011] FIG. **3** provides a side cross-sectional view of a water heater appliance in accordance with another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0012] 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.

[0013] FIG. **1** provides a perspective view of a water heater appliance **100** according to an exemplary embodiment of the present subject matter. Water heater appliance **100** includes a casing **102**. A tank **101** (FIGS. **2** and **3**) is positioned within casing **102** for heating water therein. As will be understood by those skilled in the art and as used herein, the term "water" includes purified water and solutions or mixtures containing water and, e.g., elements (such as calcium, chlorine, and fluorine), salts, bacteria, nitrates, organics, and other chemical compounds or substances.

[0014] Water heater appliance **100** also includes a cold water conduit **104** and a hot water conduit **106** that are both in fluid communication with a chamber **111** (FIGS. **2** and **3**) defined by tank **101**. As an example, cold water from a water source, e.g., a municipal water supply or a well, can enter water heater appliance **100** through cold water conduit **104** (shown schematically with arrow labeled F_{cool}). From cold water conduit **104**, such cold water can enter chamber **111** of tank **101** wherein it is heated with heating elements, discussed herein, to generate heated water. Such heated water can exit water heater appliance **100** at hot water conduit **106** (shown schematically with arrow labeled F_{hot}) and, e.g., be supplied to a bath, shower, sink, or any other suitable feature.

[0015] Water heater appliance **100** extends longitudinally between a top portion **108** and a bottom portion **109** along a vertical direction V. Thus, water heater appliance **100** is generally vertically oriented. Water heater appliance **100** can be leveled, e.g., such that casing **102** is plumb in the vertical direction V, in order to facilitate proper operation of water heater appliance **100**. A drain pan **110** is positioned at bottom portion **109** of water heater appliance **100** such that water heater appliance **100** sits on drain pan **110**. Drain pan **110** sits beneath water heater appliance **100** along the vertical direction V, e.g., to collect water that leaks from water heater appliance **100** or water that condenses on an evaporator (not shown) of water heater appliance **100**. It should be understood that water heater appliance **100** is provided by way of example only and that the present subject matter may be used with any suitable water heater appliance.

[0016] Water heater appliance **100** may further include a controller **134** (see FIGS. **2** and **3**) that is configured for regulating operation of water heater appliance **100**. Controller **134** may be in operative communication with various components of the water heater appliances, including, for example, heating elements and heating assemblies as discussed herein, a temperature sensor as discussed herein, and a control panel **107**. Control panel **107** may include various displays and input controls for user interface with the appliance **100**. Controller **134** can, for example, selectively activate heating elements in order to heat water within chamber **102** of tank **101**.

[0017] Controller **134** includes memory and one or more processing devices such as microprocessors, CPUs or the like, such as general or special purpose microprocessors operable to execute programming instructions or micro-control code associated with operation of water heater appliance **100**. The memory can represent random access memory such as DRAM, or read only memory such as ROM or FLASH. The processor executes programming instructions stored in the memory. The memory can be a separate component from the processor or can be included onboard within the processor. Alternatively, controller **134** may be constructed without using a microprocessor, e.g., using a combination of discrete analog and/or digital logic circuitry (such as switches, amplifiers, integrators, comparators, flip-flops, AND gates, and the like) to perform control functionality instead of relying upon software.

[0018] Referring now to FIGS. **2** and **3**, tank **101** may define an inlet aperture **150** and an outlet aperture **152**. The inlet and outlet apertures **150**, **152** may be provided to facilitate the flow of water into and from the chamber **111**. For example, cold water conduit **104** may extend through inlet aperture **150**, and hot water conduit **106** may extend through outlet aperture **152**. Apertures **150**, **152** may in exemplary embodiments be define on an upper portion of the tank **101** along the vertical direction V, such that the conduits **104**, **106** extend generally vertically into the chamber **111**.

[0019] In exemplary embodiments, appliance **100** may include a temperature sensor **160**. Temperature sensor **160** may generally sense the temperature in the appliance **100**, such as of water in the chamber **111**, and may for example be in operative communication with the controller **134**.

