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(54) **ABSORPTION CHILLERS**

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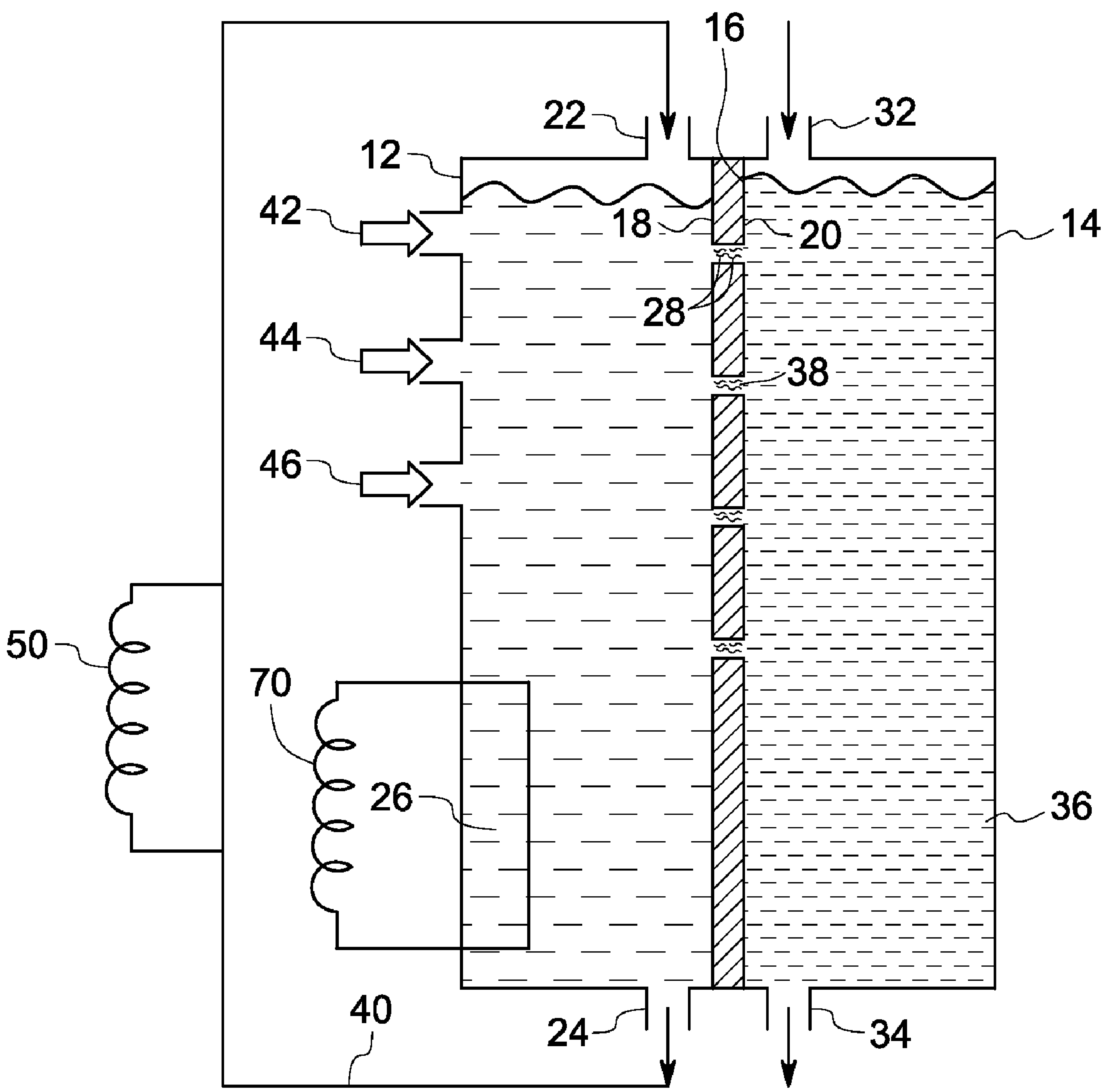
(57) **ABSTRACT**

An absorption chiller system is provided. The system includes an evaporator, an absorber, a divider, a recirculating loop, and a primary heater. The evaporator includes a first working fluid inlet and a first working fluid outlet. The absorber includes a second working fluid inlet and a second working fluid outlet. The divider has opposing first and second sides, wherein the first side is in fluid communication with the evaporator and the second side is in fluid communication with the absorber. The recirculating loop connects the first working fluid outlet back to the evaporator, and the primary heater is disposed in thermal communication with the recirculating loop.



