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(54) **FLUID DISTRIBUTOR FOR AN INLET HEADER OF A HEAT EXCHANGER**

(71) Applicant: **Carrier Corporation**, Palm Beach Gardens, FL (US)

(72) Inventors: **Lokanath Mohanta**, Liverpool, NY (US); **Tobias Sienel**, Baldwinsville, NY (US); **Arindom Joardar**, Jamesville, NY (US); **Christopher Keinath**, Jamesville, NY (US); **Fatemeh Hejripour Rafsanjani**, Jamesville, NY (US); **Thomas Visalli**, Oneida, NY (US)

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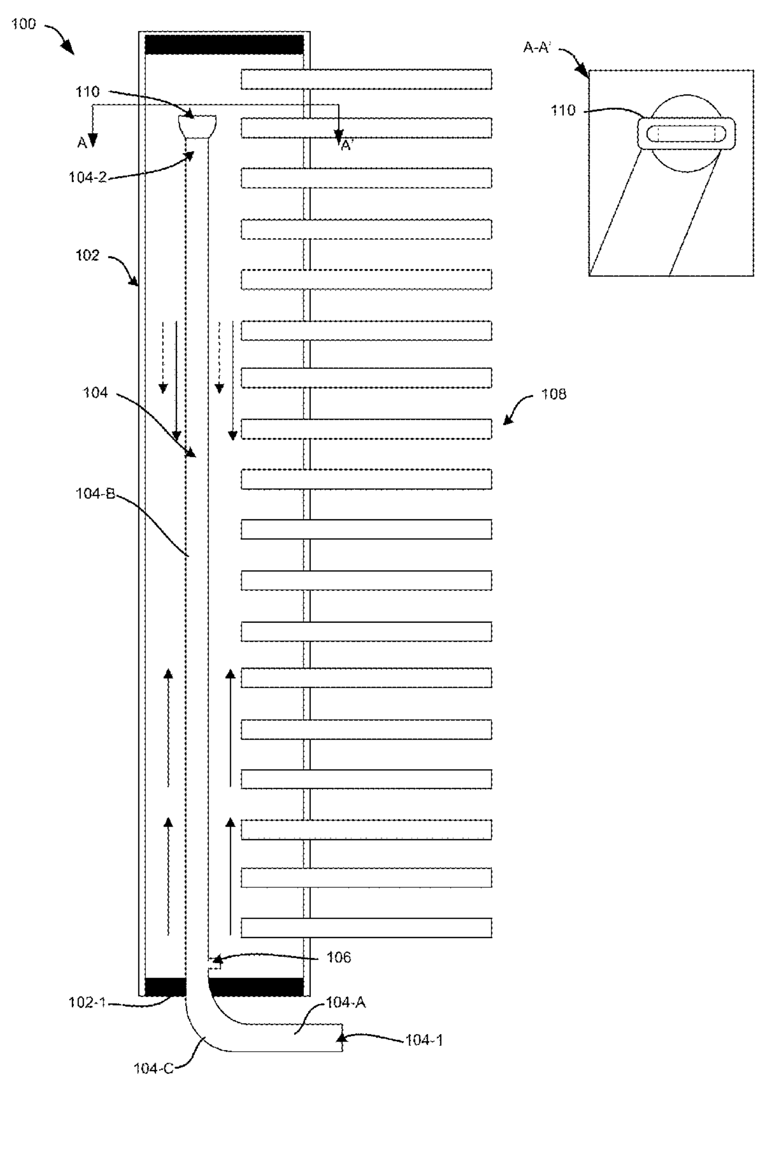
(57) **ABSTRACT**

Described herein is a fluid distributor for a header associated with a heat exchanger. The distributor comprises a distributor tube comprising a first tube segment, and a second tube segment extending at a predefined angle from an end of the first tube segment, wherein the distributor tube comprises a hole at a predefined position on a predefined side, facing towards the first tube segment on an inner side of a bend, of the second tube segment, wherein the distributor tube is configured with the header such that the first tube segment remains outside of the header and the second tube segment extends longitudinally within the header via a first end of the header, with the hole located at the first end of the header.



