



(11) **EP 1 895 255 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
18.11.2009 Bulletin 2009/47

(51) Int Cl.:
F28D 1/04 ^(2006.01) **F28F 27/02** ^(2006.01)
F28D 1/053 ^(2006.01) **F28F 9/02** ^(2006.01)

(21) Application number: **07075538.4**

(22) Date of filing: **29.06.2007**

(54) **Dual mode heat exchanger assembly**

Wärmetauscheranordnung mit zwei Betriebsarten

Ensemble échangeur thermique bimode

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE
SI SK TR**

(30) Priority: **25.07.2006 US 492476**

(43) Date of publication of application:
05.03.2008 Bulletin 2008/10

(73) Proprietor: **Delphi Technologies, Inc.**
Troy, Michigan 48007 (US)

(72) Inventors:
• **Beamer, Henry E.**
Middleport, NY 14105 (US)

• **Runk, Robert M.**
Lockport, NY 14094 (US)

(74) Representative: **Robert, Vincent et al**
Delphi European Headquarters
64, Avenue de la Plaine de France
Paris Nord II
BP 65059 Tremblay-en-France
95972 Roissy Charles de Gaulle Cedex (FR)

(56) References cited:
EP-A- 0 855 567 GB-A- 2 409 510

EP 1 895 255 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

TECHNICAL FIELD

[0001] The present invention relates to a dual mode heat exchanger assembly and a method of operating the heat exchanger assembly.

BACKGROUND OF THE INVENTION

[0002] Dual mode heat exchanger assemblies operate in a condenser mode for cooling and an evaporator mode for heating. System operating requirements related to refrigerant phase, velocity and distribution vary between the condenser and the evaporator modes. In the evaporator mode, partially expanded two phase refrigerant enters the heat exchanger where the refrigerant continues to expand absorbing heat from the air. Momentum effects due to large mass differences between gas and liquid phase can result in separation of the phases. This two phase flow can result in poor refrigerant distribution in the heat exchanger assembly degrading performance in the evaporator mode and can cause icing/frosting of the core.

[0003] Dual mode heat exchanger assemblies and methods of addressing the differences in refrigerant flow characteristics, are known in the art. One approach involves modifying the pass arrangements depending on the mode of operation. This generally involves establishing a flow path length for circulating the refrigerant in the condenser mode and reducing the flow path length of the refrigerant in the evaporator mode, generally by bypassing some of the flow tubes that pass refrigerant between manifolds. Another method involves inclusion of distribution tubes, structures with a plurality of apertures, to facilitate the distribution of the refrigerant within the manifolds when the heat exchanger assembly is operating in the evaporator mode.

[0004] Examples of such assemblies are disclosed in Patent Application 2,409,510 A to Heys, U.K Patent Application 2,375,596 A to Heys, U.S. Patent 5,826,649 to Chapp et al.

[0005] The Heys '510 Patent Application discloses a dual purpose heat exchanger assembly with an external bypass means of reducing the number of passes during the evaporator mode. The heat exchanger assembly uses one port to introduce refrigerant and one port to exit refrigerant from the heat exchanger assembly. The bypass means is associated with one of the manifolds, which, when open, connects the manifold with the port where refrigerant is introduced, to reduce the number of passes by at least one. This reduces the length of the flow path when the system is in evaporator mode reducing the pressure drop through the heat exchanger assembly and both improving efficiency and reducing ice formation on the heat exchanger assembly during the evaporator mode.

[0006] The Heys '596 Patent Application discloses a

dual mode heat exchanger assembly with an external bypass means of reducing the number of refrigerant passes when the heat exchanger assembly is operating in the evaporator mode. This is for a vehicle air conditioning system including the heat exchanger assembly in the '510 patent.

[0007] The Chapp '649 Patent discloses a dual mode heat exchanger assembly and includes curved headers to address the problem of condensate on the outside of the plurality of tubes in the evaporator mode. There is a lower and upper header with a plurality of flow tubes running vertically. In the evaporation mode, the refrigerant enters the top manifold, drop through pipes to the lower manifold and is directed to the upper manifold through a jumper tube, more similar in diameter to the manifolds, where the refrigerant drops to the lower manifold and is exited through the outlet port. When operating in the evaporator mode, the refrigerant enters the lower manifold and follows exactly the reverse path. Valves inside the heat exchanger assembly can also be used to direct the flow of refrigerant. The path length is the same for each mode.

[0008] Current dual mode heat exchanger assemblies modify the pass arrangements by providing internal and external bypass means which avoid circulating refrigerant through all of the flow tubes in the heat exchanger, resulting in sub-optimal efficiency in both modes. An opportunity exists to provide a heat exchanger assembly and a method of operating the heat exchanger assembly, which optimizes heat exchange in both the evaporator and the condenser modes.

SUMMARY OF THE INVENTION

[0009] The subject invention provides a heat exchanger assembly having a first manifold and a second manifold each defining a hollow cavity, and in spaced and substantially parallel relationship with each other. A separator is disposed within the first manifold and divides the cavity of the first manifold into a first chamber and a second chamber. A plurality of flow tubes are fluidly connected to the first and second manifolds for passing refrigerant between the manifolds. A plurality of ports are connected to at least one of the first and second manifolds. Each of the ports have an open position for allowing refrigerant to flow into and out of the manifolds and a closed position for preventing refrigerant from flowing into and out of the manifolds. There is at least a first port, a second port, and a third port. An external controller switches the heat exchanger assembly between an evaporator mode and a condenser mode. At least one of the ports in each of the chambers and cavity of one of the manifolds is in the open position for circulating refrigerant through all of the plurality of flow tubes in at least one pass when the heat exchanger assembly is operating in the evaporator mode and at least one of the ports is in the closed position for circulating refrigerant through the plurality of flow tubes in at least two passes when the

heat exchanger assembly is operating in the condenser mode.

[0010] The subject invention also provides a method of operating a heat exchanger assembly circulating the refrigerant through all of the plurality of flow tubes in at least one pass in the evaporator mode and in more than one pass in the condenser mode, including the following steps: opening one of the ports in each of the manifolds to define an evaporator mode; introducing refrigerant into one of the manifolds; passing the refrigerant through all of the plurality of tubes in a single pass; exiting the refrigerant from an opposing manifold; closing the third port of the second manifold to define a condenser mode; introducing the refrigerant into one of the chambers of each one of the manifolds to define an inlet chamber; passing the refrigerant through the plurality of tubes connected to the inlet chamber; passing the refrigerant into another chamber of one of the manifolds to define a mid-flow chamber; passing the refrigerant through the plurality of tubes connected to the mid-flow chamber; passing the refrigerant into another chamber of one of the manifolds to define an outlet chamber; and exiting refrigerant through the port connected to the outlet chamber.

[0011] The subject invention also provides a method of operating a heat exchanger assembly circulating the refrigerant through all of the plurality of flow tubes in at least two circuits and in more than one pass in the evaporator mode and in more than one pass in the condenser mode, including the following steps: opening at least one of the ports in one of the manifolds to define an evaporator mode; introducing the refrigerant into one of the manifolds to define an inlet chamber; passing the refrigerant through the plurality of flow tubes connected to the inlet chamber; passing the refrigerant into the opposing manifold to define a mid-flow chamber; passing the refrigerant through the plurality of flow tubes connected to the mid-flow chamber; passing the refrigerant into the opposing manifold to define an outlet chamber; exiting the refrigerant through the port connected to the outlet chamber; closing the fourth port and opening the third and fifth ports to define a condenser mode; introducing the refrigerant into the third port of the second manifold to define an inlet chamber; passing the refrigerant through the plurality of flow tubes connected to the inlet chamber; passing the refrigerant into the first chamber of the first manifold to define a first mid-flow chamber; passing the refrigerant through the plurality of flow tubes connected to the first mid-flow chamber; passing the refrigerant into the fourth chamber of the second manifold to define a second mid-flow chamber; passing the refrigerant through the plurality of flow tubes connected to the second mid-flow chamber; passing the refrigerant into the second chamber of the first manifold to define a third mid-flow chamber; passing the refrigerant through the plurality of flow tubes connected to the third mid-flow chamber; passing the refrigerant into the fifth chamber of the second manifold to define an outlet chamber; and exiting the refrigerant through the fifth port connected to the outlet chamber.

[0012] While current dual mode heat exchanger assemblies have different refrigerant flow paths depending on the mode of operation, this has been accomplished by bypassing a portion of the plurality of flow tubes. The subject invention optimizes heat exchange when the heat exchanger assembly is operating in both the evaporator mode as well as when the heat exchanger assembly is operating in the condenser mode, by using all of the plurality of flow tubes to circulate the refrigerant in one or more passes through the heat exchanger assembly when operating in the evaporator mode and circulating the refrigerant in more than one pass when the heat exchanger assembly is operating in the condenser mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0014] Figure 1 is a perspective view of one embodiment of a heat exchanger assembly;

[0015] Figure 1A is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 1 in an evaporator mode;

[0016] Figure 1B is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 1 in a condenser mode;

[0017] Figure 1C is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 1 illustrating a single pass refrigerant flow path in the evaporator mode;

[0018] Figure 1D is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 1 illustrating a two pass refrigerant flow path in the condenser mode;

[0019] Figure 2 is a perspective view of another embodiment of a heat exchanger assembly;

[0020] Figure 2A is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 2 in an evaporator mode;

[0021] Figure 2B is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 2 in a condenser mode;

[0022] Figure 2C is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 2 illustrating a single pass refrigerant flow path in the evaporator mode;

[0023] Figure 2D is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 2 illustrating a three pass refrigerant flow path in the condenser mode;

[0024] Figure 3 is a perspective view of another embodiment of a heat exchanger assembly;

[0025] Figure 3A is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 3 in an evaporator mode;

[0026] Figure 3B is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 3 in a condenser mode;

[0027] Figure 3C is a planar view of the embodiment of the heat exchanger assembly of Figure 3 illustrating a single pass refrigerant flow path in the evaporator mode;

[0028] Figure 3D is a schematic planar view of the embodiment of the heat exchanger assembly of Figure 3 illustrating a four pass refrigerant flow path in the condenser mode;

[0029] Figure 4 is a perspective view of another embodiment of a heat exchanger assembly with a distribution tube;

[0030] Figure 4A is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a two circuit, two pass refrigerant flow path in an evaporator mode;

[0031] Figure 4B is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a four pass refrigerant flow path in a condenser mode.

[0032] Figure 4C is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a two pass refrigerant flow path in the evaporator mode.

[0033] Figure 4D is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a four pass refrigerant flow path in the condenser mode.

[0034] Figure 5 is a perspective view of another embodiment of a heat exchanger assembly with a distribution tube;

[0035] Figure 5A is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a two pass refrigerant flow path in an evaporator mode;

[0036] Figure 5B is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a four pass refrigerant flow path in a condenser mode.

[0037] Figure 5C is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a two pass refrigerant flow path in the evaporator mode;

[0038] Figure 5D is a schematic planar view of the embodiment of the heat exchanger assembly illustrating a four pass refrigerant flow path in the condenser mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a heat exchanger assembly is generally shown at 20 in Figures 1-1D. The heat exchanger assembly 20 includes a first manifold 22 and a second manifold 24. The first manifold 22 defines a cavity 26 and has a length and a width, substantially transverse the length, with a first end 48 and a second end 50, adjacent the length. The second manifold 24 is in spaced and substantially parallel relationship to the first manifold 22 and defines a cavity 27. The second manifold 24 has a length and a width, substantially transverse the length, with a first end 49 and a second end 51, adjacent the length. The second manifold 24 is shown throughout the drawings as having

the same general appearance as that of the first manifold 22, however it can be readily appreciated that the first and second manifolds 22, 24 can have different dimensions, for example, the width of the second manifold 24 can be greater than the width of the first manifold 22. In addition, the construction of the manifolds 22, 24 can vary, for example, but not limited to, the first manifold 22 can comprise a single piece and the second manifold 24 can comprise multiple joined pieces. Similarly, it can be appreciated that though the manifolds 22, 24 are illustrated throughout the various drawings as generally cylindrical, the manifolds can take on a variety of shapes, for example but not limited to, the cross section of the manifolds 22, 24 at the width, can define a D-shape or a polygon.

[0040] A first separator 38 is disposed within the cavity 26 of the first manifold 22 dividing the first manifold 22 into a first chamber 40 and a second chamber 42. A substantially flat first separator 38 is shown which is disposed along the width of the first manifold 22, however, it can be readily appreciated that the first separator 38 can have a variety of cross-section shapes, such as, but not limited to, a crescent, and the first separator 38 can also be disposed within the cavity 26 in various ways, such as, but not limited to, diagonally forming acute and obtuse angles where the first separator 38 is adjacent the first manifold 22. It can further be appreciated that the first separator 38 can be constructed in a variety of ways, such as, but not limited to, being a portion of an insert slideably inserted within the cavity 26 or a single piece inserted through a cut in the first manifold 22. In addition, though the first separator 38 is shown approximately midway between the ends 48, 50 of the first manifold 22, it can be appreciated that the placement of the first separator 38 relative to the length of the first manifold 22 can vary. In addition, it can be readily appreciated that additional separators can be disposed within the first manifold cavity 26.