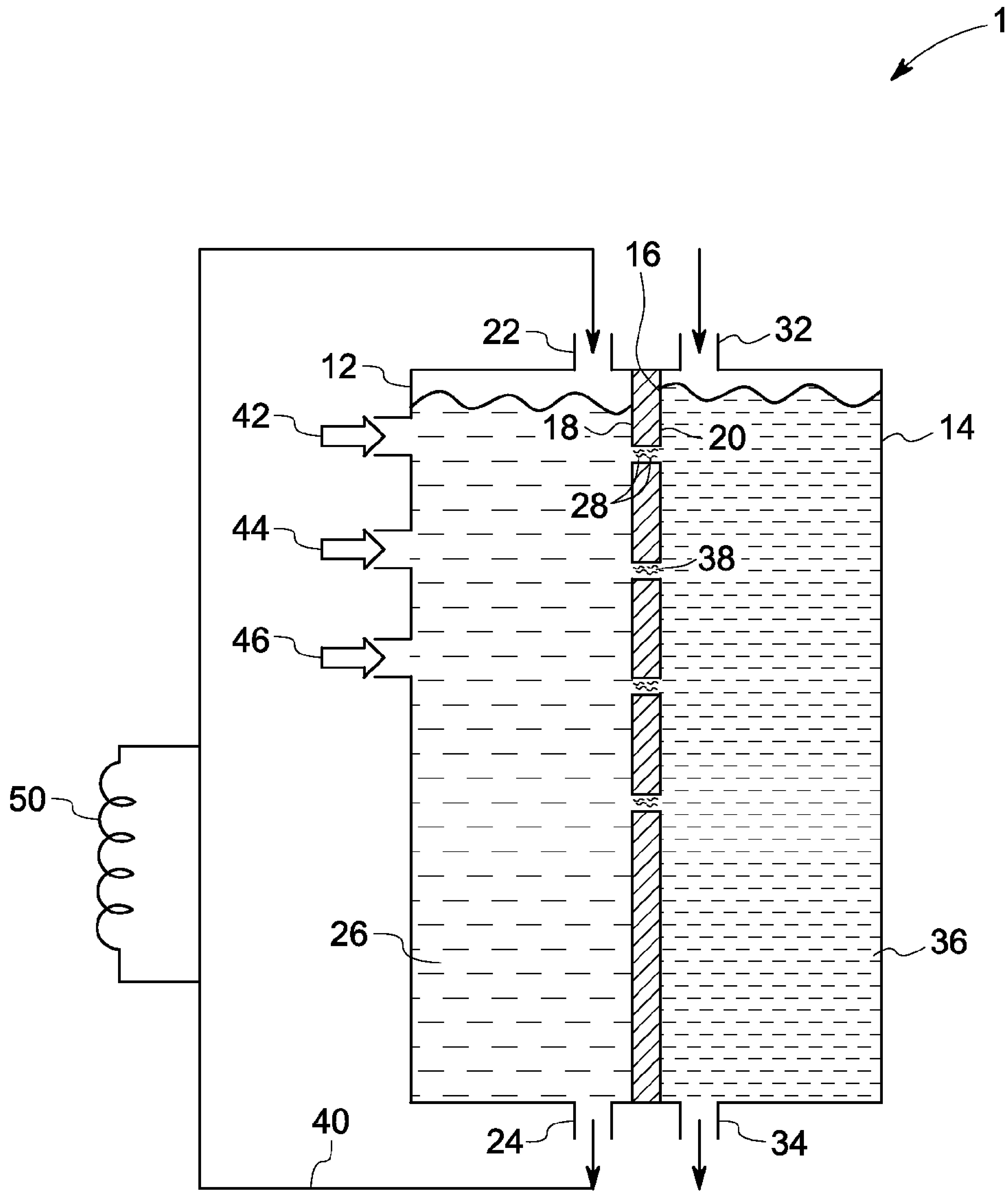


FIG. 1

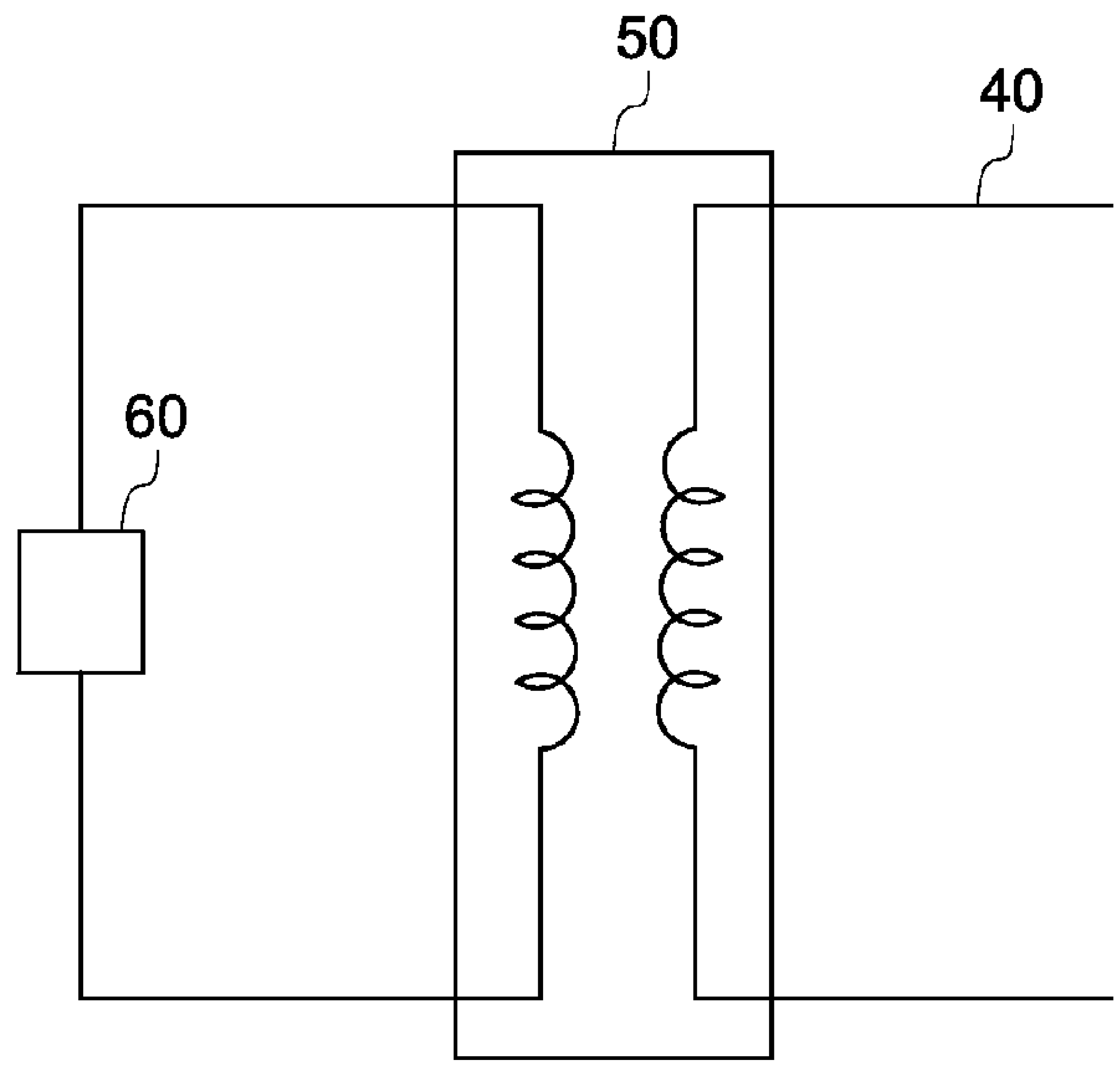


FIG. 2

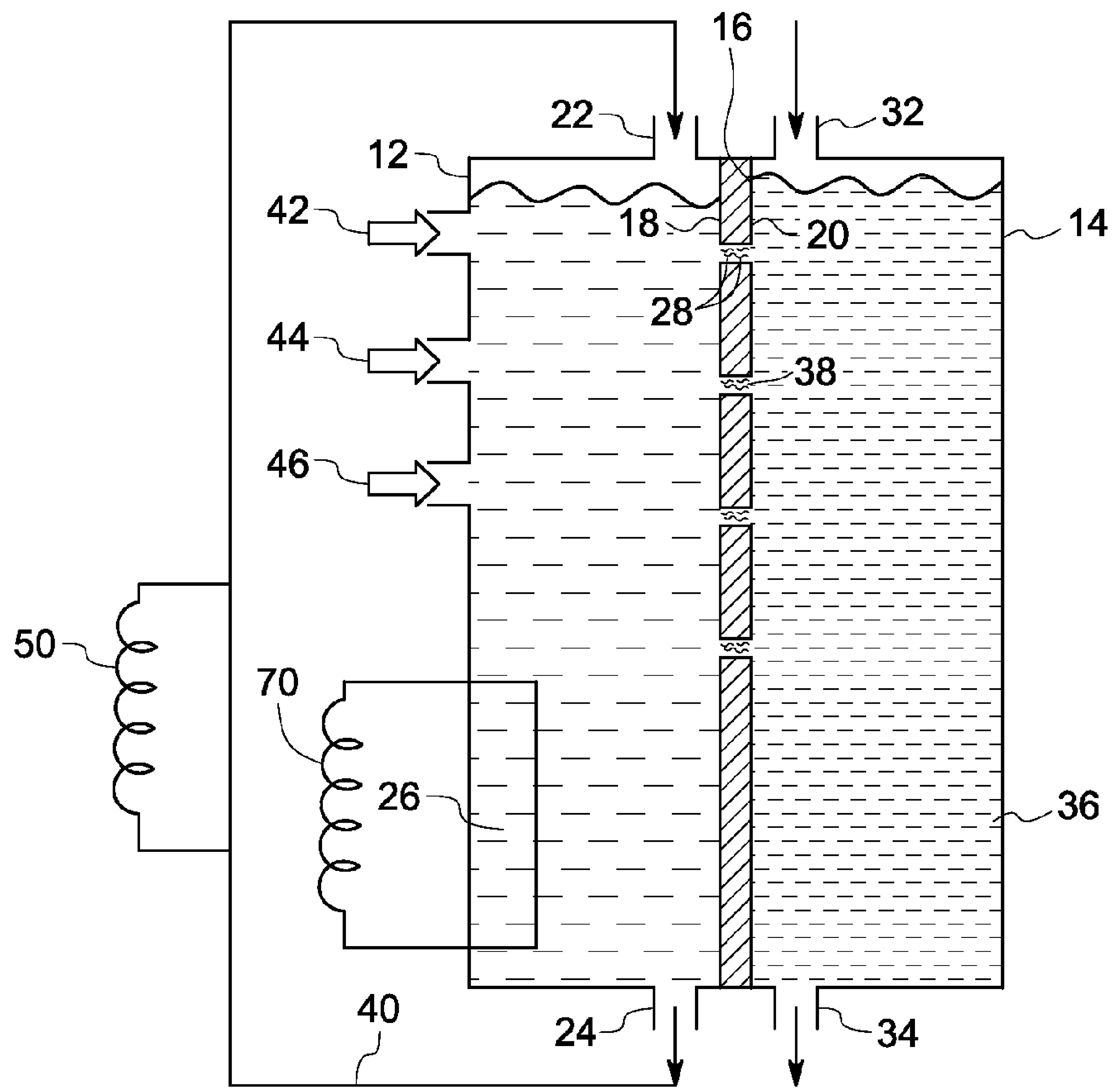


FIG. 3

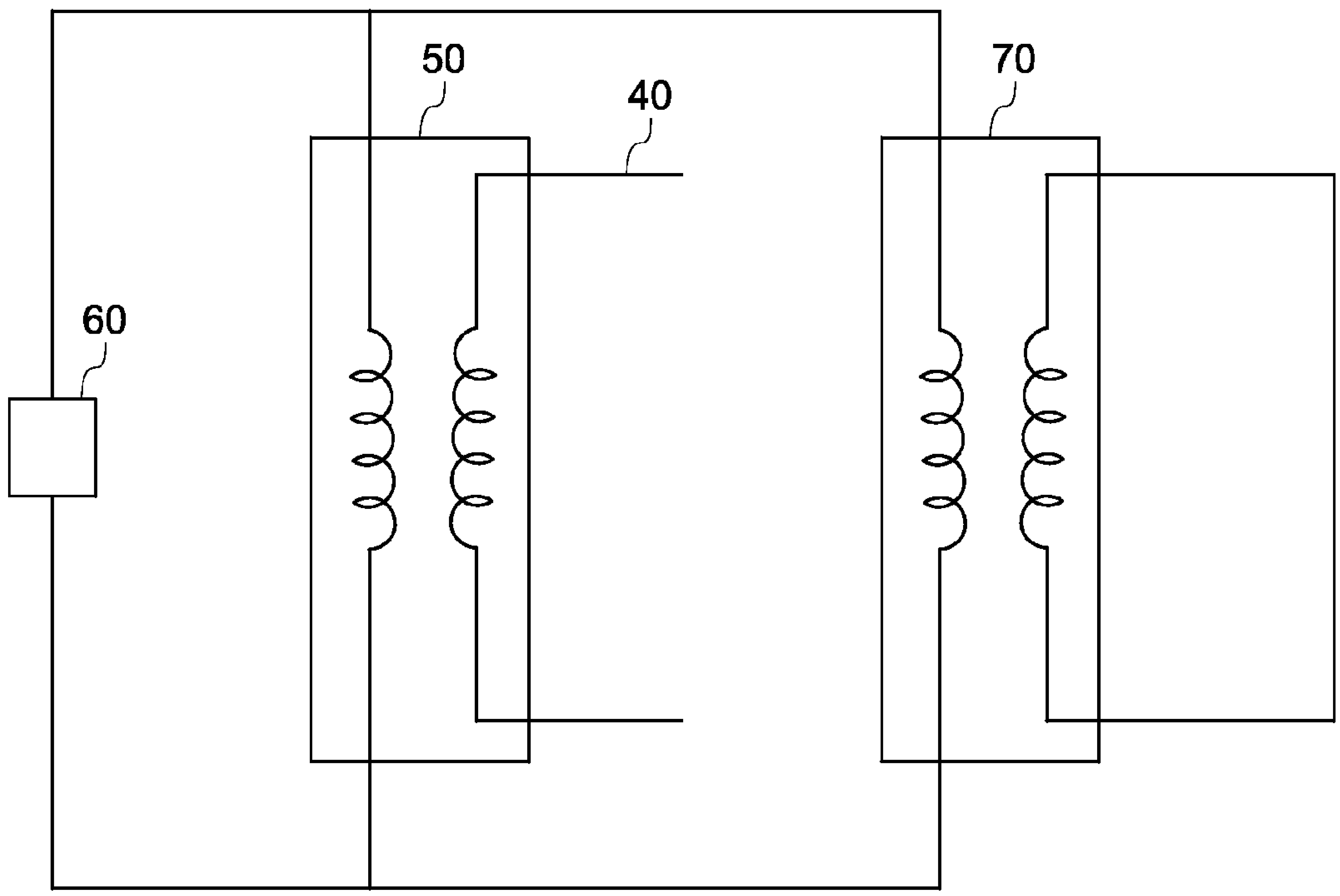


FIG. 4

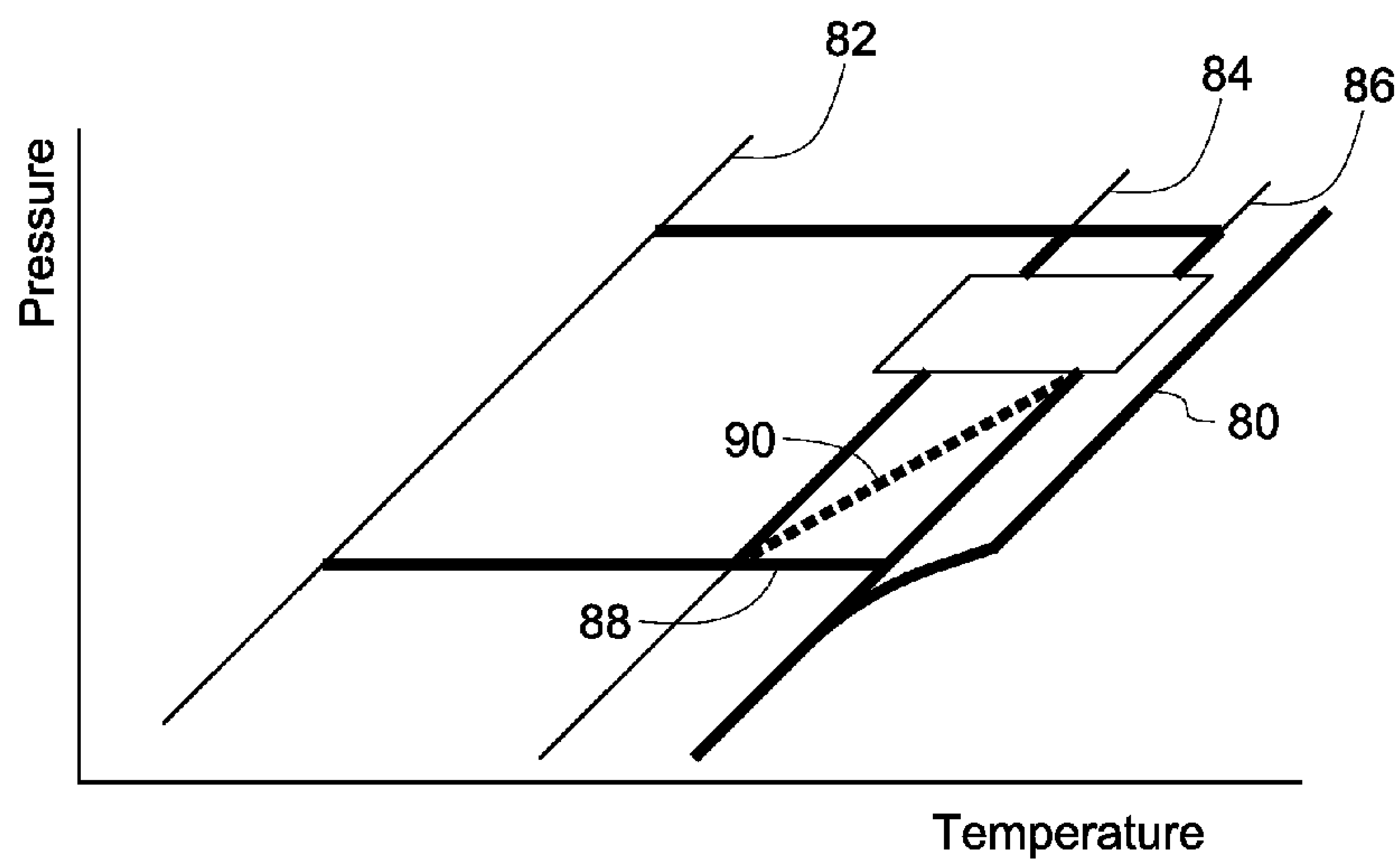

82
84
86
Pressure
90
80
88
Temperature

FIG. 5

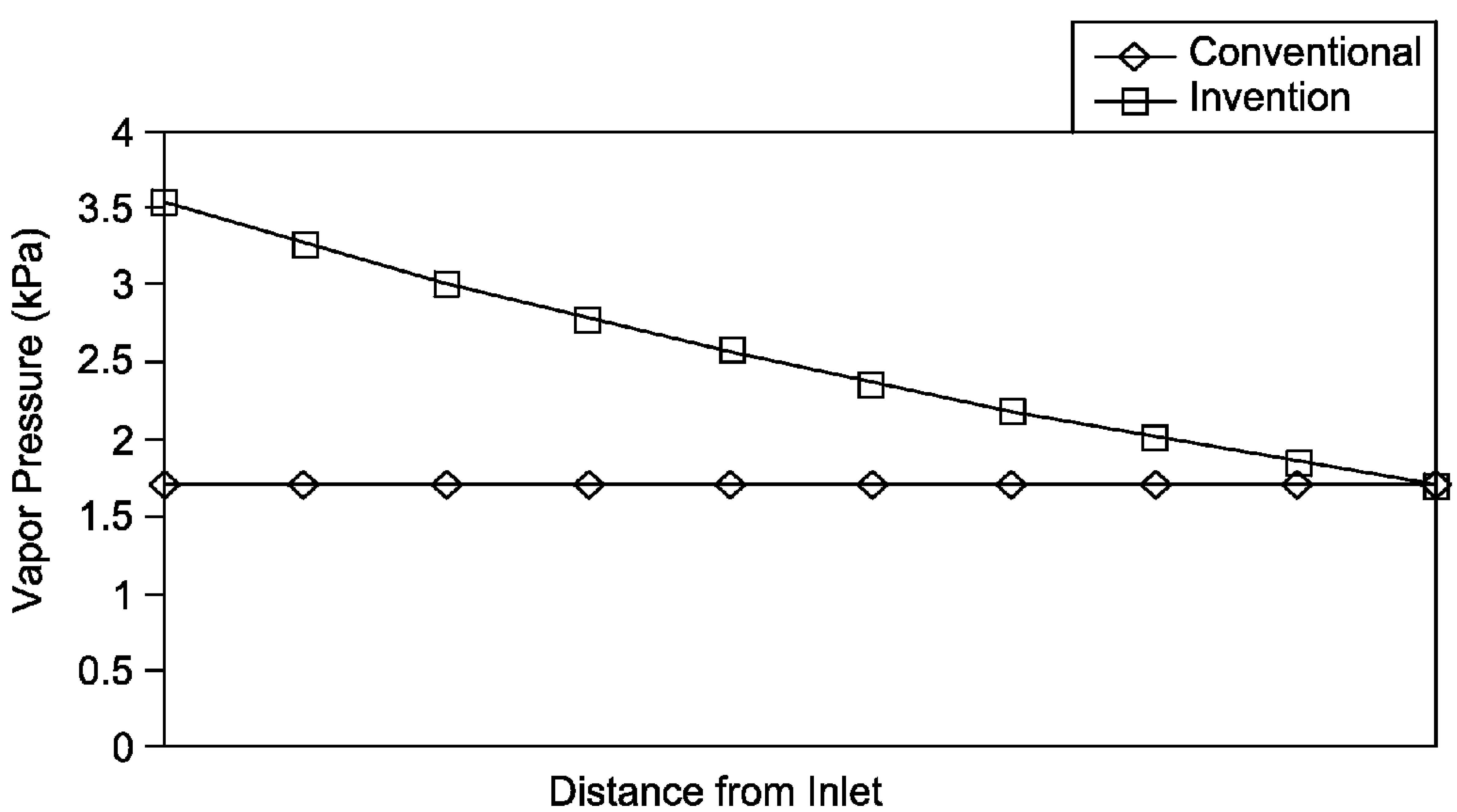

Conventional
Invention
4
3.5
3
2.5
2
1.5
1
0.5
0
Vapor Pressure (kPa)
Distance from Inlet

FIG. 6

ABSORPTION CHILLERS

BACKGROUND

[0001] This invention relates generally to an absorption chiller system. Particularly the invention relates to an absorption chiller system including an external recirculating loop for a working fluid.

[0002] Absorption chillers are thermally driven temperature lift devices where heat sources provide the driving thermal energy. Absorption chillers are environmentally friendly and generally use less electrical energy compared to conventional coolers that use electrically driven vapor compressors to provide the primary driving energy. Absorption chillers provide a cooling effect by evaporating a refrigerant in an evaporator. The resultant refrigerant vapor is then combined with an absorbent in an absorber. The absorption chillers may be powered by different means, including natural gas, steam, or waste heat.

[0003] Crystallization of the absorbents such as lithium bromide in the absorber is one of the classic technical challenges for commercializing absorption chillers. Membrane-based absorption chillers generally help in reducing the crystallization of the absorbents. Further control of crystallization of absorbents at the absorber, thereby