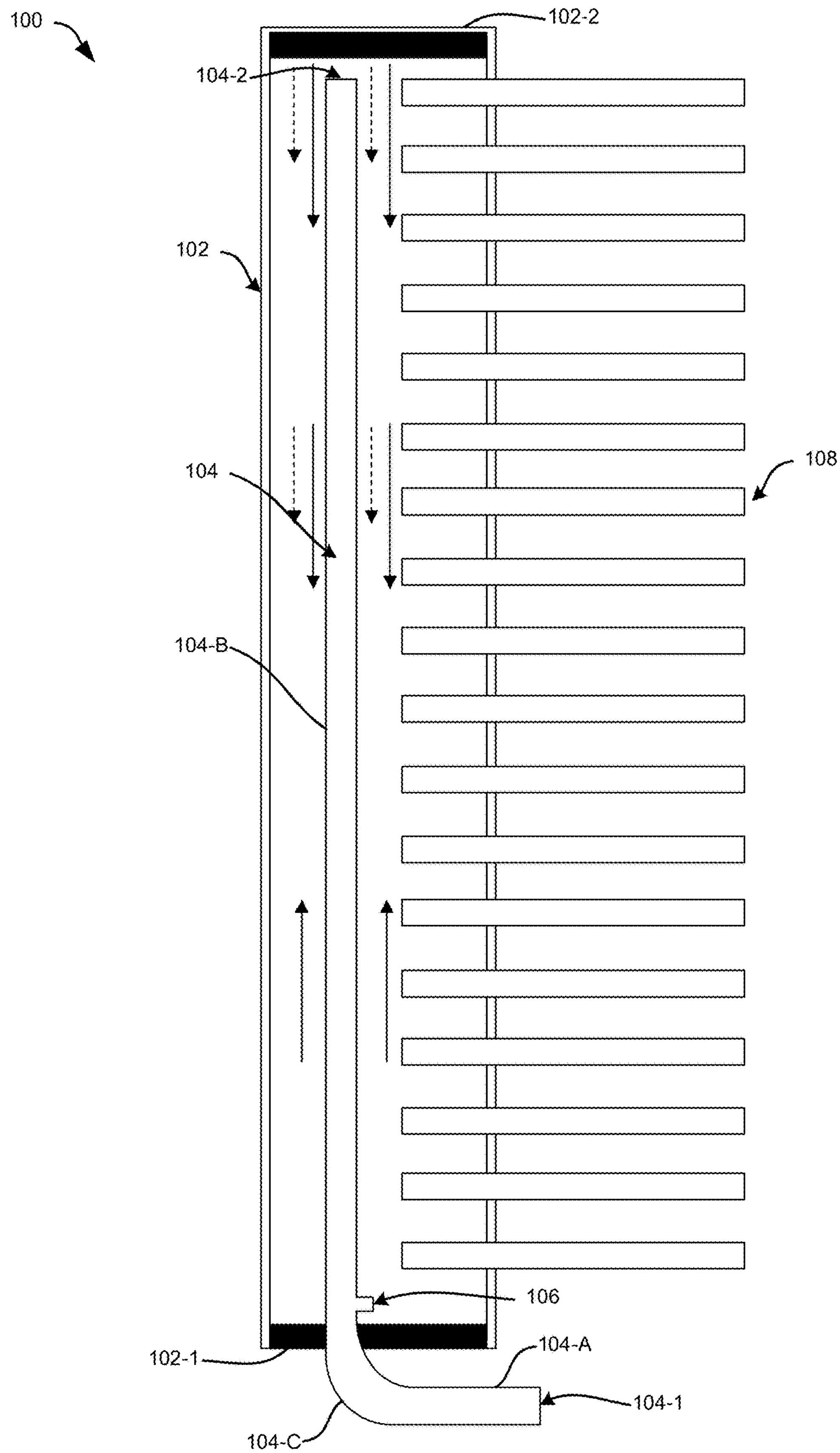


FIG. 1A

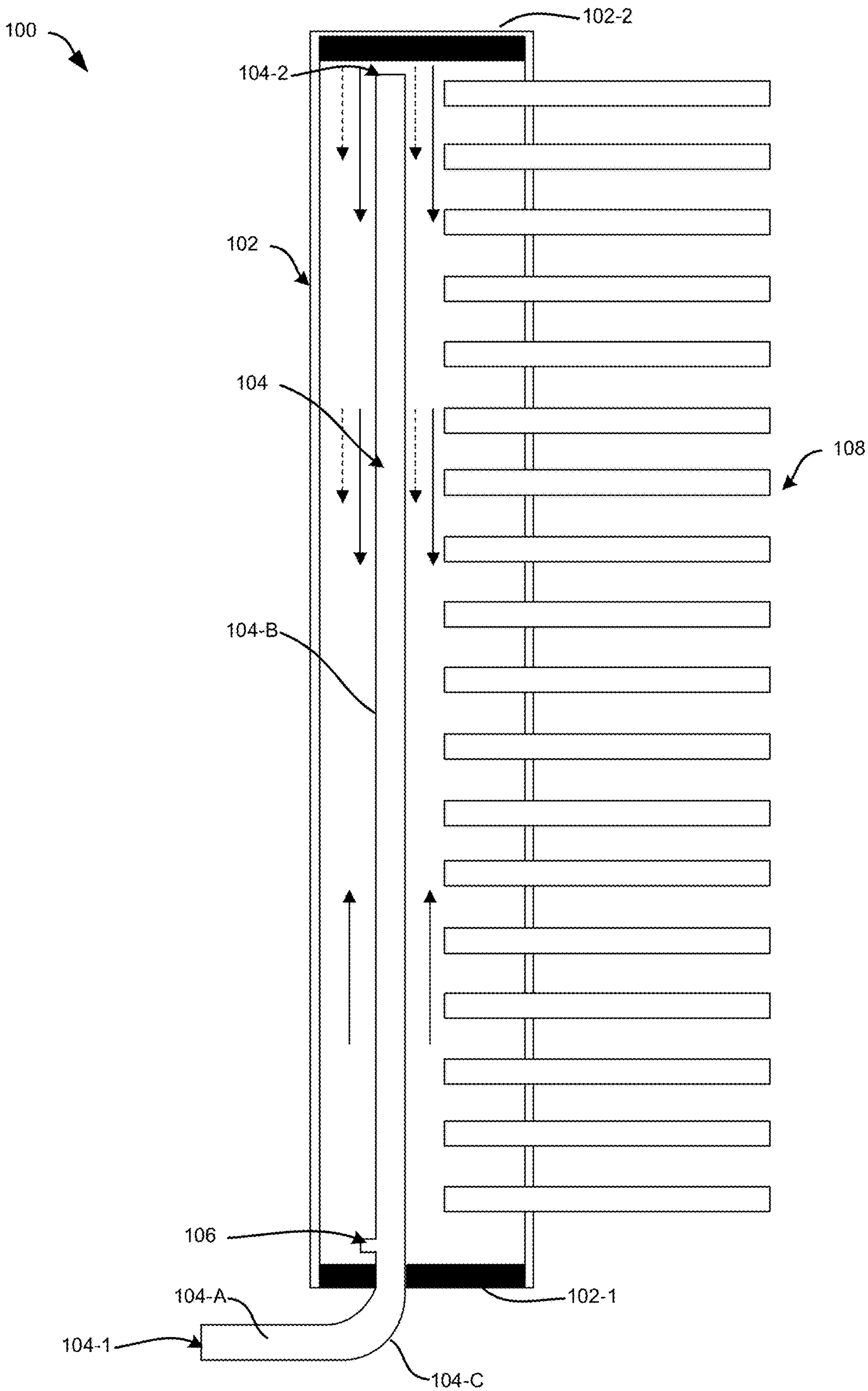