[0041] A plurality of flow tubes 28 extend between and fluidly connect the first and second manifolds 22, 24 for passing refrigerant between the manifolds 22, 24. It can be appreciated that additional heat dissipating structures, such as fins 29, can be included adjacent the plurality of flow tubes 28. The plurality of flow tubes 28 are substantially parallel to each other, and are generally transverse the length of the manifolds 22, 24. For purposes of illustration throughout the drawings, ten to twelve flow tubes are depicted, however it can be readily appreciated, that the number is not limited to those illustrated, but can vary based on the requirements of the heat exchanger assembly 20.

[0042] Groups of flow tubes 62, 64, 66, 68 are defined by flow tubes which are fluidly connected to the same chambers. Referring to Figure 1A-1B, a first group 62 of flow tubes is fluidly connected to the first chamber 40 and the cavity of the second manifold 27. A second group 64 of flow tubes is fluidly connected to the second chamber 40 and the first cavity 27. The groups 62, 64 of flow tubes

enable the serpentine circulation path of the refrigerant through the heat exchanger assembly 20.

[0043] A plurality of ports 30 are fluidly connected to at least one of the manifolds 22, 24, and have an open position for allowing refrigerant into and out of the manifolds 22, 24 and a closed position for preventing the refrigerant from passing into or out of the manifolds 22, 24. An external tube is fluidly connected to each of the ports 30, and refrigerant passes through the external tubes to enter or exit the heat exchanger assembly 20. It can be readily appreciated that the external tubes can be joined directly to any portion of the manifold 22, 24 in a variety of ways, including but not being limited to, by a process such as brazing or welding. Alternatively, an attachment means such as a coupler can be disposed within the port 30, and the external tube inserted through the coupler to form the connection. It is understood that the plurality of ports 30 are illustrated throughout the figures as including the external tube as part of the port 30. It can further be understood that the term port 30 within the context of the present invention is intended to include other structures, such as couplers, where required by a specific application. It can be readily appreciated that for the present invention, when reference is made to the port 30 having a closed position, refrigerant does not enter or exit the manifold 22, 24 at that location. Similarly when a port 30 is in the open position, refrigerant enters or exits the heat exchanger assembly 20 through the port 30. An external controller restricts or permits the flow of refrigerant into the port 30, and the actual means is external to the heat exchanger assembly 20. A first port 92 is fluidly connected to the first chamber 40, a second port 94 is fluidly connected to the second chamber 42 and a third port 96 is fluidly connected to the cavity 27 of the second manifold 24. It can be appreciated that each port 92, 94, 96 can be used to either permit the refrigerant to enter or exit the heat exchanger assembly 20, depending on the configuration desired.

[0044] An external controller switches the heat exchanger assembly 20 between an evaporator mode 34 for heating and a condenser mode 36 for cooling. In the evaporator mode 34, the refrigerant is circulated through the heat exchanger assembly 20, absorbing heat from air passing over the plurality of flow tubes 28. As the refrigerant absorbs heat from the air, the refrigerant expands as liquid refrigerant is converted to gaseous refrigerant. In the condenser mode, the refrigerant in a gaseous state, enters the heat exchanger assembly 20 and heat is dissipated as the refrigerant is changed from the gaseous state to a liquid state. When operating in the evaporator mode 34, refrigerant is passed through all of the plurality of flow tubes 28 in one pass by opening at least one of the plurality of ports 30 in each of the chambers 40, 42 and cavities 27. In the condenser mode 36, at least one of the plurality of ports 30 is closed, for allowing the refrigerant to pass through all of the plurality of flow tubes 28 in more than one pass. It can be readily appreciated, that a number of alternative embodiments

are possible, by varying the number of separators, the number of ports 30 and the configuration of open and closed ports 30.

[0045] Referring to Figure 2, another embodiment is illustrated. A second separator 52 is disposed within the cavity 27 of the second manifold 24 forming a third chamber 56 and a fourth chamber 58. The second separator 52 is offset from the first separator 38. Referring to Figures 2A-2B, the third port 96 is fluidly connected to the third chamber 56 and a fourth port 98 is fluidly connected to the fourth chamber 58. Three groups of flow tubes are formed, including a first group 62 having flow tubes connected to the first chamber 40 and the third chamber 56, a second group 64 having flow tubes connected to the second chamber 42 and the third chamber 56, and a third group 66 having flow tubes connected to the second chamber 42 and the fourth chamber 58. In the evaporator mode 34, the first, second, third and fourth ports 92, 94, 96, 98 are in the open position for allowing the refrigerant to pass through all of the plurality of flow tubes 28 in one pass. In the condenser mode 36, the first and fourth ports 92, 98 are in the open position for passing the refrigerant through the heat exchanger assembly 20 in three passes.

[0046] Referring to Figure 3, another embodiment is illustrated having having a third separator 54 disposed within the second manifold 24 further dividing the cavity 27 of the second manifold 24 into a fifth chamber 60. The second and third separators 52, 54 in the second manifold 24 are offset from the first separator 38 in the first manifold 22. Referring to Figures 3A-3B, four groups of flow tubes 62, 64, 66, 68 are formed, including, a first group 62 having flow tubes connected to the first chamber 40 and the third chamber 56, a second group 64 having the flow tubes connected to the first chamber 40 and the fourth chamber 58, a third group 66 having the flow tubes connected to the second chamber 42 and the fourth chamber 58, and a fourth group 68, having flow tubes connected to the second chamber 42 and the fifth chamber 60. In the evaporator mode 34, the first, second, third, fourth and fifth ports 92, 94, 96, 98, 100 are in the open position for allowing refrigerant to pass through the heat exchanger assembly 20 in one pass. In the condenser mode 36, the third and fifth ports 96, 100 are in the open position for passing the refrigerant through the heat exchanger assembly 20 in four passes.

[0047] Referring to Figure 4, another embodiment is illustrated having no ports 30 connected to the first manifold 24. A third separator 54 is disposed within the second manifold 24 further dividing the cavity 27 of the second manifold 24 into a fifth chamber 60. The second and third separators 52, 54 in the second manifold 24 are offset from the first separator 38 in the first manifold 22. Referring to Figures 4A-4B, four groups of flow tubes 62, 64, 66, 68 are formed, including, a first group 62 having flow tubes connected to the first chamber 40 and the third chamber 56, a second group 64 having the flow tubes connected to the first chamber 40 and the fourth chamber 58, a third group 66 having the flow tubes connected to

the second chamber **42** and the fourth chamber **58**, and a fourth group **68**, having flow tubes connected to the second chamber **42** and the fifth chamber **60**. In the evaporator mode **34**, the third, fourth and fifth ports **96, 98, 100** are in the open position for allowing the refrigerant to pass through the heat exchanger assembly **20** in one pass. In the condenser mode **36**, the third and fifth ports **96, 100** are in the open position for passing the refrigerant through the heat exchanger assembly **20** in four passes. **[0048]** Distribution tubes **70, 71** can be incorporated in the heat exchanger assembly **20** to facilitate distribution of the refrigerant in the evaporator mode **34**. Referring to Figure 4-4B, one embodiment is illustrated which includes a single distribution tube **70** disposed within the fourth chamber **58** of the second manifold **24**. In the evaporator mode **34**, the third, fourth and fifth ports **96, 98, 100** are in the open position. The refrigerant enters through the fourth port **98** which is directly connected to the distribution tube **70**, and passes through the plurality of apertures disposed within the distribution tube **70**, into the fourth chamber **58**. In the condenser mode **36**, the fourth port **98** is in the closed position and the third and fifth ports **96, 100** are in the open position. Refrigerant enters through the third port **96**, and is circulated through the heat exchanger assembly **20**, without being affected by the presence of the distribution tube **70** disposed within the fourth chamber. It can be readily appreciated that more than one distribution tube **70** can be included in the heat exchanger assembly **20**.

[0049] Referring to Figure 5A-B, another embodiment includes the first distribution tube **70** disposed within the third chamber **56** and a second distribution tube **71** disposed within the fifth chamber **60**. A sixth port **102** is fluidly connected to the third chamber **56** and a seventh port **104** is fluidly connected to the fifth chamber **60**. The third port **96** is fluidly connected to the first distribution tube **70** and the fifth port **100** is fluidly connected to the second distribution tube **71**. The evaporator mode **34** is defined by the first, second, sixth and seventh ports **92, 94, 102, 104** being in the closed position and the third, fourth and fifth ports **96, 98, 100** being in the open position. The condenser mode **36** is defined by the sixth and seventh ports **102, 104** being in the open position and the first, second, third, fourth and fifth ports **92, 94, 96, 98, 100** being in the closed position. It can be readily appreciated that any number of distribution tubes **70, 71** and additional ports **30** can be incorporated into any design. It can also be readily appreciated that the same result would be accomplished where the first manifold **22** included no ports **30**.

[0050] The various embodiments described previously can be generally described in the following way. There is at least a first port **92**, a second port **94** and a third port **96**. An external controller **32** switches between an evaporator mode **34** for heating and a condenser mode **36** for cooling. The first, second and third ports **92, 94, 96** are in the open position for circulating the refrigerant through all of the plurality of flow tubes **28** in n passes in the

evaporator mode **34**. In the condenser mode **36**, at least one of the ports **30** is closed for circulating the refrigerant through all of said plurality of flow tubes **28** in at least $n+1$ passes in the condenser mode **36** where said n is an integer equal to or greater than one. It can be readily appreciated that the structure described previously encompasses any number of chambers, flow tubes and ports **30**, depending on the design requirements of the specific implementation. Similarly the schematics are merely illustrative. Any number of flow configurations in which refrigerant is introduced through different ports **30**, for example, using the reverse flow of that illustrated in the figures, or mirror images, are equivalent to those discussed.

[0051] It can be further appreciated that distribution tubes **70, 71** can be included in any of the evaporator mode **34** inlet chambers **78**. The distribution tubes **70, 71** are fluidly connected to the ports **30**, and refrigerant passes through the apertures disposed within the distribution tubes **70, 71** into the evaporator mode **34** inlet chamber **78**. It can also be appreciated that when the heat exchanger assembly **20** uses the evaporator mode **34** inlet chamber **78** as either a condenser mode **36** inlet or outlet chamber **78, 80**, additional ports **30** can be fluidly connected to the condenser mode **36** inlet and outlet chambers **78, 80** for allowing refrigerant to enter and exit the heat exchanger assembly **20**.

[0052] Two methods are described based on the structure described previously. The goal of all of the methods is the same, that is, to circulate the refrigerant in fewer passes in the evaporator mode **34** than in the condenser mode **36**, while using all of the plurality of flow tubes **28** to circulate the refrigerant in each mode. Through the use of the external controller which controls the ports that are used for introducing and exiting the refrigerant, and by the configuration of the separators, a multitude of pass arrangements can be achieved. It can further be appreciated that the methods that follow, encompass more arrangements than are illustrated, and that the methods accommodate additional separators and ports, all of which permit variations in the arrangements while still being encompassed by the methods described here. In addition, it is understood that in methods which do not require that a manifold **22, 24** have a port in an open position to effectuate the refrigerant circulation, a manifold **22, 24** without any ports produces the same effect that a manifold **22** with all ports in the closed position, and is equivalent. Detailed descriptions of the methods and several embodiments follow.

[0053] Referring to Figures 1A-1D, a method of operating a heat exchanger assembly **20** is provided wherein the refrigerant circulates in one pass in the evaporator mode **34** and in at least 2 passes in the condenser mode **36**. A heat exchanger assembly **20** has a first manifold **22** divided into a first chamber **40** and a second chamber **42** with a first port **92** and second port **94**, a second manifold **24** defining at least one chamber with a third port **96**, and a plurality of flow tubes **28** fluidly connecting the

manifolds **22, 24**. The method includes the step of opening one of the ports **30** in each chamber of the manifolds **22, 24** defining an evaporator mode **34**. The method further includes introducing the refrigerant into one of the manifolds **22, 24**, to define an inlet chamber **78**. The method further includes passing the refrigerant through all of the plurality of flow tubes **28** in a single pass. The method further includes the step of passing the refrigerant into an opposing manifold **22, 24** defining an outlet chamber **80**. The method further includes the step of exiting the refrigerant from a port connected to the opposing manifold **22, 24**. The method further includes the step of closing the third port **96** of the second manifold **24** to define a condenser mode **36**. The method further includes the step of introducing the refrigerant into one of the chambers of one of the manifolds **22, 24** to define an inlet chamber **78**. The method further includes the step of passing the refrigerant through the plurality of flow tubes **28** connected to the inlet chamber **78**. The method further includes the step of passing the refrigerant into another chamber of one of the manifolds **22, 24** to define a mid-flow chamber **72**. The method further includes passing the refrigerant through the plurality of flow tubes **28** connected to the mid-flow chamber **72**. The method further includes passing the refrigerant into another chamber of one of the manifolds **22, 24** to define an outlet chamber **80**. The method further includes the step of exiting refrigerant through the port connected to the outlet chamber **80**. The method allows refrigerant to pass through the heat exchanger assembly **20** in one pass when the heat exchanger assembly **20** is operating in the evaporator mode **34**, and in more than one pass when the heat exchanger assembly **20** is operating in the condenser mode **36**. It can be readily appreciated that the method encompasses heat exchanger assemblies **20** having manifolds **22, 24** with different numbers of chambers and ports.