[0020] Referring still to FIGS. **2** and **3**, the present disclosure is further directed to water heater appliances **100** which provide improved energy factors. Water heater appliances in accordance with the present disclosure advantageously utilize heat pump assemblies and thermo-electric assemblies to heat water in tanks **101** thereof. The combined use of heat pump assemblies and thermo-electric assemblies as discussed herein advantageously improves the energy factor of the associated water heater appliance. For example, in some cases, an energy factor of greater than 1.5, such as greater than 1.7, is attainable in water heater appliances in accordance with the present disclosure. Further, advantageously, electrical current generated by the thermo-electric assembly of a water heater appliance in accordance with the present disclosure can be utilized to at least partially power the heat pump assembly and components thereof, as well as the controller **134** and various exhaust assembly components as discussed herein. This allows exemplary water heater appliances in accordance with the present disclosure to advantageously remain operational even during, for example, mainline power outages.

[0021] As illustrated, a water heater appliance **100** may include a heat pump assembly **200**. Heat pump assembly **200** and the various components thereof may, for example, be in communication with the controller **134**. Controller **134** may thus be operable to activate and deactivate the heat pump assembly **200** to heat water in the chamber **111**. The heat pump assembly **200** may include, for example, a compressor **202**, a condenser **204**, an expansion device **206** and an evaporator **208**. Tubing generally connects and extends between these various components of the heat pump assembly **200**, and a refrigerant is flowed through the various components of through the tubing between the various components when the heat pump assembly **200** is active. Any suitable refrigerant may be utilized in a heat pump assembly **200** in accordance with the present disclosure. One exemplary refrigerant for use in a heat pump assembly **200**

in accordance with the present disclosure is 1,1,1,2-tetrafluoroethane, also known as R-134A.

[0022] As is generally understood, the refrigerant is compressed within the compressor **202** and then flowed to the condenser **204**. Condenser **204** in exemplary embodiments comprises a condenser conduit **210** which defines a passage therethrough, through which refrigerant from the compressor **202** is flowed. At least a portion of the condenser conduit **210** is in contact with the tank **101**, such as with an exterior surface of the tank **101**. For example, as illustrated, at least a portion of the condenser conduit **210** may be wrapped around the tank **101**, such as in a generally helical manner. Heat exchange between the tank **101** (and water therein) and the conduit **210** (and refrigerant therein) may heat the water and cool the refrigerant via emission of heat from the refrigerant.

[0023] Condensed refrigerant from the condenser **204** may be flowed to and through the expansion device **206**, where the pressure of the refrigerant is lowered. In exemplary embodiments as illustrated, expansion device **206** is a capillary tube. Alternatively, other suitable expansion devices **206** may be utilized. Refrigerant may be flowed from expansion device **206** to and through evaporator **208**, wherein the refrigerant absorbs heat. An evaporator fan **212** may be utilized to direct air towards and past the evaporator **208** to facilitate heat exchange to heat the refrigerant. The refrigerant is then flowed back to the compressor **202** and the cycle is repeated as required or desired.

[0024] As further illustrated, water heater appliance **100** may further include a thermo-electric assembly **220** which is generally configured to generate an electrical current. In general, a thermo-electric assembly **220** converts heat to electrical energy. Thermo-electric assembly **220** and the various components thereof may, for example, be in communication with the controller **134**. Controller **134** may thus be operable to activate and deactivate the thermo-electric assembly **220** to generate electricity. Assembly **220** may include, for example, a thermo-electric converter **222**. Converter **222** generally includes anodes, cathodes, and other components suitable for converting heat from a working fluid to electrical energy. In exemplary embodiments, a thermo-electric converter **222** in accordance with the present disclosure is an alkali-metal thermo-electric converter **222**. Examples of suitable thermo-electric converters **222** are provided in U.S. Pat. No. 8,865,999 to Rossi et al., entitled "Thermoelectric Converter with Projecting Cell Stack", issued on Oct. 21, 2014, and which is incorporated by reference in its entirety herein.