FIG. 1B

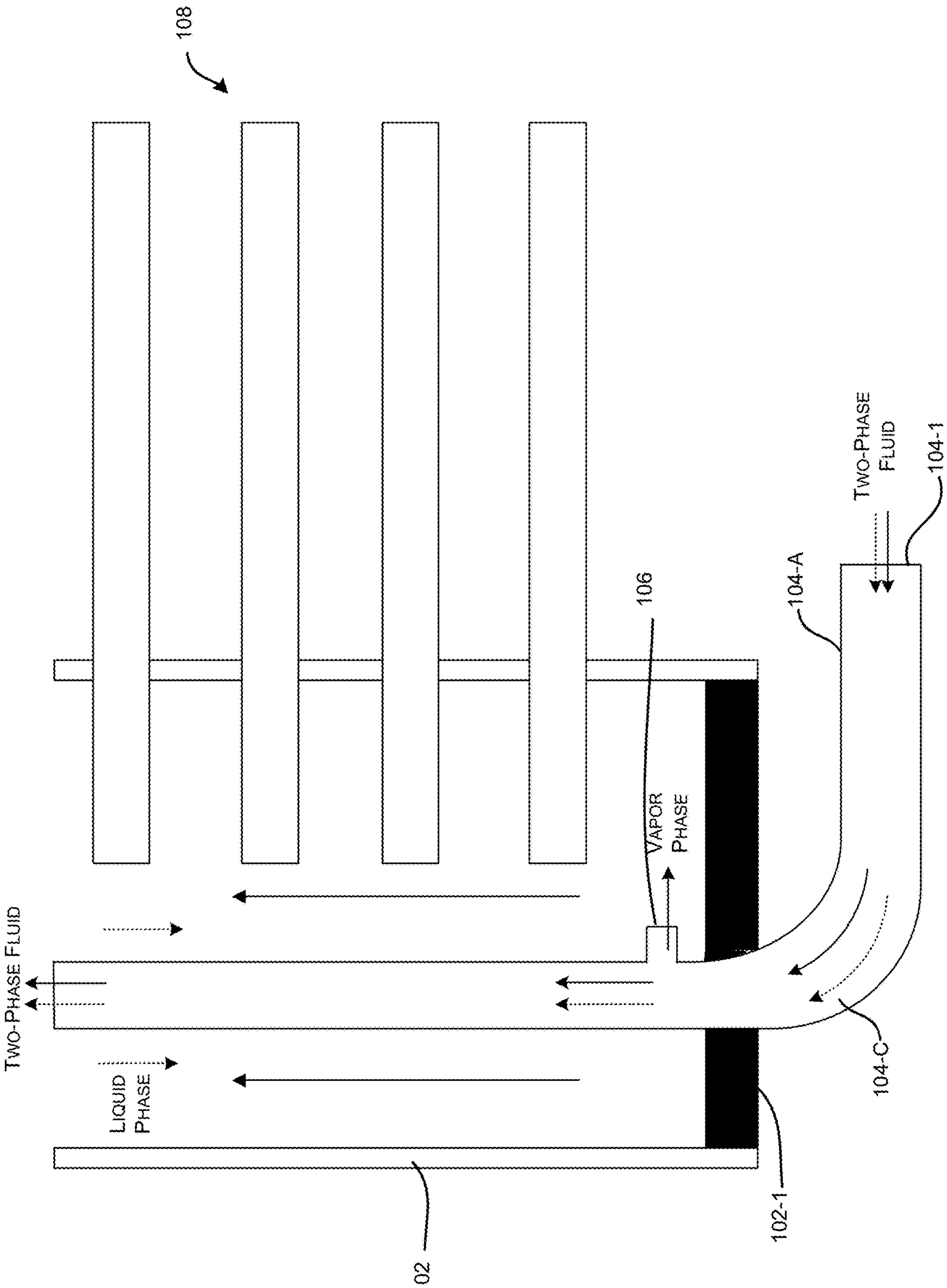

108
106
Vapor Phase
Two-Phase Fluid
104-1
104-A
Two-Phase Fluid
Liquid Phase
104-C
102-1
102