[0054] This method is applied in the embodiment illustrated in Figures 1C-1D. The refrigerant is introduced into the first and second ports **92, 94**, passes through all of the plurality of flow tubes **28** in a single pass, and is exited from the second manifold **24**. To define the condenser mode **36** the third port **96** is closed. The refrigerant is introduced into the second chamber **42**, and passes through the second group **64** of flow tubes into the third chamber **56**. The refrigerant is then passed through the first group **62** of flow tubes into the first chamber **40**. The refrigerant is then exited through the first port **92**. It can be readily appreciated that when the heat exchanger **20** is operating in the evaporator mode **34**, the refrigerant can alternatively be introduced through the third port **96** into the third chamber **56**. Similarly, when the heat exchanger **20** is operating in the condenser mode **36**, the refrigerant can be introduced through the first port **92** into the first chamber **40**. It can be further appreciated that distribution tubes **70, 71** can be included in any of the evaporator mode inlet chambers **78**. The distribution tubes **70, 71** are fluidly connected to the ports **30**, and

refrigerant passes through the apertures disposed within the distribution tubes **70, 71** into the evaporator mode **34** inlet chamber **78**. It can also be appreciated that when the heat exchanger assembly **20** uses the evaporator mode **34** inlet chamber **78** as either a condenser mode **36** inlet or outlet chamber **78, 80**, additional ports **30** can be fluidly connected to the condenser mode **36** inlet and outlet chambers **78, 80** for allowing refrigerant to enter and exit the heat exchanger assembly **20**.

[0055] Referring to Figures 2A-2D, another embodiment of the method is described which allows the heat exchanger assembly **20** to circulate the refrigerant in one pass in the evaporator mode **34** and in at least three passes in the condenser mode **36**. In addition to the structure described previously, this embodiment includes a fourth chamber **58** and a fourth port **98** fluidly connected to the fourth chamber **58**. In addition to the steps described previously, the method further includes the step of closing the second port **94** of the first manifold **22** as well the third port **96** of the second manifold **24** and opening the first port **92** of the first manifold **22** and the fourth port **98** of the second manifold **24** to define the condenser mode **36**. The method is the same for the evaporator mode **34** as in the previous embodiment. In the condenser mode **36**, additional steps are required. After the refrigerant enters the mid-flow chamber **72**, the refrigerant is passed through the plurality of flow tubes **28** connected to the mid-flow chamber **72**. The method further includes passing the refrigerant into another chamber of one of the manifolds **22, 24** to define a second mid-flow chamber **74**. The method further includes passing a refrigerant through the plurality of flow tubes **28** connected to the second mid-flow chamber **74**. The method further includes passing the refrigerant into another chamber of one of the manifolds **22, 24** to define an outlet chamber **80**. The method further includes the step of exiting refrigerant through the port connected to the outlet chamber **80**. Thus, the method allows refrigerant to pass through the heat exchanger assembly **20** in one pass in the evaporator mode **34**, and in three or more passes when the heat exchanger assembly **20** is operating in the condenser mode **36**. It can be readily appreciated that the method encompasses heat exchanger assemblies **20** having manifolds **22, 24** with different numbers of chambers and ports.

[0056] This general embodiment is illustrated in a more specific embodiment illustrated in Figures 2C-2D. To define the evaporator mode **34**, all of the ports **92, 94, 96, 98** in each of the manifolds **22, 24** are opened. The refrigerant is introduced into the first and second ports **92, 94**, passes through all of the plurality of flow tubes **28** in a single pass, and is exited from the third and fourth ports **96, 98** of the second manifold **24**. The condenser mode **36** is defined by closing the second and third port **94, 96**. The refrigerant is introduced into the first chamber **40**, passed through the first group **62** of flow tubes, into the third chamber **56**. Refrigerant is then passed through the second group **64** of flow tubes into the second chamber

42. Refrigerant then passes through the third group 66 of flow tubes into the fourth chamber 58, and is exited through the fourth port 98. It can be readily appreciated that when the heat exchanger assembly 20 is operating in the evaporator mode 34, the refrigerant can alternatively be introduced through the third port 96 and fourth port 98 into the third and fourth chambers 56, 58, and exited through the first and second ports 92, 94 in the first manifold 22. Similarly, when the heat exchanger assembly 20 is operating in the condenser mode 36, the refrigerant can be introduced through the fourth port 98, passed into the fourth chamber 58, and exited through the first port 92 in the first chamber 40. In addition, it can be appreciated that distribution tubes 70, 71 can be included in any of the evaporator mode 34 inlet chambers 78. The distribution tubes 70, 71 are fluidly connected to the ports 30, and refrigerant passes through the apertures disposed within the distribution tubes 70, 71 into the evaporator mode 34 inlet chamber 78. It can also be appreciated that when the heat exchanger assembly 20 uses the evaporator mode 34 inlet chamber 78 as either a condenser mode 36 inlet or outlet chamber 78, 80, additional ports 30 can be fluidly connected to the condenser mode 36 inlet and outlet chambers 78, 80 for allowing refrigerant to enter and exit the heat exchanger assembly 20 in the condenser mode 36.

[0057] Referring to Figures 3A-3D, another embodiment of the method of operating a heat exchanger assembly 20 is provided wherein the refrigerant circulates in one pass in the evaporator mode 34 and in at least four passes in the condenser mode 36. The heat exchanger assembly 20 includes the elements of the previous embodiment, with the addition of a fifth chamber 60 disposed within the second manifold 24 and a fifth port 100 fluidly connected to the fifth chamber 60. The evaporator mode is the same as described in the previous embodiment. The condenser mode 36 is defined by the step of closing the first and second ports 92, 94 of the first manifold 22 and the fourth port 98 of the second manifold 24 to define a condenser mode 36. The method further includes the step of introducing the refrigerant into one of the chambers of one of the manifolds to define an inlet chamber 78. The method further includes the step of passing the refrigerant through the plurality of flow tubes 28 connected to the inlet chamber 78. The method further includes the step of passing the refrigerant into another chamber of one of the manifolds 22, 24 to define a first mid-flow chamber 72. The method further includes passing the refrigerant through the plurality of flow tubes 28 connected to the first mid-flow chamber 72. The method further includes the step of passing the refrigerant into another chamber of one of the manifolds 22, 24 to define a second mid-flow chamber 74. The method further includes passing the refrigerant through the plurality of flow tubes 28 connected to the second mid-flow chamber 74. The method further includes the step of passing the refrigerant into another chamber of one of the manifolds 22, 24 to define a third mid-flow chamber 76. The method

further includes passing the refrigerant through the plurality of flow tubes 28 connected to the third mid-flow chamber 76. The method further includes passing the refrigerant into another chamber of one of the manifolds 22, 24 to define an outlet chamber 80. The method further includes the step of exiting refrigerant through the port connected to the outlet chamber 80. The method allows refrigerant to pass through the heat exchanger assembly 20 in one pass when the heat exchanger assembly 20 is operating in the evaporator mode 34, and in four or more passes when the heat exchanger assembly 20 is operating in the condenser mode 36. It can be readily appreciated that the method encompasses heat exchanger assemblies 20 having manifolds 22, 24 with different numbers of chambers and ports.

[0058] This general embodiment is illustrated in a more specific embodiment illustrated in Figures 3C-3D. The evaporator mode is defined by opening all of the ports 92, 94, 96, 98, 100 in each of the manifolds 22, 24. The refrigerant is introduced into the first and second ports 92, 94, circulated through all of the plurality of flow tubes 28 in a single pass, and exited from the third, fourth and fifth ports 96, 98, 100. The condenser mode is defined by closing the first, second and fourth ports 92, 94, 98. The refrigerant is introduced through the third port 96 into the third chamber 56, and passed through the first group 62 of flow tubes, into the first chamber 40. The refrigerant passes through the second group 64 of flow tubes into the fourth chamber 58. The refrigerant passes through the third group 66 of flow tubes into the second chamber 42. The refrigerant passes through the fourth group 68 of flow tubes into the fifth chamber 60, and is exited through the fifth port 100. It can be readily appreciated that when the heat exchanger 20 is operating in the evaporator mode 34, the refrigerant can alternatively be introduced through the third, fourth and fifth ports 96, 98, 100 of the second manifold 24, and exited through the first and second ports 92, 94 of the first manifold 22. Similarly, when the heat exchanger 20 is operating in the condenser mode 36, the refrigerant can be introduced through the fifth port 100 into the fifth chamber 60, and exited through the third port 96 connected to the third chamber 56. It can be readily appreciated that this method encompasses any number of passes in the evaporator mode and in the condenser mode. In addition, it can be appreciated that distribution tubes 70, 71 can be included in any of the evaporator mode inlet chambers 78. The distribution tubes 70, 71 are fluidly connected to the ports 30, and refrigerant passes through the apertures disposed within the distribution tubes 70, 71 into the evaporator mode 34 inlet chamber 78. It can also be appreciated that when the heat exchanger assembly 20 uses the evaporator mode 34 inlet chamber 78 as either a condenser mode 36 inlet or outlet chamber 78, 80, additional ports 30 can be fluidly connected to the condenser mode 36 inlet and outlet chambers 78, 80 for allowing refrigerant to enter and exit the heat exchanger assembly 20.

[0059] Referring to Figures 4A-4D, another method for operating a heat exchanger assembly **20** is provided where the refrigerant is divided into more than one circuit and passes through the heat exchanger assembly **20** in at least two passes in the evaporator mode **34**. In this method, in the condenser mode **36**, the refrigerant passes through the heat exchanger assembly **20** in four or more passes, as previously described and being illustrated at Figure 3D, and will not be described again here. The heat exchanger assembly **20** has a first manifold **22** divided into a first chamber **40** and a second chamber **42** and a second manifold **24** defining a third chamber **(56)**, a fourth chamber **(58)** and a fifth chamber **(60)**, with a third port **(96)**, a fourth port **98**, a fifth port **100** and a plurality of flow tubes **28** fluidly connecting the manifolds **22**, **24**. The method includes the step of opening all of the ports **30** in the second manifold **24** to define an evaporator mode **34**. The method further includes the step of introducing the refrigerant into at least one chamber of the second manifold **24** to define an inlet chamber **78**. The method further includes the step of passing the refrigerant through the plurality of flow tubes **28** connected to the inlet chamber **78**. The method further includes the step of passing the refrigerant into the first manifold **22** to define a first and second mid-flow chamber **72**, **74**. The method further includes the step of passing the refrigerant through the plurality of flow tubes **28** connected to the first and second mid-flow chambers **72**, **74**. The method further includes the step of passing the refrigerant into the second manifold **24** to define at least one outlet chamber **80**. The method further includes the step of exiting the refrigerant through the port connected to the outlet chamber **80**. It can be readily appreciated that the method encompasses more complex heat exchanger assemblies **20** requiring more than two circuits as well as more than two passes for the circulation of the refrigerant.

[0060] One embodiment of this method is illustrated in Figures 4C-4D. The evaporator mode **34** is defined by opening all of the ports **96**, **98**, **100** in the second manifold **24**. The refrigerant is introduced into the fourth chamber **58** of the second manifold **24**, where it is separated into a first portion and a second portion. The first portion of the refrigerant passes through the second group **64** of flow tubes into the first chamber **40**, through the first group **62** of flow tubes into the third chamber **56**, and is exited through the third port **96**. Similarly, the second portion passes through the third group **66** of flow tubes, into the second chamber **42**, through the fourth group **68** of flow tubes into the fifth chamber **60**, and is exited from the fifth port **100**. It can be readily appreciated that the refrigerant can be introduced through the third and fifth ports **96**, **100** and exited through the fourth port **98**, thus creating more than one inlet chamber **78**, **79** and one outlet chamber **80**. It can also be readily appreciated that the same flow path is possible by closing all of the ports **30** of the first manifold **22** in embodiments which include ports **30** in the first manifold **22**. In addition, it can be

appreciated that distribution tubes **70** can be included in any of the evaporator mode **34** inlet chambers **78**. The distribution tube **70** is fluidly connected to the port **30**, and refrigerant passes through the apertures disposed within the distribution tubes **70**, **71** into the evaporator mode inlet chamber **78**. Here, the distribution tube **70** is illustrated as being disposed within the fourth chamber **58**. It can also be appreciated that when the heat exchanger assembly **20** uses the evaporator mode **34** inlet chamber **78** as either a condenser mode **36** inlet or outlet chamber **78**, **80**, additional ports **30** can be fluidly connected to the condenser mode **36** inlet and outlet chambers **78**, **80** for allowing refrigerant to enter and exit the heat exchanger assembly **20**.