[0025] Assembly **220** may additionally include a working fluid **224**, which in exemplary embodiments is an alkali-metal working fluid **224**. For example, in exemplary embodiments, working fluid **224** includes sodium. Working fluid **224** is flowable through the thermo-electric converter **222**, wherein electrical current is generated by such flow therethrough.

[0026] Additionally, assembly **220** may include a heat source **226** which is configured to heat the working fluid **224** within the thermo-electric converter **222**. Such heating of the working fluid **224** facilitates the conversion of the heat to electrical current within the converter **222**. In exemplary embodiments, the heat source **226** is a gas burner, such as a natural gas burner as illustrated. Alternatively, other gas sources such as propane may be utilized, or other suitable heat sources may be utilized.

[0027] As discussed, the thermo-electric assembly **220** generates an electrical current. This electrical current may advantageously be utilized to at least partially power various other components of the appliance **100**. Accordingly, electrical current may be flowed to these components to power them. For example, as illustrated, electrical wires **230** may be connected between the converter **222** and the various components which are powered by the generated electrical current. The current may flow through the wires to at least partially power the various components. Additionally, one or more transformers **232** may be provided between the converter **222** and the various components as required to convert the direct current ("DC") electricity generated by the converter **222** to alternating current ("AC") electricity utilized to power the various components.

[0028] In exemplary embodiments as illustrated, at least a portion of the electrical current generated by the thermo-electric assembly **220** may be flowed to the heat pump assembly **200** to at least partially power the heat pump assembly **200**. For example, electrical current may be flowed to the compressor **202** and to the evaporator fan **212** to at least partially power these components of the heat pump assembly **200**. Additionally or alternatively, at least a portion of the electrical current generated by the thermo-electric assembly **220** may be flowed to the controller **134** to at least partially power the controller **134**. Additionally or alternatively, at least a portion of the electrical current generated by the thermo-electric assembly **220** may be flowed to components of an exhaust assembly as discussed herein to at least partially power the components of the exhaust assembly.

[0029] In some embodiments, between approximately 10% and approximately 40% of the thermal energy from the working fluid **224** can be converted to electricity. At least a portion of the remaining thermal energy, such as between approximately 60% and approximately 90% of the thermal energy, from the working fluid **224** can thus advantageously be utilized to heat water within chamber **111**. For example, in exemplary embodiments, thermo-electric assembly **220** may further include a conduit **240** through which working fluid **224** may flow. Conduit **240** may define a passage **242** that extends between an inlet **244** and an outlet **246**. The inlet **244** may be connected to and in fluid communication with the thermo-electric converter **222** for flowing the working fluid **224** from the thermo-electric converter **222** into the passage **242**. The outlet **246** may be connected to an in fluid communication with the thermo-electric converter **222** for flowing the working fluid **224** from the passage **242** into the thermo-electric converter **222**. Accordingly, working fluid **224** may have a closed-loop flow path between the converter **222** and conduit **240**.

[0030] The working fluid **224** exiting converter **222** into conduit **240** may be relatively hot working fluid **224** which has been heated by heat source **226**. The working fluid **224** entering converter **222** from conduit **240** may be relatively cool working fluid **224** which has undergone heat exchange and thus emitted heat. For example, in some embodiments, as illustrated in FIG. **2**, at least a portion of the conduit **240** may be in contact with the tank **101**, such as with an exterior surface of the tank **101**. For example, as illustrated, at least a portion of the conduit **240** may be wrapped around the tank **101**, such as in a helical manner. Heated working fluid **224** may be flowed into and through the conduit **240**. Heat exchange between the tank **101** (and water therein) and the conduit **240** (and working fluid **224** therein) may heat the water and cool the working fluid **224** via emission of heat from the working fluid **224**. The cooled working fluid **224** may then be flowed from conduit **240** into converter **222**, wherein the working fluid **224** may again be heated by heat source **226**.