FIG. 1C

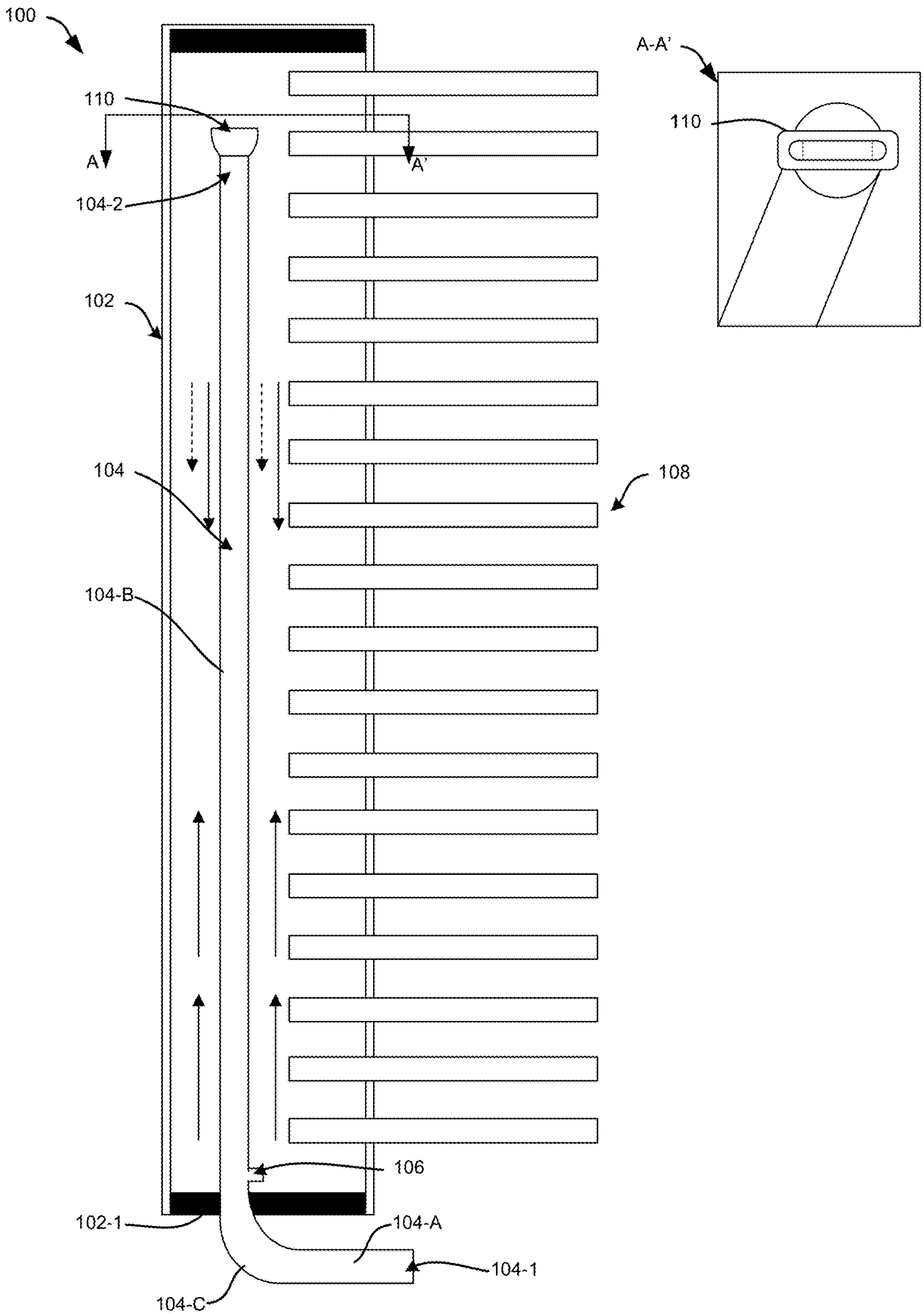


FIG. 2

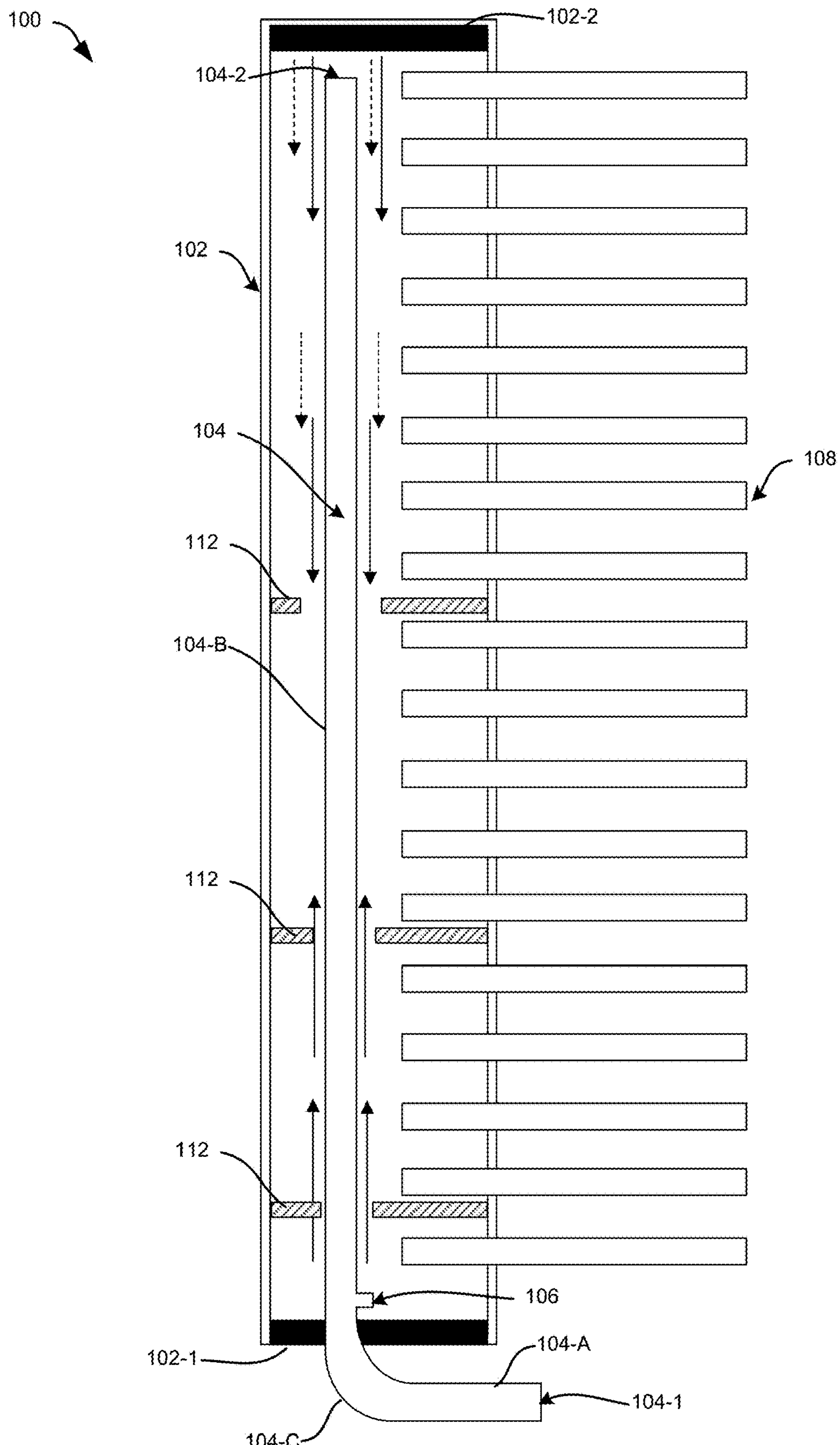

100
102-2
104-2
102
104
108
112
104-B
112
112
106
102-1
104-A
104-1
104-C

FIG. 3

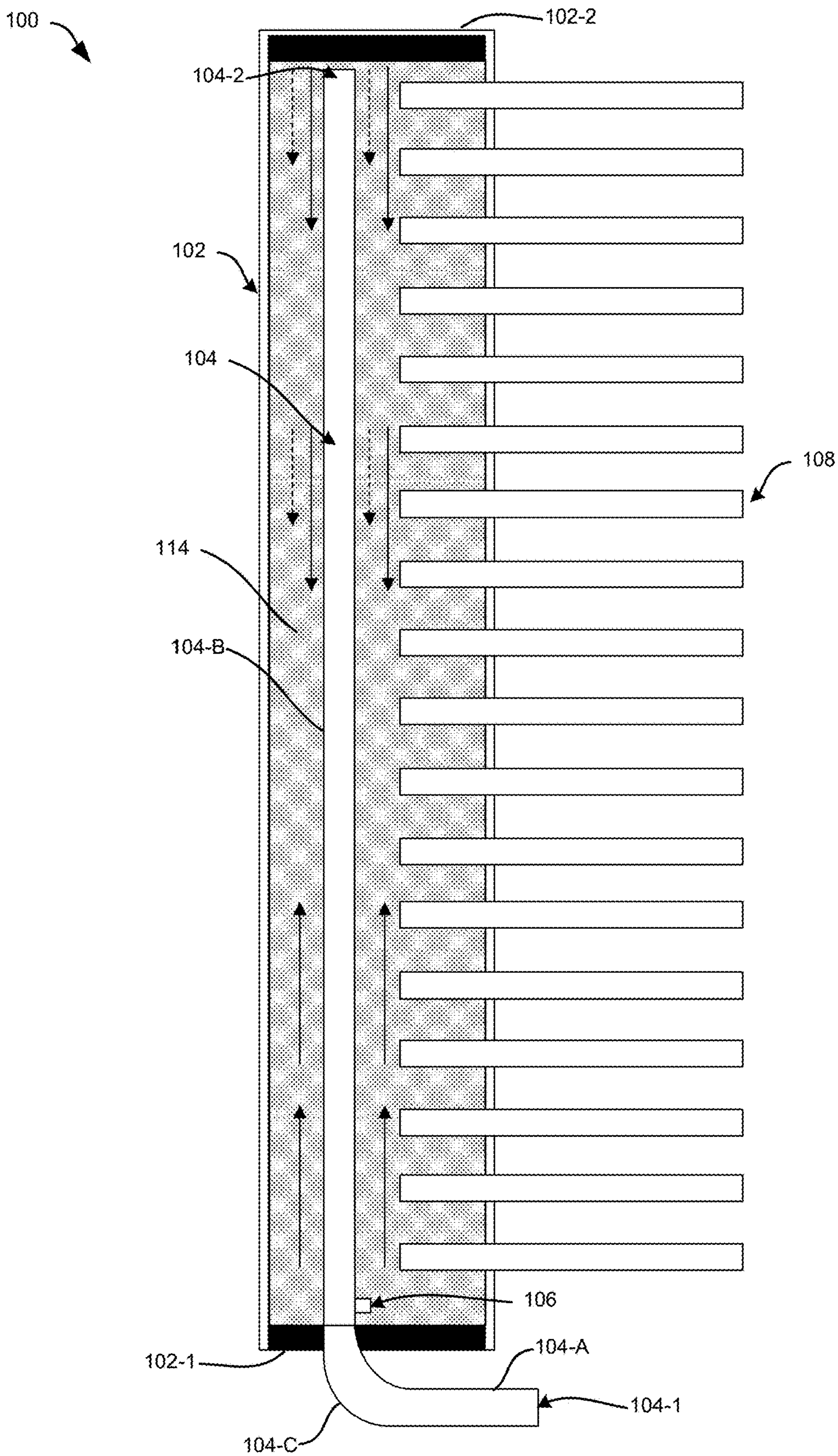


FIG. 4

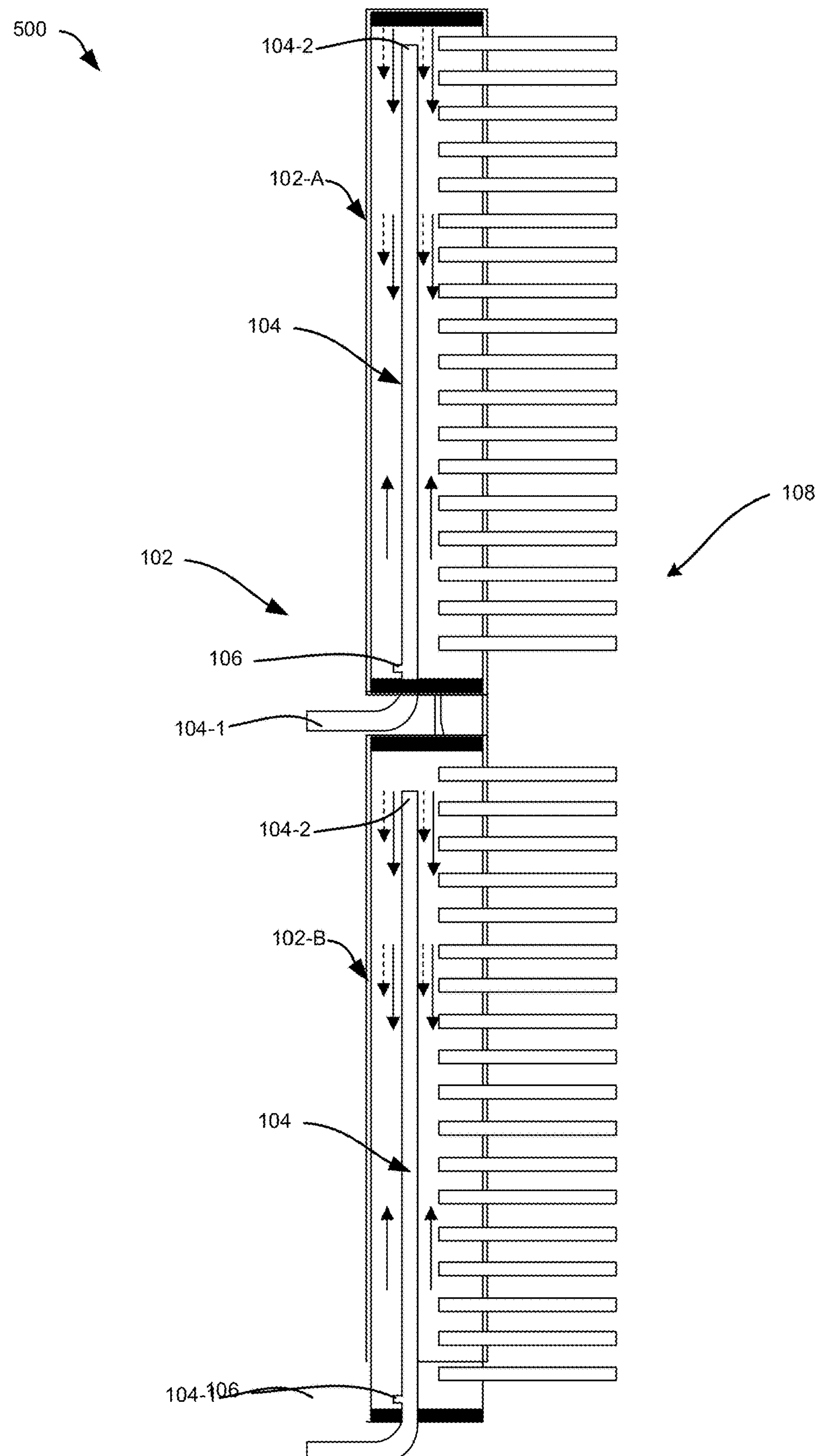


FIG. 5

FLUID DISTRIBUTOR FOR AN INLET HEADER OF A HEAT EXCHANGER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent application claims the benefit of U.S. Provisional Patent Application No. 63/555,437, filed on Feb. 20, 2024, which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] The subject disclosure relates to the field of heat exchangers, and more particularly, to an internal distributor for an inlet header associated with a heat exchanger.

SUMMARY

[0003] Described herein is a fluid distributor for a header associated with a heat exchanger. The distributor comprises a distributor tube comprising a first tube segment, and a second tube segment extending at a predefined angle from an end of the first tube segment, wherein the distributor tube comprises a hole at a predefined position on a predefined side, facing towards the first tube segment on an inner side of a bend, of the second tube segment, wherein the distributor tube is configured with the header such that the first tube segment remains outside of the header and the second tube segment extends longitudinally within the header via a first end of the header, with the hole located at the first end of the header.