[0061] Referring to Figures 5A-5D, an embodiment is illustrated including distribution tubes **70**, **71** in chambers used as both evaporator mode inlet chambers and condenser mode **36** outlet chamber **80** and the condenser mode **36** inlet chamber **78**. Here the evaporator mode **34** is defined by opening the third, fourth and fifth ports **96**, **98**, **100**. A first portion of the refrigerant is introduced into the third port **96** and a second portion of the refrigerant into the fifth port **98**. The first portion of the refrigerant passes through the first distribution tube **70** into the third chamber **56**. The refrigerant then passes through the first group **62** of flow tubes, into the first chamber **40**, through the second group **64** of flow tubes into the fourth chamber **58**. Similarly, the second portion passes into the second distribution tube **71**, into the fifth chamber **60**, through the fourth group **68** of flow tubes, into the first chamber **40**, through the third group **66** of flow tubes, and into the fourth chamber **58**. All of the refrigerant is then exited through the fourth port **98**. The condenser mode **36** is defined by closing the first, second, third, fourth and fifth port **92**, **94**, **96**, **98**, **100** and opening the sixth and seventh ports **102**, **104**. The refrigerant is introduced through the seventh port **104** into the fifth chamber **60**, passes through the fourth group **68** of flow tubes, and into the second chamber **42**. The refrigerant then passes through the third group **66** of flow tubes, into fourth chamber **58**. The refrigerant then passes through the second group **64** of flow tubes, into the first chamber **40**, and through the first group **62** of flow tubes into the third chamber **56**. The refrigerant is exited through the sixth port **102**. It can be readily appreciated that when the heat exchanger **20** is operating in the condenser mode **36**, the refrigerant can alternatively be introduced into the sixth port **102** and exited through the seventh port **104**.

[0062] Obviously, many modifications and variations of the present invention are possible in light of the above teachings without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed, but that the invention will include all embodiments falling within the scope of the appended claims. The reference numerals are merely for convenience and are not to be read in any way as limiting.

Claims

1. A heat exchanger (20) assembly comprising:

a first manifold (22) and a second manifold (24) each defining a hollow cavity (26, 27) and in spaced and substantially parallel relationship with each other;
 a plurality of flow tubes (28) extending between and fluidly connecting said first and second manifolds (22, 24) for passing refrigerant between said manifolds (22, 24);
 a separator (38) disposed within said first manifold (22) and dividing said cavity (26) into a first chamber (40) and a second chamber (42);
 a plurality of ports (30) fluidly connected to at least one of said first and second manifolds (22, 24) with each of said ports (30) having an open position for allowing refrigerant to flow into and out of said manifolds (22, 24) and a closed position for preventing refrigerant from flowing into and out of said manifolds (22, 24) with said plurality of ports (30) including at least a first port (92), a second port (94), and a third port (96);
 an external controller (32) for switching between an evaporator mode (34) and a condenser mode (36); and
 one of said ports (30) in each chamber and cavity (40, 42, 27) of one of said manifolds (22, 24) being in said open position for circulating refrigerant through all of said plurality of flow tubes (28) in at least one pass when in said evaporator mode (34) and at least one of said ports (30) being in said closed position for circulating refrigerant through said plurality of flow tubes (28) in at least two passes when in said condenser mode (36).

2. An assembly as set forth in claim 1 wherein said first port (92) is connected to said first chamber (40) said second port (94) is connected to said second chamber (42) and said third port (96) is connected to said cavity (27) of said second manifold (24).

3. An assembly as set forth in claim 2 wherein said evaporator mode (34) is further defined by at least one of said ports (30) in each chamber (40, 42) of said first manifold (22) and at least one of said ports (30) in said cavity (27) of said second manifold (24) being in said open position for circulating refrigerant in one pass.

4. An assembly as set forth in claim 2 wherein said condenser mode (36) is further defined by said first port (92) and said second port (94) being in said open position and said third port (96) being in said closed position for circulating refrigerant in two passes.

5. An assembly as set forth in claim 2 wherein said separator (38) is further defined as a first separator (38) and further including a second separator (52) disposed within said cavity (27) of said second manifold (24) dividing said cavity (27) of said second manifold (24) into a third chamber (56) and a fourth chamber (58).

6. An assembly as set forth in claim 5 wherein said second separator (52) is offset from said first separator (38) with said first chamber (40) fluidly connected to said third chamber (56) through a first group (62) of said flow tubes (28), said second chamber (42) fluidly connected to said third chamber (56) by a second group (64) of said flow tubes (28), and said second chamber (42) fluidly connected to said fourth chamber (58) by a third group (66) of said flow tubes (28).

7. An assembly as set forth in claim 5 further including a fourth port (98) connected to said fourth chamber (58) with said first, second, third, and fourth ports (92, 94, 96, 98) being in said open position when in said evaporator mode (34) for circulating refrigerant in one pass.

8. An assembly as set forth in claim 7 wherein said condenser mode (36) is further defined by said first port (92) and said fourth port (98) being in said open position and said second port (94) and said third port (96) being in said closed position for circulating refrigerant in three passes.

9. An assembly as set forth in claim 2 wherein said separator is further defined as a first separator (38) and further including a second and a third separator (52, 54) disposed within said second manifold (24) dividing said cavity (27) into a third, fourth and fifth chamber (56, 58, 60).

10. An assembly as set forth in claim 9 wherein both of said second and third separators (52, 54) are offset from said first separator (38) with said first chamber (40) fluidly connected to said third chamber (56) by a first group (62) of said flow tubes (28), said first chamber (40) fluidly connected to said fourth chamber (58) by a second group (64) of said flow tubes (28), said second chamber (42) fluidly connected to said fourth chamber (58) by a third group (66) of said flow tubes (28), and said second chamber (42) fluidly connected to said fifth chamber (60) by a fourth group (68) of said flow tubes (28).

11. An assembly as set forth in claim 9 further including a fourth port (98) connected to said fourth chamber (58) and a fifth port (100) connected to said fifth chamber (60) with said first, second, third, fourth, and fifth ports (92, 94, 96, 98, 100) being in said

open position when in said evaporator mode (34) for circulating refrigerant in one pass.

12. An assembly as set forth in claim 11 wherein said condenser mode (36) is further defined by said first port (92) said second port (94) and said fourth port (98) being in said closed position and said third port (96) and said fifth port (100) being in said open position for circulating refrigerant in four passes.
13. An assembly as set forth in claim 1 wherein said separator is further defined as a first separator (38) and further including a second separator (52) and a third separator (54) disposed within said second manifold (24) dividing said cavity (26) into a third, fourth and fifth chamber (56, 58, 60).
14. An assembly as set forth in claim 13 wherein both of said second and said third separators (52, 54) are offset from said first separator (38) with said first chamber (40) fluidly connected to said third chamber (56) by a first group (62) of said flow tubes (28), said first chamber (40) fluidly connected to said fourth chamber (58) by a second group (64) of said flow tubes (28), said second chamber (42) fluidly connected to said fourth chamber (58) by a third group (66) of said flow tubes (28), and said second chamber (42) fluidly connected to said fifth chamber (60) by a fourth group (68) of said flow tubes (28).
15. An assembly as set forth in claim 13 further including a third port connected to said third chamber and a fourth port (98) connected to said fourth chamber (58) and a fifth port (100) connected to said fifth chamber (60) and with said third, fourth and fifth ports (96, 98, 100) being in said open position when in said evaporator mode (34) for circulating refrigerant in two passes.
16. An assembly as set forth in claim 15 wherein said condenser mode (36) is further defined by said fourth port (98) being in said closed position and said third port (96) and said fifth port (100) being in said open position for circulating refrigerant in four passes.
17. An assembly as set forth in claim 1 including a distribution tube (70) disposed within one of said chambers (22, 24) and said cavity (27) with said distribution tube (70) having a plurality of apertures and with said distribution tube (70) being fluidly connected to one of said plurality of ports (30) for passing refrigerant from one of said plurality of ports (30) into at least one of said chambers (40, 42) and said cavity (27) and further defining an evaporator mode (36) inlet chamber (78).
18. An assembly as set forth in claim 17 including a fourth port (98) fluidly connected to said evaporator mode

(34) inlet chamber (78) for circulating the refrigerant in said condenser mode (36).

19. A method of operating a heat exchanger (20) having a first manifold (22) divided into a first chamber (40) and a second chamber (42) with a first port (92) and second port (94), a second manifold (24) defining at least one chamber with a third port (96), and a plurality of flow tubes (28) fluidly connecting the manifolds (22, 24), said method comprising the steps of:

opening one of said ports (30) in each chamber of said manifolds (22, 24) to define an evaporator mode (34) ;
introducing refrigerant into one of the manifolds (22, 24) defining an inlet chamber (78);
passing the refrigerant through all of the plurality of flow tubes (28) in a single pass;
exiting the refrigerant from an opposing manifold;
closing the third port (96) of the second manifold (24) to define a condenser mode (36);
introducing the refrigerant into one of the chambers of one of the manifolds (20, 22) to define an inlet chamber (78);
passing the refrigerant through the plurality of flow tubes (28) connected to the inlet chamber (78);
passing the refrigerant into another chamber of one of the manifolds (22, 24) to define a mid-flow chamber (72);
passing the refrigerant through the plurality of flow tubes (28) connected to the mid-flow chamber (72);
passing the refrigerant into another chamber of one of the manifolds (22, 24) to define an outlet chamber (80); and
exiting the refrigerant through the port connected to the outlet chamber (80).

20. A method of operating a heat exchanger (20) having a first manifold (22) divided into a first chamber (40) and a second chamber (42) and a second manifold (24) divided into a third chamber (56), a fourth chamber (58) and a fifth chamber (60), with a third port (96), a fourth port (98), a fifth port (100) and a plurality of flow tubes (28) fluidly connecting the manifolds (22, 24), said method comprising the steps of:

opening at least one of the ports (30) to define an evaporator mode (34);
introducing the refrigerant into one of the manifolds (22, 24) to define an inlet chamber (78);
passing the refrigerant through the plurality of flow tubes (28) connected to the inlet chamber (78);
passing the refrigerant into the opposing manifold (22, 24) to define a mid-flow chamber (72);

passing the refrigerant through the plurality of
 flow tubes (28) connected to the mid-flow cham-
 ber (72);
 passing the refrigerant into the opposing mani-
 fold (22, 24) to define an outlet chamber (80); 5
 exiting the refrigerant through the port (30) con-
 nected to the outlet chamber (80);
 closing the fourth port (94) and opening the third
 and fifth ports (96, 100) to define a condenser
 mode (36); 10
 introducing the refrigerant into the third port (96)
 of the second manifold (24) to define an inlet
 chamber (78);
 passing the refrigerant through the plurality of
 flow tubes (28) connected to the inlet chamber 15
 (78);
 passing the refrigerant into the first chamber
 (40) of the first manifold (22) to define a first mid-
 flow chamber (72);
 passing the refrigerant through the plurality of 20
 flow tubes (28) connected to the first mid-flow
 chamber (72);
 passing the refrigerant into the fourth chamber
 (58) of the second manifold (22) to define a sec-
 ond mid-flow chamber (74); 25
 passing the refrigerant through the plurality of
 flow tubes (28) connected to the second mid-
 flow chamber (74);
 passing the refrigerant into the second chamber
 (42) of the first manifold (22) to define a third 30
 mid-flow chamber (76);
 passing the refrigerant through the plurality of
 flow tubes (28) connected to the third mid-flow
 chamber (76);
 passing the refrigerant into the fifth chamber 35
 (60) of the second manifold (20) to define an
 outlet chamber (80); and
 exiting the refrigerant through the fifth port (100)
 connected to the outlet chamber (80). 40

Patentansprüche

1. Wärmetauscheranordnung (20), die aufweist:

einen ersten Verteiler (22) und einen zweiten
 Verteiler (24), die jeweils einen hohlen Hohl-
 raum (26, 27) definieren und in einer im Wesent-
 lichen parallelen Beziehung mit Abstand zuein-
 ander vorgesehen sind; 45
 eine Vielzahl von Durchflussrohren (28), die sich
 zwischen den ersten und zweiten Verteilern (22,
 24) erstrecken und für diese eine Fluid-Verbin-
 dung bilden, um ein Kältemittel zwischen den
 Verteilern (22, 24) fließen zu lassen; 50
 einen Separator (38), der in dem ersten Verteiler
 (22) angeordnet ist und den Hohlraum (26) in
 eine erste Kammer (40) und eine zweite Kam- 55

mer (42) teilt;
 eine Vielzahl von Anschlüssen (30), die eine
 Fluid-Verbindung haben mit zumindest einem
 der ersten und zweiten Verteiler (22, 24), wobei
 jeder der Anschlüsse (30) eine offene Position
 hat, um zu ermöglichen, dass Kühlmittel in die
 Verteiler (22, 24) hinein und aus ihnen heraus
 fließt, und eine geschlossene Position hat, um
 zu verhindern, dass Kühlmittel in die Verteiler
 (22, 24) hinein und aus ihnen heraus fließt, wo-
 bei die Vielzahl von Anschlüssen (30) zumindest
 einen ersten Anschluss (92), einen zweiten An-
 schluss (94) und einen dritten Anschluss (96)
 umfasst;
 eine externe Steuervorrichtung (32) zum Um-
 schalten zwischen einem Evaporator-Modus
 (34) und einem Kondensator-Modus (36); und
 wobei einer der Anschlüsse (30) in jeder Kam-
 mer und jedem Hohlraum (40, 42, 27) von einem
 der Verteiler (22, 24) in der offenen Position ist
 zum Zirkulieren von Kühlmittel durch alle der
 Vielzahl von Durchflussrohren (28) in zumindest
 einem Durchlauf, wenn in dem Evaporator-Mo-
 dus (34), und wobei zumindest einer der An-
 schlüsse (30) in der geschlossenen Position ist
 zum Zirkulieren von Kühlmittel durch die Viel-
 zahl von Durchflussrohren (28) in zumindest
 zwei Durchläufen, wenn in dem Kondensator-
 Modus (36).