[0031] In other embodiments, as illustrated in FIG. **3**, heat exchange may occur with an auxiliary assembly rather than directly between the tank **101** (and water therein) and the conduit **240** (and working fluid **224** therein). For example, assembly **220** may further include an auxiliary fluid tank **250** and an auxiliary conduit **252**. An auxiliary fluid **254** may be flowed into and through the tank **250** and conduit **252**. In exemplary embodiments, the auxiliary fluid **254** may be water or another suitable liquid. Conduit **252** may define a passage **262** that extends between an inlet **264** and an outlet **266**. The inlet **264** may be connected to and in fluid communication with the tank **250** for flowing the auxiliary fluid **254** from the tank **250** into the passage **262**. The outlet **266** may be connected to and in fluid communication with the tank **250** for flowing the auxiliary fluid **254** from the passage **262** into the tank **250**. Accordingly, auxiliary fluid **254** may have a closed-loop flow path between the tank **250** and conduit **252**. Notably, in some embodiments, assembly **220** may additionally include a pump **256** disposed at least partially in auxiliary fluid tank **250** for flowing auxiliary fluid **254** from tank **250** through inlet **264** into passage **262**.

[0032] A portion of the conduit **240** may be disposed within the auxiliary fluid tank **250** as illustrated or in contact with the auxiliary fluid tank **250** (such as with an exterior surface thereof). Heated working fluid **224** may be flowed into and through the conduit **240**. Heat exchange between the tank **250** (and auxiliary fluid **254** therein) and the conduit **240** (and working fluid **224** therein) may heat the auxiliary fluid **254** and cool the working fluid **224** via emission of heat from the working fluid **224**. The cooled working fluid **224** may then be flowed from conduit **240** into converter **222**, wherein the working fluid **224** may again be heated by heat source **226**.

[0033] The auxiliary fluid **254** exiting tank **250** into conduit **252** may thus be relatively hot auxiliary fluid **254** which has been heated by such heat exchange. The auxiliary fluid **254** entering tank **250** from conduit **252** may be relatively cool auxiliary fluid **254** which has undergone heat exchange and thus emitted heat. For example, in some embodiments, as illustrated in FIG. **3**, at least a portion of the conduit **252** may be in contact with the tank **101**, such as with an exterior surface of the tank **101**. For example, as illustrated, at least a portion of the conduit **252** may be wrapped around the tank **101**, such as in a helical manner. Heated auxiliary fluid **254** may be flowed into and through the conduit **252**. Heat exchange between the tank **101** (and water therein) and the conduit **252** (and auxiliary fluid **254** therein) may heat the water and cool the auxiliary fluid **254** via emission of heat from the auxiliary fluid **254**. The cooled auxiliary fluid **254** may then be flowed from conduit **252** into tank **250**, wherein the auxiliary fluid **254** may again be heated by heat exchange between the tank **250** (and auxiliary fluid **254** therein) and the conduit **240** (and working fluid **224** therein).

[0034] Referring again to FIGS. **2** and **3**, appliance **100** may further include a heat recovery vessel **270**. Heat recovery vessel **270** may be disposed at least partially within the chamber **111**, and may thus for example, extend through the tank **101** into the chamber **111**. Vessel **270** may define a passage **272** extending between an inlet **274** and an outlet **276**. The outlet **276** may be disposed within the chamber **211**. The inlet **274** may be configured to receive exhaust fluid (such as exhaust gas) from the heat source **226** therethrough, and thus for example, may be disposed exterior to tank **101**. For example, inlet **274** may be positioned to receive exhaust fluid from heat source **226** as the exhaust fluid flows past thermo-electric converter **222**, as illustrated. The exhaust fluid may include heat not emitted to converter **222** and working fluid **224** therein. This exhaust fluid may flow through inlet **274** into and through passage **272**. During such flow through passage **272**, heat exchange may occur through the vessel **270** between the water in the chamber **211** and the exhaust fluid in the vessel **270**, thus heating the water and cooling the exhaust fluid. In some embodiments, vessel **270** may further include fins **278** projecting to the chamber **211** to further facilitate such heat exchange.