enabling the absorption chillers to operate in a wide temperature range, is an existing need. Embodiments of the present invention relate to the systems and methods that enable further reduction in crystallization of absorbent at the absorber.

BRIEF DESCRIPTION

[0004] Briefly, in one embodiment, a system is provided. The system includes an evaporator, an absorber, a divider, a recirculating loop, and a primary heater. The evaporator includes a first working fluid inlet and a first working fluid outlet. The absorber includes a second working fluid inlet and a second working fluid outlet. The divider has opposing first and second sides, wherein the first side is in fluid communication with the evaporator and the second side is in fluid communication with the absorber. The recirculating loop connects the first working fluid outlet back to the evaporator, and the primary heater is disposed in thermal communication with the recirculating loop.

[0005] In one embodiment, a system is provided. The system includes an evaporator, an absorber, a divider, a recirculating loop, a primary heater, and a secondary heater. The evaporator includes a first working fluid inlet and a first working fluid outlet. The absorber includes a second working fluid inlet and a second working fluid outlet. The divider can be a hydrophobic porous membrane and has opposing first and second sides, wherein the first side is in fluid communication with the evaporator and the second side is in fluid communication with the absorber. The recirculating loop connects the first working fluid outlet back to the evaporator. The primary heater is disposed in thermal communication with the recirculating loop and the secondary heater is disposed in thermal communication with the evaporator.