2. Anordnung gemäß Anspruch 1, wobei der erste An-
 schluss (92) mit der ersten Kammer (40) verbunden
 ist, der zweite Anschluss (94) mit der zweiten Kam-
 mer (42) verbunden ist und der dritte Anschluss (96)
 mit dem Hohlraum (27) des zweiten Verteilers (24)
 verbunden ist.

3. Anordnung gemäß Anspruch 2, wobei der Evapora-
 tor-Modus (34) weiter dadurch definiert ist, dass zu-
 mindest einer der Anschlüsse (30) in jeder Kammer
 (40, 42) des ersten Verteilers (22) und zumindest
 einer der Anschlüsse (30) in dem Hohlraum (27) des
 zweiten Verteilers (24) in der offenen Position sind
 zum Zirkulieren von Kühlmittel in einem Durchlauf.

4. Anordnung gemäß Anspruch 2, wobei der Konden-
 sator-Modus (36) weiter dadurch definiert ist, dass
 der erste Anschluss (92) und der zweite Anschluss
 (94) in der offenen Position sind und der dritte An-
 schluss (96) in der geschlossenen Position ist zum
 Zirkulieren von Kühlmittel in zwei Durchläufen.

5. Anordnung gemäß Anspruch 2, wobei der Separator
 (38) weiter als ein erster Separator (38) definiert ist
 und weiter einen zweiten Separator (52) umfasst,
 der in dem Hohlraum (27) des zweiten Verteilers (24)
 angeordnet ist und den Hohlraum (27) des zweiten
 Verteilers (24) in eine dritte Kammer (56) und eine

vierte Kammer (58) teilt.

6. Anordnung gemäß Anspruch 5, wobei der zweite Separator (52) von dem ersten Separator (38) versetzt ist, wobei die erste Kammer (40) mit der dritten Kammer (56) über eine erste Gruppe (62) der Durchflussrohre (28) Fluid-mäßig verbunden ist, wobei die zweite Kammer (42) mit der dritten Kammer (56) über eine zweite Gruppe (64) der Durchflussrohre (28) Fluid-mäßig verbunden ist, und die zweite Kammer (42) mit der vierten Kammer (58) über eine dritte Gruppe (66) der Durchflussrohre (28) Fluid-mäßig verbunden ist.
7. Anordnung gemäß Anspruch 5, die weiter aufweist einen vierten Anschluss (98), der mit der vierten Kammer (58) verbunden ist, wobei die ersten, zweiten, dritten und vierten Anschlüsse (92, 94, 96, 98) in der offenen Position sind, wenn in dem Evaporator-Modus (34), zum Zirkulieren von Kühlmittel in einem Durchlauf.
8. Anordnung gemäß Anspruch 7, wobei der Kondensator-Modus (36) weiter dadurch definiert ist, dass der erste Anschluss (92) und der vierte Anschluss (98) in der offenen Position sind und der zweite Anschluss (94) und der dritte Anschluss (96) in der geschlossenen Position sind zum Zirkulieren von Kühlmittel in zwei Durchläufen.
9. Anordnung gemäß Anspruch 2, wobei der Separator weiter als ein erster Separator (38) definiert ist und weiter aufweist einen zweiten und einen dritten Separator (52, 54), die in dem zweiten Verteiler (24) angeordnet sind und den Hohlraum (27) in eine dritte, vierte und fünfte Kammer (56, 58, 60) teilen.
10. Anordnung gemäß Anspruch 9, wobei beide der zweiten und dritten Separatoren (52, 54) von dem ersten Separator (38) versetzt sind, wobei die erste Kammer (40) mit der dritten Kammer (56) über eine erste Gruppe (62) der Durchflussrohre (28) Fluid-mäßig verbunden ist, wobei die erste Kammer (40) mit der vierten Kammer (58) über eine zweite Gruppe (64) der Durchflussrohre (28) Fluid-mäßig verbunden ist, wobei die zweite Kammer (42) mit der vierten Kammer (58) über eine dritte Gruppe (66) der Durchflussrohre (28) Fluid-mäßig verbunden ist, und wobei die zweite Kammer (42) mit der fünften Kammer (60) über eine vierte Gruppe (68) der Durchflussrohre (28) Fluid-mäßig verbunden ist.
11. Anordnung gemäß Anspruch 9, die weiter aufweist einen vierten Anschluss (98), der mit der vierten Kammer (58) verbunden ist, und einen fünften Anschluss (100), der mit der fünften Kammer (60) verbunden ist, wobei die ersten, zweiten, dritten, vierten und fünften Anschlüsse (92, 94, 96, 98, 100) in der

offenen Position sind, wenn in dem Evaporator-Modus (34), zum Zirkulieren von Kühlmittel in einem Durchlauf.

12. Anordnung gemäß Anspruch 11, wobei der Kondensator-Modus (36) weiter dadurch definiert ist, dass der erste Anschluss (92), der zweite Anschluss (94) und der vierte Anschluss (98) in der geschlossenen Position sind und der dritte Anschluss (96) und der fünfte Anschluss (100) in der offenen Position sind zum Zirkulieren von Kühlmittel in vier Durchläufen.
13. Anordnung gemäß Anspruch 1, wobei der Separator weiter definiert ist als ein erster Separator (38) und weiter einen zweiten Separator (52) und einen dritten Separator (54) umfasst, die in dem zweiten Verteiler (24) angeordnet sind und den Hohlraum (26) in eine dritte, vierte und fünfte Kammer (56, 58, 60) teilen.
14. Anordnung gemäß Anspruch 13, wobei beide der zweiten und dritten Separatoren (52, 54) von dem ersten Separator (38) versetzt sind, wobei die erste Kammer (40) mit der dritten Kammer (56) über eine erste Gruppe (62) der Durchflussrohre (28) Fluid-mäßig verbunden ist, wobei die erste Kammer (40) mit der vierten Kammer (58) über eine zweite Gruppe (64) der Durchflussrohre (28) Fluid-mäßig verbunden ist, wobei die zweite Kammer (42) mit der vierten Kammer (58) über eine dritte Gruppe (66) der Durchflussrohre (28) Fluid-mäßig verbunden ist, und wobei die zweite Kammer (42) mit der fünften Kammer (60) über eine vierte Gruppe (68) der Durchflussrohre (28) Fluid-mäßig verbunden ist.
15. Anordnung gemäß Anspruch 13, die weiter umfasst einen dritten Anschluss, der mit der dritten Kammer verbunden ist, und einen vierten Anschluss (98), der mit der vierten Kammer (58) verbunden ist, und einen fünften Anschluss (100), der mit der fünften Kammer (60) verbunden ist, und wobei die dritten, vierten und fünften Anschlüsse (96, 98, 100) in der offenen Position sind, wenn in dem Evaporator-Modus (34), zum Zirkulieren von Kühlmittel in zwei Durchläufen.
16. Anordnung gemäß Anspruch 15, wobei der Kondensator-Modus (36) weiter dadurch definiert ist, dass der vierte Anschluss (98) in der geschlossenen Position ist und der dritte Anschluss (96) und der fünfte Anschluss (100) in der offenen Position sind, zum Zirkulieren von Kühlmittel in vier Durchläufen.
17. Anordnung gemäß Anspruch 1, die umfasst ein Verteilerrohr (70), das in einer der Kammern (22, 24) und dem Hohlraum (27) angeordnet ist, wobei das Verteilerrohr (70) eine Vielzahl von Öffnungen hat und wobei das Verteilerrohr (70) Fluid-mäßig verbunden ist mit einem der Vielzahl von Anschlüssen

(30) zum Durchlauf von Kühlmittel von einem der Vielzahl von Anschlüssen (30) in zumindest eine der Kammern (40,42) und den Hohlraum (27) hinein, und weiter eine Evaporator-Modus(36)-Einlasskammer (78) definiert.

5

18. Anordnung gemäß Anspruch 17, die einen vierten Anschluss (98) in Fluid-Verbindung mit der Evaporator-Modus(34)-Einlasskammer (78) umfasst zum Zirkulieren des Kühlmittels in dem Kondensator-Modus (36).

10

19. Verfahren zum Betreiben eines Wärmetauschers (20) mit einem ersten Verteiler (22), der in eine erste Kammer (40) und eine zweite Kammer (42) geteilt ist, mit einem ersten Anschluss (92) und einem zweiten Anschluss (94), einem zweiten Verteiler (24), der zumindest eine Kammer mit einem dritten Anschluss (96) definiert, und einer Vielzahl von Durchflussrohren (28), welche die Verteiler (22, 24) Fluid-mäßig verbinden, wobei das Verfahren die Schritte aufweist:

15

20

Öffnen eines der Anschlüsse (30) in jeder Kammer der Verteiler (22, 24), um einen Evaporator-Modus (34) zu definieren;

25

Zuführen von Kühlmittel in einen der Verteiler (22, 24), um eine Einlasskammer (78) zu definieren;

Leiten des Kühlmittels durch alle der Vielzahl von Durchflussrohren (28) in einem einzigen Durchlauf;

30

Auslassen des Kühlmittels aus einem gegenüberliegenden Verteiler;

Schließen des dritten Anschlusses (96) des zweiten Verteilers (24), um einen Kondensator-Modus (36) zu definieren;

35

Zuführen des Kühlmittels in eine der Kammern eines der Verteiler (20, 22), um eine Einlasskammer (78) zu definieren;

40

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der Einlasskammer (78) verbunden sind;

Leiten des Kühlmittels in eine andere Kammer eines der Verteiler (22, 24), um eine Zwischenfluss-Kammer (72) zu definieren;

45

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der Zwischenfluss-Kammer (72) verbunden sind;

Leiten des Kühlmittels in eine andere Kammer eines der Verteiler (22, 24), um eine Auslasskammer (80) zu definieren; und

50

Auslassen des Kühlmittels durch den Anschluss, der mit der Auslasskammer (80) verbunden ist.

55

20. Verfahren zum Betreiben eines Wärmetauschers (20) mit einem ersten Verteiler (22), der in eine erste

Kammer (40) und eine zweite Kammer (42) geteilt ist, und einem zweiten Verteiler (24), der in eine dritte Kammer (56), eine vierte Kammer (58) und eine fünfte Kammer (60) geteilt ist, wobei ein dritter Anschluss (96), ein vierter Anschluss (98), ein fünfter Anschluss (100) und eine Vielzahl von Durchflussrohren (28) die Verteiler (22, 24) Fluid-mäßig verbinden, wobei das Verfahren die Schritte aufweist:

Öffnen zumindest eines der Anschlüsse (30), um einen Evaporator-Modus (34) zu definieren; Zuführen des Kühlmittels in einen der Verteiler (22, 24), um eine Einlasskammer (78) zu definieren;

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der Einlasskammer (78) verbunden sind;

Leiten des Kühlmittels in den gegenüberliegenden Verteiler (22, 24), um eine Zwischenfluss-Kammer (72) zu definieren;

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der Zwischenfluss-Kammer (72) verbunden sind;

Leiten des Kühlmittels in den gegenüberliegenden Verteiler (22, 24), um eine Auslasskammer (80) zu definieren;

Auslassen des Kühlmittels durch den Anschluss (30), der mit der Auslasskammer (80) verbunden ist;

Schließen des vierten Anschlusses (94) und Öffnen der dritten und fünften Anschlüsse (96, 100), um einen Kondensator-Modus (36) zu definieren;

Zuführen des Kühlmittels in den dritten Anschluss (96) des zweiten Verteilers (24), um eine Einlasskammer (78) zu definieren;

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der Einlasskammer (78) verbunden sind;

Leiten des Kühlmittels in die erste Kammer (40) des ersten Verteilers (22), um eine erste Zwischenfluss-Kammer (72) zu definieren;

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der ersten Zwischenfluss-Kammer (72) verbunden sind;

Leiten des Kühlmittels in die vierte Kammer (58) des zweiten Verteilers (22), um eine zweite Zwischenfluss-Kammer (74) zu definieren;

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der zweiten Zwischenfluss-Kammer (74) verbunden sind;

Leiten des Kühlmittels in die zweite Kammer (42) des ersten Verteilers (22), um eine dritte Zwischenfluss-Kammer (76) zu definieren;

Leiten des Kühlmittels durch die Vielzahl von Durchflussrohren (28), die mit der dritten Zwischenfluss-Kammer (76) verbunden sind;

Leiten des Kühlmittels in die fünfte Kammer (60)

des zweiten Verteilers (20), um eine Auslasskammer (80) zu definieren; und Auslassen des Kühlmittels durch den fünften Anschluss (100), der mit der Auslasskammer (80) verbunden ist.