[0035] Exhaust fluid flowing through passage **272** may exit passage **272** through outlet **276**, and may further flow to exterior to tank **101** to be exhausted from appliance **100**. For example, in some embodiments, a condensing conduit **280** may be connected to the vessel **270**. Condensing conduit **280** may define a passage **282** extending between and inlet **284** and an outlet **286**. Inlet **284** may be connected to outlet **276**, such that exhaust fluid flows from passage **272** into passage **282**. The exhaust fluid may further flow through condensing conduit **280**, wherein further heat exchange may occur between the water in the chamber **211** and the exhaust fluid in the conduit **280**, thus heating the water and cooling the exhaust fluid. The outlet **286** of conduit **280** may be disposed exterior to the tank **101** (and may further be exterior to the casing **102** as illustrated). Cooled exhaust fluid may exit conduit **280** through outlet **286**.

[0036] In some embodiments, appliance **100** may further include an exhaust assembly **290** which may be connected to the outlet **286** of the condensing conduit **280**. Exhaust assembly **290** may, for example, be disposed exterior to the tank **101** (and may further be exterior to the casing **102** as illustrated). Exhaust assembly **290** may receive exhaust fluid from the vessel **270** generally, such as from the condensing conduit **280**, and may exhaust the exhaust fluid therefrom. For example, exhaust assembly **290** may include a housing **296**, vent **298**, exhaust fan **292** and drain **294** (which may for example be a preexisting drain of a home or office to which the appliance is coupled). Exhaust fluid may flow from outlet **286** into housing **296**. Gaseous components of the exhaust fluid may flow through vent **298** to be exhausted, and this flow may be encouraged by fan **292**. Liquid components of the exhaust fluid may flow through drain **294** to be exhausted. Notably, in exemplary embodiments, at least a portion of the electrical current generated by the thermo-electric assembly **220** may be flowed to fan **292** to at least partially power the fan **292**.

[0037] As discussed, water heater appliances **100** in accordance with the present disclosure advantageously operate with improved energy factors. In particular, the combined use of heat pump assemblies and thermo-electric assemblies as discussed herein, and in particular the use of the electrical current generated by the thermo-electric assemblies to power various other components of the water heater appliances **100**, advantageously improves the energy factor of the associated water heater appliance. Additionally, the use of heat recovery vessels **270** and other components as disclosed herein advantageously provides further increased and efficient heat exchange, thus further contributing to the improved energy factors of water heater appliances in accordance with the present disclosure.

[0038] 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 water heater appliance, comprising:

a tank defining a chamber, the tank further defining an inlet aperture and an outlet aperture;

a hot water conduit extending through the outlet aperture and in fluid communication with the chamber of the tank, the hot water conduit configured for directing a flow of water out of the chamber of the tank;

a cold water conduit extending through the inlet aperture and in fluid communication with the chamber of the tank, the cold water conduit configured for directing a flow of water into the chamber of the tank;

a heat pump assembly configured to heat water within the chamber of the tank; and

a thermo-electric assembly configured to generate an electrical current, the thermo-electric assembly comprising an thermo-electric converter, a working fluid flowable through the thermo-electric converter, and a heat source configured to heat the working fluid within the thermo-electric converter,

wherein at least a portion of the electrical current generated by the thermo-electric assembly is flowed to the heat pump assembly to at least partially power the heat pump assembly.

2. The water heater appliance of claim **1**, wherein the working fluid is an alkali-metal working fluid.

3. The water heater appliance of claim **1**, wherein the thermo-electric assembly further comprises a conduit, the conduit defining a passage extending between an inlet and an outlet for flowing the working fluid therethrough, the inlet in fluid communication with the thermo-electric converter for flowing the working fluid from the thermo-electric converter into the passage, the outlet in fluid communication with the thermo-electric converter for flowing the working fluid from the passage into the thermo-electric converter.