[0006] In one embodiment, a method is disclosed. The method includes the steps of evaporating at least a part of a first working fluid in an evaporator, passing at least a part of the first working fluid vapor through a divider to an absorber that includes a second working fluid, exiting at least a part of the first working fluid through a first working fluid outlet of the evaporator, heating at least a part of the first working fluid after departing from the first working fluid outlet, and recirculating at least a part of the heated first working fluid back to the evaporator.

DRAWINGS

[0007] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0008] FIG. **1** illustrates an absorption chiller system, according to an embodiment of the invention;

[0009] FIG. **2** illustrates arrangement of primary heater according to an embodiment of the invention;

[0010] FIG. **3** illustrates an absorption chiller system as per an example according to one embodiment of the invention;

[0011] FIG. **4** illustrates arrangement of primary heater according to an embodiment of the invention;

[0012] FIG. **5** illustrates a Dühring plot as per an example according to one embodiment of the invention; and

[0013] FIG. **6** compares the vapor pressures of a conventional system with an absorption chiller, according to one embodiment of the invention.

DETAILED DESCRIPTION

[0014] One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0015] In the following specification and the claims that follow, the singular forms "a", "an" and "the" include plural referents unless the context clearly dictates otherwise.

[0016] Referring to FIG. **1**, a part of an absorption chiller system **10**, configured in accordance with an example embodiment, is shown. The system **10** can include an evaporator **12** and an absorber **14**. A divider **16** may be disposed between the evaporator **12** and the absorber **14**. In one embodiment, the divider **16** may be a membrane. The divider **16** has opposing first **18** and second **20** sides with the evaporator **12** being in fluid communication with the first side **18** and the absorber **14** being in fluid communication with the second side **20**. For example, in one embodiment, the evaporator **12** can be coupled to the first side **18** and the absorber **14** can be coupled to the second side **20**.

[0017] The evaporator **12** may have a first working fluid inlet **22** and a first working fluid outlet **24**. The evaporator **12** may be configured to receive a first working fluid (refrigerant) **26** and to produce first working fluid vapor **28**. For example, in one embodiment, the first working fluid **26** may be water, and the evaporator **12** may receive liquid water (for example, through first working fluid inlet **22**) and may produce water vapor **28**. Other candidate first working fluids are discussed below. Liquid first working fluid **26** may circulate through the evaporator **12**, and the unevaporated portions are emitted from the evaporator, for example, at the first working fluid outlet **24**.