Revendications

1. Ensemble échangeur thermique (20) comprenant :

un premier collecteur (22) et un second collecteur (24) qui définissent chacun une cavité creuse (26, 27) et disposés l'un par rapport à l'autre dans une relation espacée et sensiblement parallèles ;
une pluralité de tubes d'écoulement (28) qui s'étendent entre ledit premier et ledit second collecteur (22, 24) et qui les relient sur le plan fluide pour faire passer un réfrigérant entre lesdits collecteurs (22, 24) ;
un séparateur (38) disposé dans ledit premier collecteur (22) et divisant ladite cavité (26) en une première chambre (40) et une seconde chambre (42) ;
une pluralité d'orifices (30) reliés sur le plan fluide à l'un au moins dudit premier et dudit second collecteur (22, 24), chacun desdits orifices (30) ayant une position ouverte pour permettre au réfrigérant de s'écouler en entrant et en sortant desdits collecteurs (22, 24) et une position fermée pour empêcher au réfrigérant de s'écouler en entrant et en sortant desdits collecteurs (22, 24), et ladite pluralité d'orifices (30) inclut au moins un premier orifice (92), un second orifice (94) et un troisième orifice (96) ;
un contrôleur externe (32) pour commuter entre un mode évaporateur (34) et un mode condenseur (36) ; et
l'un desdits orifices (30) dans chaque chambre et la cavité (40, 42, 27) de l'un desdits collecteurs (22, 24) étant dans ladite position ouverte pour faire circuler un réfrigérant à travers tous les tubes de ladite pluralité de tubes d'écoulement (28) en au moins une passe lorsque l'échangeur est dans ledit mode évaporateur (34), et l'un au moins desdits orifices (30) étant dans ladite position fermée pour faire circuler le réfrigérant à travers ladite pluralité de tubes d'écoulement (28) en au moins deux passes lorsque l'échangeur est dans ledit mode condenseur (36).

2. Ensemble selon la revendication 1, dans lequel ledit premier orifice (92) est raccordé à ladite première chambre (40), ledit second orifice (94) est raccordé à ladite seconde chambre (42), et ledit troisième orifice (96) est raccordé à ladite cavité (27) dudit second collecteur (24).

3. Ensemble selon la revendication 2, dans lequel ledit mode évaporateur (34) est encore défini par le fait que l'un au moins desdits orifices (30) dans chaque chambre (40, 42) dudit premier collecteur (22) et l'un au moins desdits orifices (30) dans ladite cavité (27) dudit second collecteur (24) est dans ladite position ouverte pour faire circuler le réfrigérant en une passe.

4. Ensemble selon la revendication 2, dans lequel ledit mode condenseur (36) est encore défini par le fait que ledit premier orifice (92) et ledit second orifice (94) sont dans ladite position ouverte, et ledit troisième orifice (96) est dans ladite position fermée pour faire circuler le réfrigérant en deux passes.

5. Ensemble selon la revendication 2, dans lequel ledit séparateur (38) est encore défini comme étant un premier séparateur (38) et inclut en outre un second séparateur (52) disposé dans ladite cavité (27) dudit second collecteur (24) en divisant ladite cavité (27) dudit second collecteur (24) en une troisième chambre (56) et une quatrième chambre (58).

6. Ensemble selon la revendication 5, dans lequel ledit second séparateur (52) est décalé depuis ledit premier séparateur (38) alors que ladite première chambre (40) est raccordée sur le plan fluide à ladite troisième chambre (56) via un premier groupe (62) desdits tubes d'écoulement (28), ladite seconde chambre (42) est raccordée sur le plan fluide à ladite troisième chambre (56) par un second groupe (64) desdits tubes d'écoulement (28), et ladite seconde chambre (42) est raccordée sur le plan fluide à ladite quatrième chambre (58) par un troisième groupe (66) desdits tubes d'écoulement (28).

7. Ensemble selon la revendication 5, incluant en outre un quatrième orifice (98) raccordé à ladite quatrième chambre (58) alors que lesdits premier, second, troisième et quatrième orifices (92, 94, 96, 98) sont dans ladite position ouverte quand l'ensemble est dans ledit mode évaporateur (34) pour faire circuler le réfrigérant en une passe.

8. Ensemble selon la revendication 7, dans lequel ledit mode condenseur (36) est encore défini par le fait que ledit premier orifice (92) et ledit quatrième orifice (98) sont dans ladite position ouverte, et ledit second orifice (94) et ledit troisième orifice (96) sont dans ladite position fermée pour faire circuler le réfrigérant en trois passes.

9. Ensemble selon la revendication 2, dans lequel ledit séparateur est en outre défini comme étant un premier séparateur (38), et inclut en outre un second et un troisième séparateur (52, 54) disposés dans ledit second collecteur (24) en divisant ladite cavité (27)

en une troisième, une quatrième et une cinquième chambre (56, 58, 60).

10. Ensemble selon la revendication 9, dans lequel ledit second et ledit troisième séparateur (52, 54) sont tous les deux décalés depuis ledit premier séparateur (38) alors que ladite première chambre (40) est raccordée sur le plan fluïdique à ladite troisième chambre (56) par un premier groupe (62) desdits tubes d'écoulement (28), ladite première chambre (40) est raccordée sur le plan fluïdique à ladite quatrième chambre (58) par un second groupe (64) desdits tubes d'écoulement (28), ladite seconde chambre (42) est raccordée sur le plan fluïdique à ladite quatrième chambre (58) par un troisième groupe (66) desdits tubes d'écoulement (28), et ladite seconde chambre (42) est raccordée sur le plan fluïdique à ladite cinquième chambre (60) par un quatrième groupe (68) desdits tubes d'écoulement (28).
11. Ensemble selon la revendication 9, incluant en outre un quatrième orifice (98) raccordé à ladite quatrième chambre (58) et un cinquième orifice (100) raccordé à ladite cinquième chambre (60), et lesdits premier, second, troisième, quatrième et cinquième orifices (92, 94, 96, 98, 100) sont dans ladite position ouverte quand l'ensemble est dans ledit mode évaporateur (34) pour faire circuler le réfrigérant en une passe.
12. Ensemble selon la revendication 11, dans lequel ledit mode condenseur (36) et encore défini par le fait que ledit premier orifice (92), ledit second orifice (94) et ledit quatrième orifice (98) sont dans ladite position fermée, et ledit troisième orifice (96) et ledit cinquième orifice (100) sont dans ladite position ouverte pour faire circuler le réfrigérant en quatre passes.
13. Ensemble selon la revendication 1, dans lequel ledit séparateur est en outre défini comme étant un premier séparateur (38) et inclut en outre un second séparateur (52) et un troisième séparateur (54) disposés dans ledit second collecteur (24) en divisant ladite cavité (26) en une troisième, une quatrième et une cinquième chambre (56, 58, 60).
14. Ensemble selon la revendication 13, dans lequel ledit second et ledit troisième séparateur (52, 54) sont tous les deux décalés depuis ledit premier séparateur (38) alors que ladite première chambre (40) est raccordée sur le plan fluïdique à ladite troisième chambre (56) par un premier groupe (62) desdits tubes d'écoulement (28), ladite première chambre (40) est raccordée sur le plan fluïdique à ladite quatrième chambre (58) par un second groupe (64) desdits tubes d'écoulement (28), ladite seconde chambre (42) est raccordée sur le plan fluïdique à ladite quatrième chambre (58) par un troisième groupe (66) desdits tubes d'écoulement (28), et ladite se-

conde chambre (42) est raccordée sur le plan fluïdique à ladite cinquième chambre (60) par un quatrième groupe (68) desdits tubes d'écoulement (28).

15. Ensemble selon la revendication 13, incluant en outre un troisième orifice raccordé à ladite troisième chambre et un quatrième orifice (98) raccordé à ladite quatrième chambre (58), et un cinquième orifice (100) raccordé à ladite cinquième chambre (60), lesdits troisième, quatrième et cinquième orifice (96, 98, 100) étant dans ladite position ouverte quand l'ensemble est dans ledit mode évaporateur (34) pour faire circuler le réfrigérant en deux passes.
16. Ensemble selon la revendication 15, dans lequel ledit mode condenseur (36) et encore défini par le fait que ledit quatrième orifice (98) est dans ladite position fermée, et ledit troisième orifice (96) et ledit cinquième orifice (100) sont dans ladite position ouverte pour faire circuler le réfrigérant en quatre passes.
17. Ensemble selon la revendication 1, incluant un tube de distribution (70) disposé dans l'une desdites chambres (22, 24), et ladite cavité (27) avec ledit tube de distribution (70) ayant une pluralité d'ouvertures, et ledit tube de distribution (70) étant raccordé sur le plan fluïdique à l'un de ladite pluralité d'orifices (30) pour faire passer le réfrigérant depuis ledit orifice de ladite pluralité d'orifices (30) vers l'une au moins desdites chambres (40, 42) et ladite cavité (27), et définissant en outre une chambre d'entrée (78) pour le mode évaporateur (36).
18. Ensemble selon la revendication 17, incluant un quatrième orifice (98) raccordé sur le plan fluïdique à ladite chambre d'entrée (78) pour le mode évaporateur (34) pour faire circuler le réfrigérant dans ledit mode condenseur (36).
19. Procédé pour le fonctionnement d'un échangeur de chaleur (20) ayant un premier collecteur (22) divisé en une première chambre (40) et une seconde chambre (42) avec un premier orifice (92) et un second orifice (94), un second collecteur (24) définissant au moins une chambre avec un troisième orifice (96), et une pluralité de tubes d'écoulement (28) qui raccordent sur le plan fluïdique les collecteurs (22, 24), ledit procédé comprenant les étapes consistant à :
ouvrir l'un desdits orifices (30) dans chaque chambre desdits collecteurs (22, 24) pour définir un mode évaporateur (34) ;
introduire du réfrigérant dans l'un des collecteurs (22, 24) définissant une chambre d'entrée (78) ;
faire passer le réfrigérant à travers tous les tubes de la pluralité de tubes d'écoulement (28) en

- une passe unique ;
 faire sortir le réfrigérant depuis un collecteur opposé ;
 fermer le troisième orifice (96) du second collecteur (24) pour définir un mode condenseur (36) ; 5
 introduire le réfrigérant dans l'une des chambres de l'un des collecteurs (20, 22) pour définir une chambre d'entrée (78) ;
 faire passer le réfrigérant à travers la pluralité de tubes d'écoulement (28) raccordés à la chambre d'entrée (78) ; 10
 faire passer le réfrigérant dans une autre chambre de l'un des collecteurs (22, 24) pour définir une chambre à mi-écoulement (72) ; 15
 faire passer le réfrigérant dans une autre chambre de l'un des collecteurs (22, 24) pour définir une chambre de sortie (80) ; et
 faire sortir le réfrigérant via l'orifice raccordé à la chambre de sortie (80). 20
- 20.** Procédé pour le fonctionnement d'un échangeur de chaleur (20) ayant un premier collecteur (22) divisé en une première chambre (40) et une seconde chambre (42) et un second collecteur (24) divisé en une troisième chambre (56), une quatrième chambre (58) et une cinquième chambre (60), avec un troisième orifice (96), un quatrième orifice (98), un cinquième orifice (100) et une pluralité de tubes d'écoulement (28) qui raccordent sur le plan fluide les collecteurs (22, 24), ledit procédé comprenant les étapes consistant à : 25
- ouvrir l'un au moins des orifices (30) pour définir un mode évaporateur (34) ; 35
 introduire le réfrigérant dans l'un des collecteurs (22, 24) pour définir une chambre d'entrée (78) ;
 faire passer le réfrigérant à travers la pluralité de tubes d'écoulement (28) raccordés à la chambre d'entrée (78) ; 40
 faire passer le réfrigérant vers le collecteur opposé (22, 24) pour définir une chambre à mi-écoulement (72) ;
 faire passer le réfrigérant à travers la pluralité de tubes d'écoulement (28) raccordés à la chambre à mi-écoulement (72) ; 45
 faire passer le réfrigérant vers le collecteur opposé (22, 24) pour définir une chambre de sortie (80) ;
 faire sortir le réfrigérant à travers l'orifice (30) raccordé à la chambre de sortie (80) ; 50
 fermer le quatrième orifice (94) et ouvrir le troisième et le cinquième orifice (96, 100) pour définir un mode condenseur (36) ;
 introduire le réfrigérant dans le troisième orifice (96) du second collecteur (24) pour définir une chambre d'entrée (78) ; 55
 faire passer le réfrigérant à travers la pluralité

de tubes d'écoulement (28) raccordés à la chambre d'entrée (78) ;
 faire passer le réfrigérant vers la première chambre (40) du premier collecteur (22) pour définir une première chambre à mi-écoulement (72) ;
 faire passer le réfrigérant à travers la pluralité de tubes d'écoulement (28) raccordés à la première chambre à mi-écoulement (72) ;
 faire passer le réfrigérant vers la quatrième chambre (58) du second collecteur (22) pour définir une seconde chambre à mi-écoulement (74) ;
 faire passer le réfrigérant à travers la pluralité de tubes d'écoulement (28) raccordés à la seconde chambre à mi-écoulement (74) ;
 faire passer le réfrigérant vers la seconde chambre (42) du premier collecteur (22) pour définir une troisième chambre à mi-écoulement (76) ;
 faire passer le réfrigérant à travers la pluralité de tubes d'écoulement (28) raccordés à la troisième chambre à mi-écoulement (76) ;
 faire passer le réfrigérant vers la cinquième chambre (60) du second collecteur (20) pour définir une chambre de sortie (80) ; et
 faire sortir le réfrigérant via le cinquième orifice (100) raccordé à la chambre de sortie (80).