4. The water heater appliance of claim **3**, wherein a portion of the conduit is in contact with the tank.

5. The water heater appliance of claim **4**, wherein the portion of the conduit is generally helically wrapped around the tank.

6. The water heater appliance of claim **3**, wherein the thermo-electric assembly further comprises an auxiliary fluid tank and an auxiliary conduit, the conduit defining a passage extending between an inlet and an outlet for flowing an auxiliary fluid therethrough, the inlet in fluid communication with the auxiliary fluid tank for flowing the auxiliary fluid from the auxiliary fluid tank into the passage, the outlet in fluid communication with the auxiliary fluid tank for flowing the auxiliary fluid from the passage into the auxiliary fluid tank.

7. The water heater appliance of claim **6**, wherein a portion of the auxiliary conduit is in contact with the tank.

8. The water heater appliance of claim **1**, wherein the heat source is a gas burner.

9. The water heater appliance of claim **8**, wherein the gas burner is a natural gas burner.

10. The water heater appliance of claim **1**, further comprising a heat recovery vessel disposed at least partially within the chamber, the heat recovery vessel defining a passage extending between an inlet and an outlet, the inlet configured to receive exhaust fluid from the heat source therethrough.

11. The water heater appliance of claim **10**, further comprising a condensing conduit connected at an inlet to the outlet of the heat recovery vessel.

12. The water heater appliance of claim **11**, further comprising an exhaust assembly exterior to the tank, the exhaust assembly connected to an outlet of the condensing conduit.

13. The water heater appliance of claim **12**, wherein the exhaust assembly comprises an exhaust fan and a vent.

14. The water heater appliance of claim **13**, wherein at least a portion of the electrical current generated by the thermo-electric assembly is flowed to the exhaust fan to at least partially power the exhaust fan.

15. The water heater appliance of claim **1**, further comprising a controller, and wherein at least a portion of the electrical current generated by the thermo-electric assembly is flowed to the controller to at least partially power the controller.

16. A water heater appliance, comprising:

a tank defining a chamber, the tank further defining an inlet aperture and an outlet aperture;

a hot water conduit extending through the outlet aperture and in fluid communication with the chamber of the tank, the hot water conduit configured for directing a flow of water out of the chamber of the tank;

a cold water conduit extending through the inlet aperture and in fluid communication with the chamber of the tank, the cold water conduit configured for directing a flow of water into the chamber of the tank;

a heat pump assembly configured to heat water within the chamber of the tank;

a thermo-electric assembly configured to generate an electrical current, the thermo-electric assembly comprising an thermo-electric converter, a working fluid flowable through the thermo-electric converter, and a heat source configured to heat the working fluid within the thermo-electric converter;

a heat recovery vessel disposed at least partially within the chamber, the heat recovery vessel defining a passage extending between an inlet and an outlet, the inlet configured to receive exhaust fluid from the heat source therethrough;

a condensing conduit connected at an inlet to the outlet of the heat recovery vessel; and

an exhaust assembly exterior to the tank, the exhaust assembly connected to an outlet of the condensing conduit,

wherein at least a portion of the electrical current generated by the thermo-electric assembly is flowed to the heat pump assembly to at least partially power the heat pump assembly.

17. The water heater appliance of claim **16**, wherein the thermo-electric assembly further comprises a conduit, the conduit defining a passage extending between an inlet and an outlet for flowing the working fluid therethrough, the inlet in fluid communication with the thermo-electric converter for flowing the working fluid from the thermo-electric converter into the passage, the outlet in fluid communication with the thermo-electric converter for flowing the working fluid from the passage into the thermo-electric converter.

18. The water heater appliance of claim **16**, wherein the exhaust assembly comprises an exhaust fan and a vent.

19. The water heater appliance of claim **18**, wherein at least a portion of the electrical current generated by the thermo-electric assembly is flowed to the exhaust fan to at least partially power the exhaust fan.

20. The water heater appliance of claim **16**, further comprising a controller, and wherein at least a portion of the electrical current generated by the thermo-electric assembly is flowed to the controller to at least partially power the controller.

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