[0018] The absorber **14** may have a second working fluid inlet **32** and a second working fluid outlet **34**. The absorber **14** may be configured to receive the first working fluid vapor **28** and to combine at least some of that first working fluid vapor **28** with a second working fluid (absorbent) **36**. The second working fluid **36** may circulate through the absorber **14**, such that the second working fluid is received, for instance, at the second working fluid inlet **32**, travels through the absorber, and exits at the second working fluid outlet **34**. Given that the second working fluid **36** enters the absorber **14** and then is combined therein with first working fluid vapor **28**, the second working fluid **36** entering the absorber has a relatively lesser concentration therein of first working fluid than does the second working fluid **36** inside and exiting the absorber. The second working fluid **36** entering the absorber **14** at the second working fluid inlet **32** is therefore referred to herein as "relatively concentrated second working fluid," and the second working fluid **36** inside the absorber and exiting at the second working fluid outlet **34** is referred to herein as "relatively diluted second working fluid."

[0019] The divider **16** can be disposed between, and in fluid communication with, the evaporator **12** and the absorber **14**. The first side **18** of the divider **16** therefore may be contacted by liquid first working fluid **26** and the first working fluid vapor **28**, and the second side **20** may be contacted by the second working fluid **36** and first working fluid vapor **28** that may be disposed in the absorber **14**. In some embodiments, virtually all of the volume within the evaporator **12** may be occupied by liquid first working fluid **26** and/or all of the volume within the absorber **14** may be occupied by the second working fluid **36**. In such cases, first working fluid vapor **28** in the evaporator **12** would be found mainly at the pores **38** of the divider **16**.

[0020] The divider **16** may be configured to allow first working fluid vapor **28** to pass through between the first and second sides **18**, **20**, and to inhibit movement of liquid first working fluid **26** and the second working fluid **36** through between said first and second sides. For example, the divider **16** may define holes **38** there through. The holes **38** may be sized in accordance with the properties of the first and second working fluids **26**, **36** and those of the material making up the divider **16** in order to assure that the interfacial energies of liquid first and second working fluids and the membrane are such that the liquid first and second working fluids are energetically prevented from assuming a configuration necessary to pass through the holes in the membrane.

[0021] The second working fluid **36** may be chosen such that, when received at the absorber **14** (under appropriate conditions), an equilibrium partial pressure P**2** of first working fluid vapor **28** at the second side **20** (and possibly throughout the absorber) is less than a partial pressure P**1** of first working fluid vapor at the first side **18** (and possibly throughout the evaporator **12**). For example, the first and second working fluids **26**, **36** may be chosen such that the second working fluid includes as a component thereof a liquid that has a strong affinity for the first working fluid. In such a case, the equilibrium partial pressure P**2** of the first working fluid vapor **28** in the vicinity of the second working fluid **36** will tend to be low relative, for example, to the partial pressure P**1** expected in the vicinity of liquid first working fluid **26**. Examples of pairs of first and second working fluids **26**, **36** that may be utilized in conjunction with embodiments of the above described system **10** include, but are not limited to, water and lithium bromide; NH_3 and water (or a mixture of water and NH_3); water and $LiClO_3$; water and $CaCl_2$, water and $ZnCl_2$; water and ZnBr; water and H_2SO_4; and SO_2 and organic solvents.

[0022] The difference in partial pressures P**1** and P**2** of first working fluid vapor **28** across the divider **16** results in a driving force for diffusion of first working fluid vapor from the first side **18** to the second side **20**. Once first working fluid vapor **28** reaches the second side **20**, it can be combined in the absorber **14** with the second working fluid **36**, with this combination being made more likely by the proper choice of a second working fluid having an affinity for first working fluid. Mass of first working fluid **26** will therefore be transferred from the evaporator **12** to the absorber **14** in the form of a vapor **28**.

[0023] As mass is transferred from the evaporator **12** to the absorber **14**, the balance in the evaporator between liquid first working fluid **26** and first working fluid vapor **28** will be disrupted, resulting in reducing the temperature of the first working fluid or absorbing external thermal energy. It is noted that continued evaporation of liquid first working fluid **26** in the evaporator **12** does not necessarily require the input of external thermal energy, but instead may proceed simply due to the affinity of the second working fluid **36** for first working fluid. The evaporation will stop when the pressure of the first working fluid vapor **28** balances the saturated pressure of the first working fluid **26**.

[0024] In the conventional chillers, the total pressure within either the evaporator or the absorber needs to be approximately the same as the respective partial pressure therein of first working fluid vapor. With the evaporator **12** and the absorber **14** separated by the divider **16** as discussed above in various embodiments of the invention, it may not be required that the total pressure within either of the evaporator or the absorber is approximately the same as the respective partial pressure therein of first working fluid vapor **28**. Rather, the evaporator **12** may be configured such that the total pressure therein is greater than the partial pressure P**1** of first working fluid vapor **28**. In one embodiment, the total pressure at the evaporator is at least twice the partial pressure P**1** of first working fluid vapor **28**. Further, the absorber **14** may be configured such that the total pressure therein is at least twice the partial pressure P**2** of first working fluid vapor **28**. As such, embodiments of the system **10** may have a total size and weight that is significantly reduced with respect to conventional absorption chiller sub-systems.

[0025] For the first working fluid vapor **28** to be driven from one side of the divider **16** to the other, particular temperatures and pressures are desired. As mentioned above, the evaporation of liquid first working fluid **26** in the evaporator **12**, the diffusion of first working fluid vapor **28** from the first side **18** of the divider **16** to the second side **20**, and the absorption of first working fluid vapor (or other energy-releasing event) in the absorber **14** can proceed spontaneously, acting to transfer thermal energy from the evaporator to the absorber. However, as thermal energy is transferred, the temperature of the liquid first working fluid **26** (in the absence of any other energy transfers) may drop, thereby reducing (and eventually eliminating) the tendency for further evaporation. At the same time, the temperature of the second working fluid **36** (again, in the absence of any other energy transfers) will rise, thereby decreasing (and eventually eliminating) the tendency of first working fluid vapor **28** therein to be absorbed. It is noted that, in some embodiments, the divider **16** may include a thermally insulating material, thereby preventing the transfer of heat through from the absorber **14** to the evaporator **12**.