FIG - 1

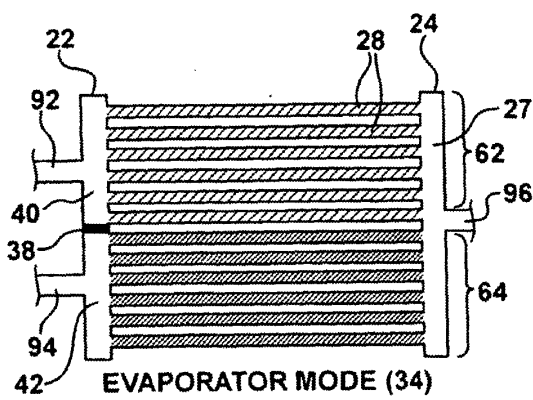
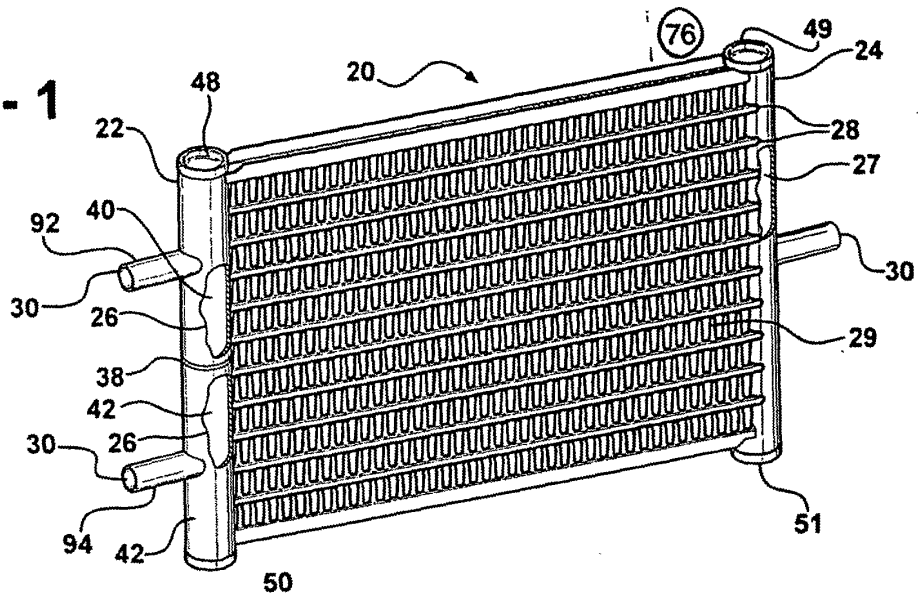


FIG - 1A

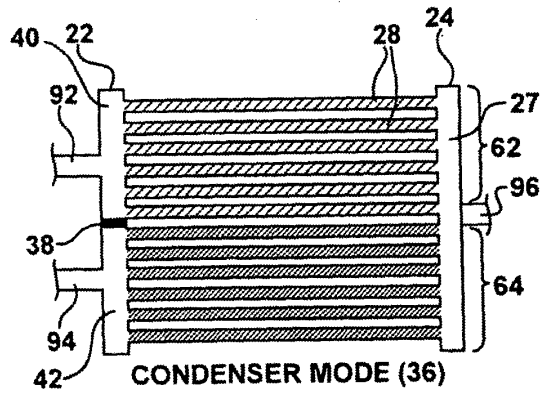


FIG - 1B

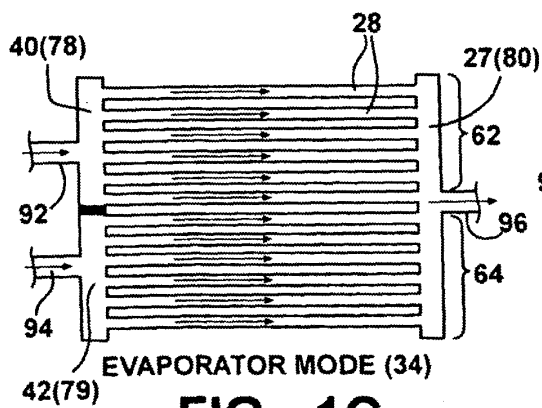


FIG - 1C

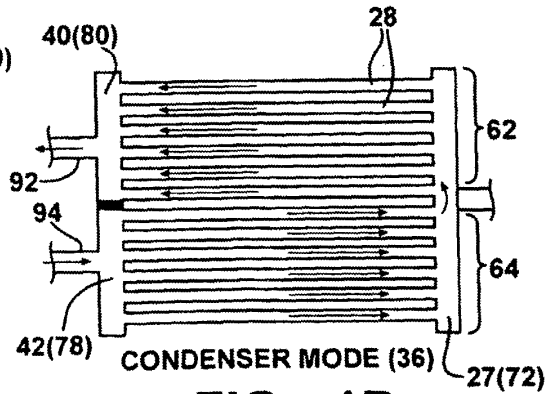
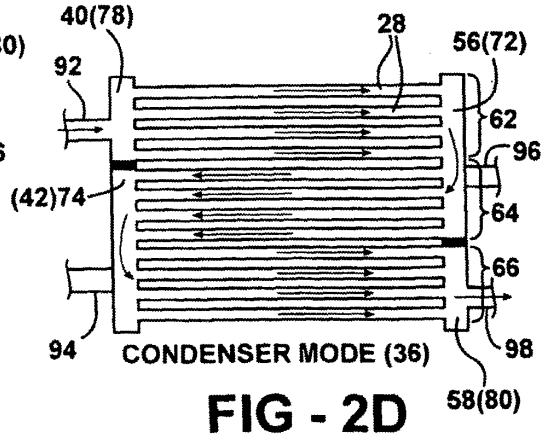
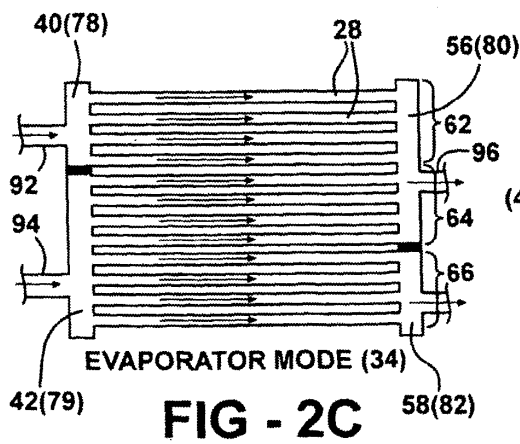
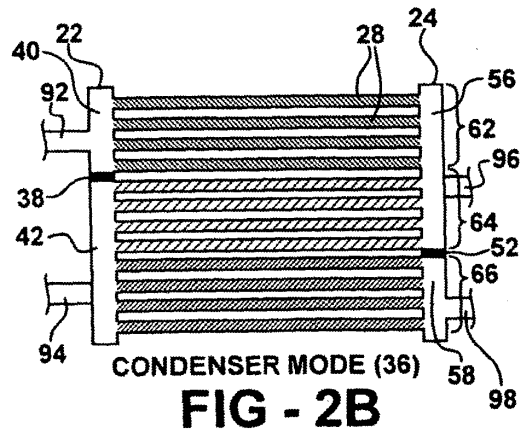
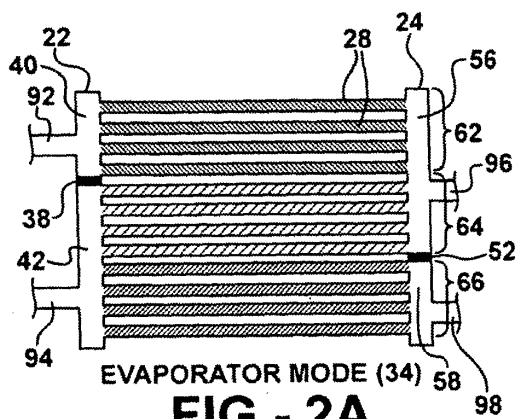
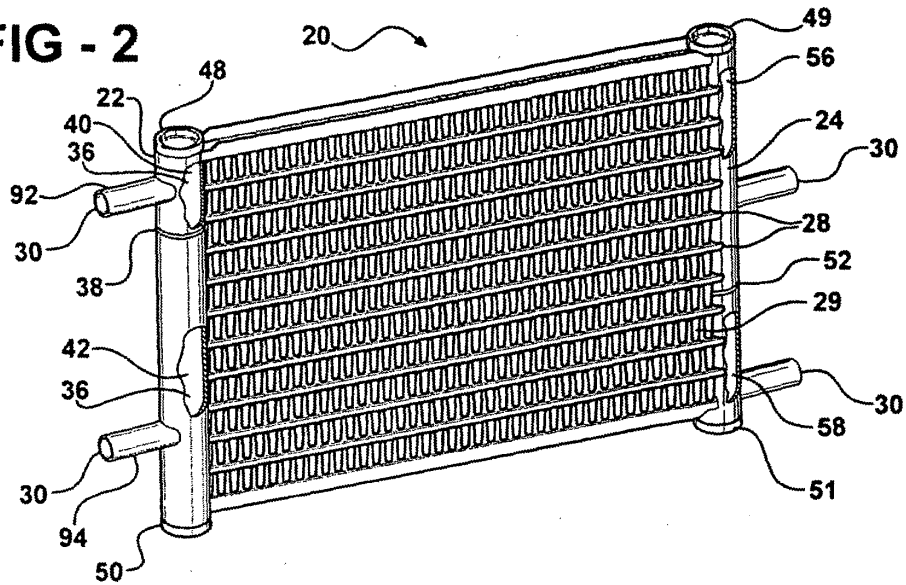
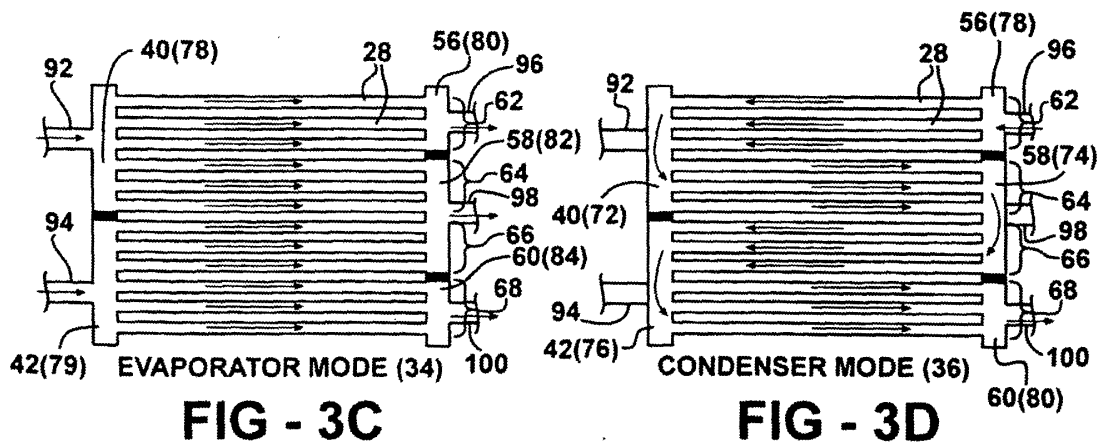
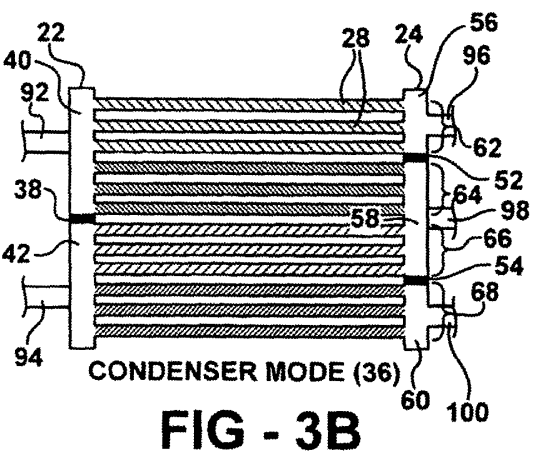
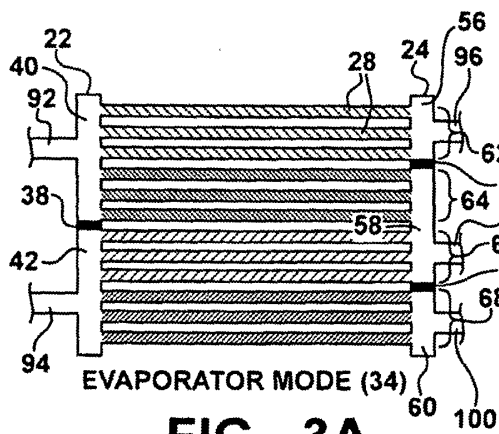
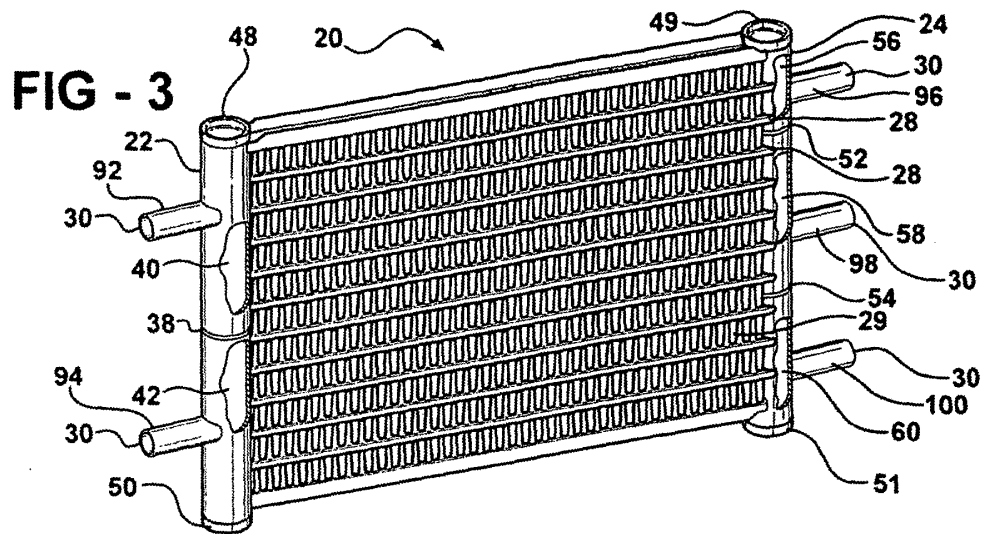