[0026] In one embodiment, the primary working fluid **26** exiting from the first working fluid outlet **24** of the evaporator **12** may be recirculated to the inlet **22** of the evaporator **12** through a recirculating loop **40**. The recirculating loop **40** may recirculate the first working fluid to the evaporator through the first working fluid inlet **22** or through any other point in between the first working fluid inlet **22** and the first working fluid outlet **24** in the evaporator **14**. For example, the recirculating loop **40** may join the evaporator **14** at any of the points **42**, **44**, **46** of the evaporator.

[0027] Generally, the temperature of the refrigerant in the evaporator decreases from the inlet to outlet. In one embodiment, the temperature of the recirculated liquid refrigerant is lower than the refrigerant temperature at the inlet **22** and higher than the refrigerant temperature at the outlet **24**. In one embodiment, it is desirable that the recirculated refrigerant meet the refrigerant in the evaporator at a point where temperature of the recirculated refrigerant matches temperature of the refrigerant in the evaporator. As a result, more vapor can be transferred to the absorber in the beginning part of the absorber, leading to increasing the crystallization margin.

[0028] In one embodiment, in order to allow the transfer of vapors from the evaporator **12** to the absorber **14** to continue, the first working fluid **26** exiting the evaporator **12** through the recirculating loop **40** is brought into thermal communication with a thermal energy source, such as a primary heater **50**. As used herein, "thermal communication" means the thermal energy transfer in between the primary heater **50** and the recirculating loop **40**. In one embodiment, the thermal energy is transferred from the primary heater **50** to the recirculating loop **40**. The thermal communication with the primary heater **50** increases the temperature of the recirculated first working fluid **26** entering the evaporator **12** (may be through any one or all the points **22**, **42**, **44**, **46**). The temperature increase of the recirculated first working fluid **26** increases the partial pressure P**1** of the first working fluid at the evaporator **12**. The increased partial pressure P**1** of the first working fluid at first side **18** further promotes the first working fluid vapor **28** transferring to the absorber **14** through the divider **16**.

[0029] In one embodiment, the primary heater **50** is a heat exchanger **50** in fluid communication with a heat-source **60** as shown in FIG. **2**. As used herein, the "fluid communication" means that the primary heater **50** and a heat source are connected through at least one fluid-passing conduit. In one embodiment, the primary heater **50** and the recirculating loop **40** are in fluid communication with each other. As used herein, a heat exchanger is a device, wherein thermal energy is transferred from one part to another. In one embodiment, a heat exchanger includes at least two fluid passing conduits, wherein the thermal energy is transferred from one conduit to another. The heat exchanger **50** may be configured to pass the heat from the heat-source **60** to the recirculating loop **40**.

[0030] In one embodiment, the system **10** may further have a secondary heater **70** disposed in thermal communication with evaporator as shown in FIG. **3**. Similar to primary heater **50**, in one embodiment, the secondary heater **70** is a heat exchanger **70** in fluid communication with a heat-source **80** as shown in FIG. **4**. In a further embodiment, the secondary heater **70** is in fluid communication with the evaporator **12**. In one embodiment, the heat-source **60** that is in fluid communication with primary heater **50** and the heat source **80** that is in fluid communication with the secondary heater **70** are the same as shown in FIG. **4**. In an instance of a same heat-source **60/80** supplying thermal energy to the primary heater **50** and the secondary heater **70**, the primary **50** and the secondary **70** heat exchangers may have a parallel fluid communication with the heat-source **60/80** as shown in FIG. **4** or may have a series or successive fluid communication with the heat-source **60/80** as shown in FIG. **5**. Depending on the design and operations requirement of the system **10**, in an instance of successive fluid communication with the primary **50** and secondary **70** heat exchangers with the heat-source **60/80**, the thermal communication may happen first with the primary heat exchanger **50** or the secondary heat exchanger **70**.

[0031] In one embodiment, in order to allow the transfer of thermal energy from the evaporator **12** to the absorber **14** to continue, the absorber may be brought into thermal communication with a thermal energy sink (not shown). For example, a fluid stream (e.g., air or water) may be circulated between the absorber **14** and the thermal energy sink. The system **10** can therefore be used to extract thermal energy from the heat-sources **60**, **80** and to deposit thermal energy at a thermal energy sink.

[0032] During operation of the system **10**, a generator (not shown) may receive the relatively diluted second working fluid **36** that is outputted at the second working fluid outlet **34** of the absorber **14**. As mentioned above, the second working fluid **36** that is outputted from the absorber **14** has been combined therein with first working fluid vapor **28** passing through the divider **16**. The generator may be configured to receive the relatively diluted second working fluid **36** and to produce separate outputs of first working fluid vapor **28** and a relatively concentrated second working fluid **36**. For example, thermal energy can be added at the generator to raise the temperature of the relatively diluted second working fluid **36**, thereby driving some of the first working fluid dissolved therein out of the solution as first working fluid vapor **28**. The remaining second working fluid, now being relatively concentrated second working fluid **36**, can be directed back to the second working fluid inlet **32** of the absorber **14**.

[0033] The first working fluid vapor **28** outputted from the generator may be directed to a condenser (not shown) to condense first working fluid vapor **28** and provide liquid first working fluid **26** to the evaporator **12**. For example, thermal energy may be removed at the condenser, for example, through the use of a heat exchanger, to cause the first working fluid vapor **28** to condense.

[0034] Overall, the evaporator **12**, absorber **14**, generator, and condenser may operate to form a continuous cycle in which the second working fluid **36** is combined with first working fluid **26** at the absorber and separated from first working fluid at the generator, and first working fluid is converted from vapor to liquid at the condenser and from liquid to vapor at the evaporator.

[0035] As described earlier, the use of a membrane **16** between the evaporator **12** and absorber **14** may alleviate the need to maintain the total pressure in either of the evaporator or the absorber at a level that is about equal to the partial pressure of water vapor in either one. Specifically, each of the evaporator **12** and the absorber **14** may be configured such that a respective total pressure therein is greater than or equal to about atmospheric pressure. This may reduce the size, cost, and/or complexity of the evaporator **12** and absorber **14**. In other embodiments either the evaporator **12** or the absorber **14** may be configured to operate either above or below atmospheric pressure and around ambient temperature.

EXAMPLE

[0036] The following example illustrates methods, materials, and results, in accordance with specific embodiments, and as such should not be construed as imposing limitations upon the claims. All components are commercially available, unless otherwise indicated.