FIG - 1D

FIG - 2





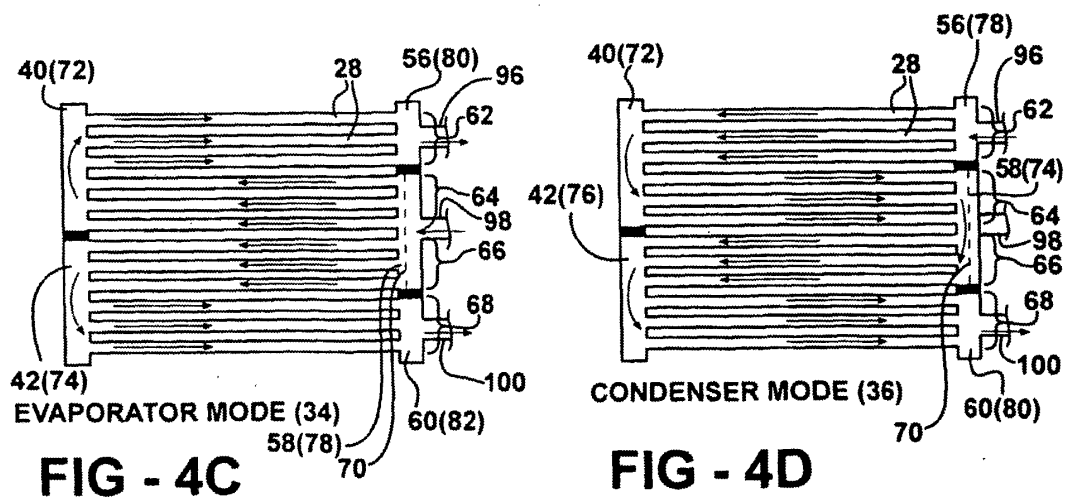
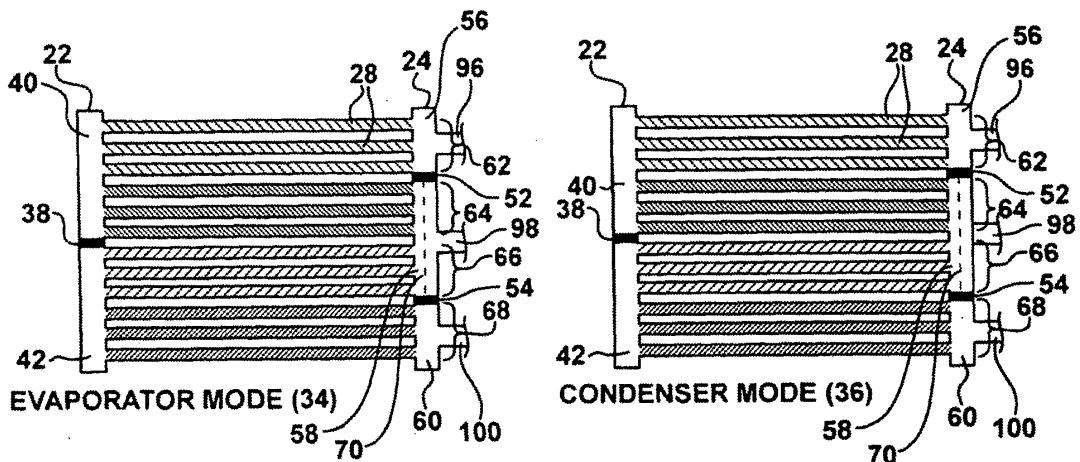
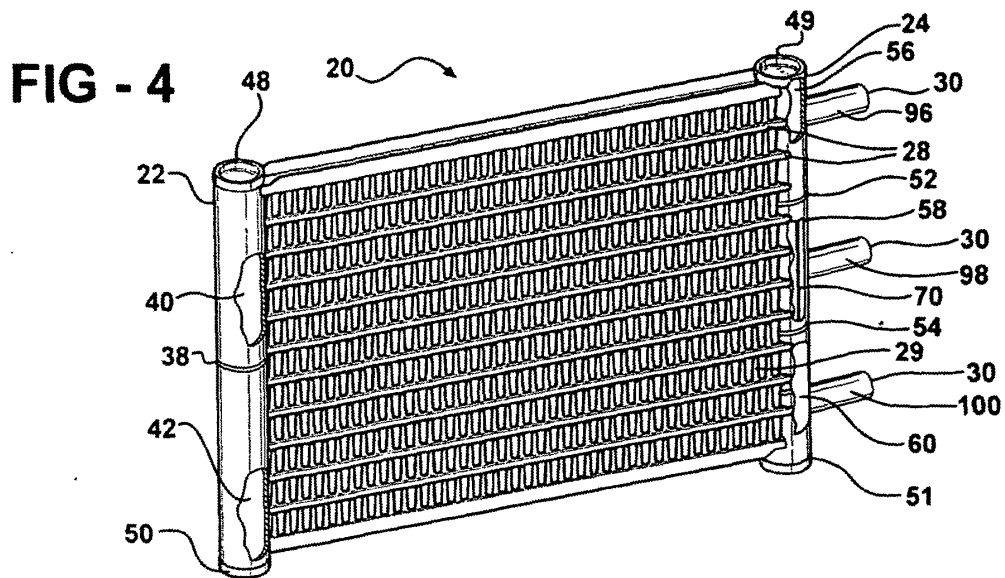


FIG - 5

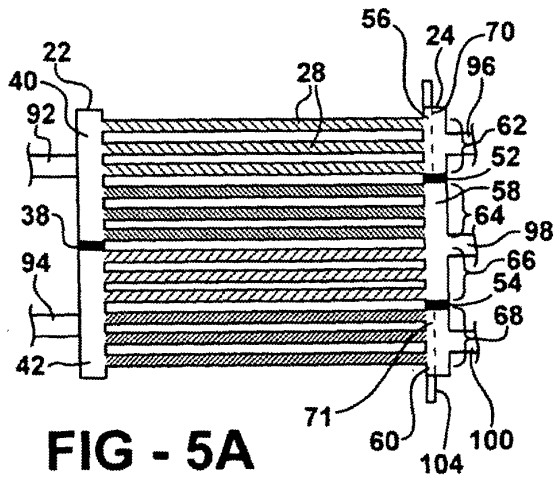
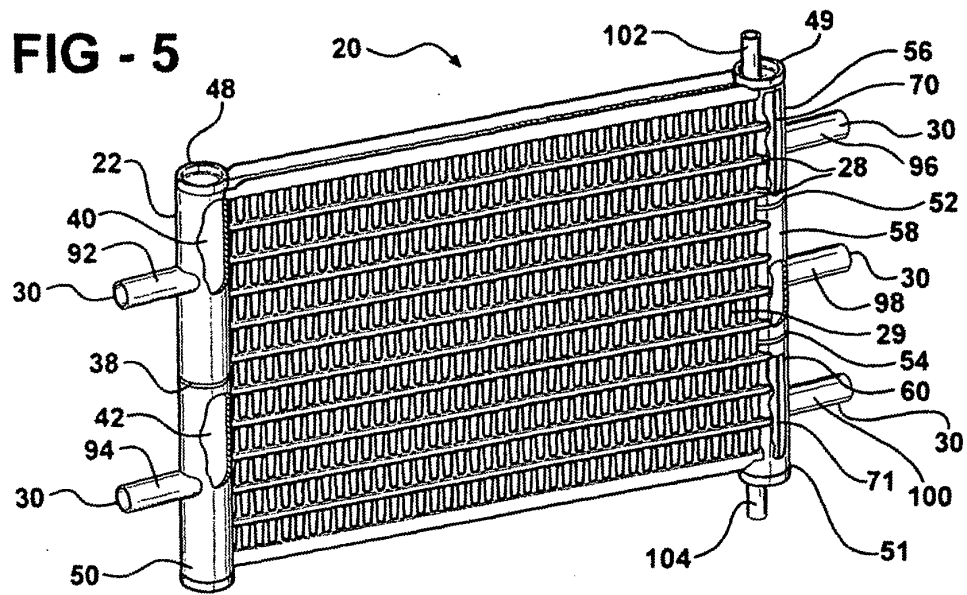


FIG - 5A

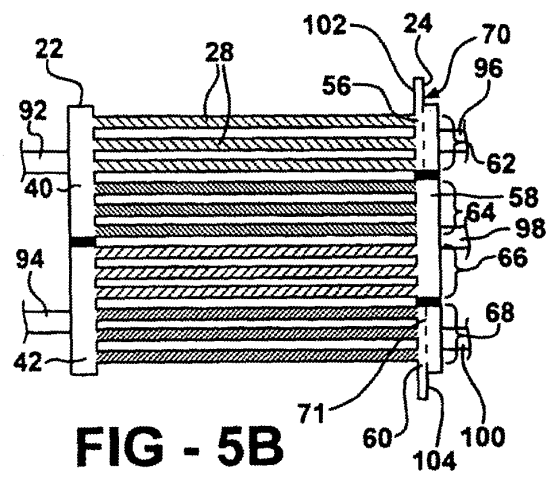


FIG - 5B

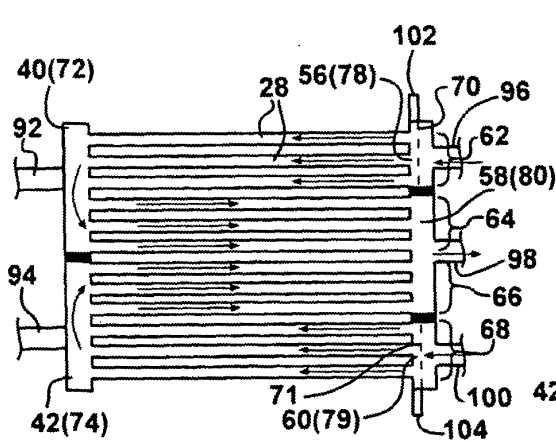


FIG - 5C

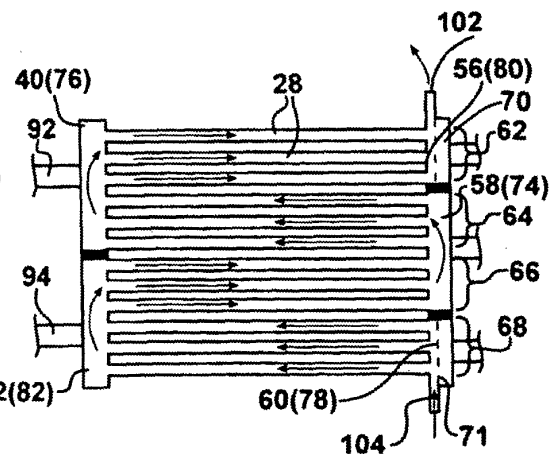


FIG - 5D

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2409510 A, Heys [0004]
- GB 2375596 A, Heys [0004]
- US 5826649 A, Chapp [0004]