[0037] In one example embodiment, the system **10** employs water as a first working fluid **26**, and a solution of lithium bromide and water as the second working fluid **36** as shown in FIG. **3**. The absorber **14** may be configured to combine water vapor **28** passing through the membrane **16** with the lithium bromide-water solution **36** entering at an inlet port **32**, thereby forming in the absorber a lithium bromide-water solution **36** that is relatively diluted with respect to lithium bromide content (the solution previously being relatively concentrated with respect to lithium bromide content prior to being combined with water vapor passing through the membrane **16**). Lithium bromide tends to have a strong affinity for water, such that the partial pressure of water vapor in the vicinity of lithium bromide tends to be relatively low and the diffusion of water vapor through the membrane **16** is facilitated. The dilution of the lithium bromide-water solution helps in reducing the crystallization of the lithium bromide at the absorber **14**. The additional water vapor **28** formed at the evaporator due to the thermal communication with the heat exchangers **50/70** further helps in evaporation of water **26** at the evaporator and further reduces the lithium bromide crystallization at the absorber.

[0038] As described earlier, in one embodiment, the divider **16** is a membrane. The membrane **16** can define holes **38** that extend between the evaporator **12** and the absorber **14**. The membrane **16**, or at least the portions through which the holes **38** are defined, may be formed of substantially hydrophobic material (e.g., polytetrafluoroethylene, polypropylene, and/or polyvinylidene fluoride). By forming the holes **38** with a maximum diameter of about 100-500 nm from a substantially hydrophobic material, the movement of liquid water **26** through the membrane **16** is substantially prevented, while water vapor **28** is permitted to pass through the holes between the evaporator **12** and absorber **14**. As mentioned earlier, in some embodiments, the membrane **16** may be formed of thermally insulating material, with examples being the hydrophobic materials listed above.

[0039] FIG. **5** shows a Dühring plot for the membrane-based system **10** of FIG. **3** with a primary heater **50** and a secondary heater **70**. The plot depicts the crystallization curve of the lithium bromide solution **80**, the water curve **82**, the diluted lithium bromide curve **84**, and the concentrated lithium bromide curve **86**. In a conventional absorption chiller, the concentrated lithium bromide solution **86** absorbs the water vapor and follows the solid line **88** to become the diluted lithium bromide solution **84**. In one embodiment of the present invention, the concentration of the lithium bromide solution gradually decreases as shown by the dotted line **90** and migrates towards the constant concentration line of the diluted lithium bromide solution **84**. The evaporation process removes heat from the liquid water on the evaporator side, reducing the water temperature, while the primary heater **50** and the secondary heater **70** increase the temperature and thereby the evaporation rate of the water at the evaporator. The process continues until the refrigerant and solution reach their lowest temperatures and vapor pressures. In one embodiment, the dotted line **90** does not intersect line **88** at the diluted lithium bromide solution line **84**. The dotted line **90** may intersect line **88** anywhere between the concentrated lithium bromide solution **86** and the diluted lithium bromide solution **84**, depending on the desired crystallization margin." Thus, in one embodiment, a decrease in the concentration of the lithium bromide solution may be slower than that depicted in FIG. **5**. In this embodiment, after a certain dilution of the lithium bromide solution, the concentration of the lithium bromide solution may follow the path of the lithium bromide solution in a conventional chiller to reach the constant concentration line of the diluted lithium bromide solution.

[0040] The vapor pressure of the first working fluid in a conventional design is lower than that for the system **10** except for the very end section of the evaporator, described herein as shown in FIG. **6**. The higher vapor pressure for the embodiments of the invention results from the higher temperature of the first working fluid for the invention. The increase of the vapor pressure of the example system **10** may result in the size reductions of the absorber and evaporator or the increase of the crystallization margin in the absorber.

[0041] While only certain features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

1. A system comprising:
- an evaporator comprising a first working fluid inlet and a first working fluid outlet;
- an absorber comprising a second working fluid inlet and a second working fluid outlet;
- a divider having opposing first and second sides, wherein the first side is in fluid communication with the evaporator and the second side is in fluid communication with the absorber;
- a recirculating loop connecting the first working fluid outlet to the evaporator; and
- a primary heater disposed in thermal communication with the recirculating loop.

2. The system of claim **1**, wherein the divider comprises a membrane.

3. The system of claim **2**, wherein the membrane comprises a substantially hydrophobic material.

4. The system of claim **2**, wherein the membrane comprises a plurality of holes having an average diameter in a range from about 100 nm to about 500 nm.

5. The system of claim **1**, wherein the recirculating loop connects the first working fluid outlet to the first working fluid inlet.

6. The system of claim **1**, wherein the recirculating loop connects the first working fluid outlet to the evaporator at a point downstream of the first working fluid inlet.

7. The system of claim **1**, further comprising a secondary heater disposed in thermal communication with the evaporator.

8. The system of claim **7**, wherein the primary heater and the secondary heater are heat exchangers in fluid communication with a heat-source.

9. The system of claim **8**, wherein the heat exchangers are connected to the heat-source in a parallel fluid communication.

10. The system of claim **8**, wherein the heat exchangers are connected to the heat-source in successive fluid communication.

11. The system of claim **7**, wherein the primary heater and the secondary heaters are heat exchangers in fluid communication with different heat-sources.

12. A system, comprising:

an evaporator comprising a first working fluid inlet and a first working fluid outlet;

an absorber comprising a second working fluid inlet and a second working fluid outlet;

a hydrophobic membrane based divider having opposing first and second sides, wherein the first side is in fluid communication with the evaporator and the second side is in fluid communication with the absorber;

a recirculating loop connecting the first working fluid outlet to the evaporator;

a primary heater disposed in thermal communication with the recirculating loop; and

a secondary heater disposed in thermal communication with the evaporator.

13. A method comprising:

evaporating at least a part of a first working fluid in an evaporator;

passing at least a part of the first working fluid vapor through a divider to an absorber comprising a second working fluid;

exiting at least a part of the first working fluid through a first working fluid outlet of the evaporator;

heating at least a part of the first working fluid after departing from the first working fluid outlet; and

recirculating at least a part of the heated first working fluid back to the evaporator.

14. The method of claim **13**, wherein the heated first working fluid is recirculated to a first working fluid inlet of the evaporator.

15. The method of claim **13**, wherein the heated first working fluid is recirculated to the evaporator at a point downstream of a first working fluid inlet.

16. The method of claim **13**, wherein the first working fluid comprises water.

17. The method of claim **13**, further comprising heating the first working fluid inside the evaporator.

18. The method of claim **13**, further comprising combining the first working fluid vapor with a second working fluid in the absorber.

19. The method of claim **18**, further comprising cooling at least a part of the second working fluid in the absorber.

20. The method of claim **18**, wherein the second working fluid comprises a lithium bromide solution.

* * * * *