[0004] In one or more embodiments, the first tube segment and the second tube segment are connected by a substantially curved portion to define the shape of the distributor tube having a first open end located outside of the header and a second open end located within the header, wherein the hole is located downstream of the curved portion on the predefined side of the second tube segment, such that the hole remains at the first end of the header and adjacent to the curved portion.

[0005] In one or more embodiments, the distributor is configured to receive a two-phase fluid within the distributor tube via the first open end, causing the two-phase fluid and/or a liquid phase associated with the two-phase fluid to flow out of the distributor into the header via the second open end and a vapor phase associated with the two-phase fluid to flow into the header via the hole, wherein the liquid phase flowing out of the second open end flows into one or more ports associated with a plurality of heat exchange tubes being fluidically connected to the header.

[0006] In one or more embodiments, the vapor phase flowing out of the hole into the header facilitates stirring of any pool of the liquid phase formed within the header while moving the stirred liquid phase in an upward direction to enable a homogeneous flow of the liquid phase within the header and further into the one or more ports.

[0007] In one or more embodiments, when a static pressure created in the header due to a liquid pool formed within the header increases above a pressure created in an interior of the curved portion of the distributor tube due to high velocity of the vapor phase therein, the hole facilitates automated suction of the liquid phase from the formed liquid pool back into the distributor tube and further allowing the two-phase fluid and/or the liquid phase to flow out of the second open end into the header.

[0008] In one or more embodiments, the distributor tube has a substantially L-shaped profile or a substantially J-shaped profile, where the second tube segment extends at the predefined angle of 90 degrees from the first tube segment.

[0009] In one or more embodiments, the second tube segment extends at the predefined angle greater than 10 degrees from the first tube segment.

[0010] In one or more embodiments, the distributor comprises a nozzle configured at the second open end of the distributor tube.

[0011] In one or more embodiments, the nozzle is a flat nozzle comprising an inlet connected to the second open end of the distributor tube, and an outlet having a substantially flat profile facing an inner wall at the second end of the header, wherein the nozzle has an area reduction in a range of 25% to 75% of a flow area of the distributor tube.

[0012] In one or more embodiments, the header comprises one or more baffles, each having an opening of predefined sizes, disposed coaxially or off-centered within the header, wherein the second tube segment of the distributor tube extends longitudinally through the openings of the one or more baffles such that a predefined gap remains between a rim of the corresponding openings and an outer surface of the distributor tube to allow flow of the two-phase fluid therethrough.

[0013] In one or more embodiments, the size of the openings of the one or more baffles and/or the predefined gap between the rim of the corresponding openings and an outer surface of the distributor tube decreases or increases while moving in a direction from the second end towards the first end of the header, thereby allowing flow of a predetermined volume flow of the two-phase fluid through each of the gaps.

[0014] In one or more embodiments, the header comprises a porous media disposed at least partially within the header around the distributor tube, wherein the porous media facilitates the liquid phase flowing out of the second open end to be supplied into one or more ports associated with a plurality of heat exchange tubes being fluidically connected to the header.

[0015] In one or more embodiments, the porous media is disposed within the header along an entire length of the header.

[0016] In one or more embodiments, density or pore size of the porous media increases while moving in a direction from the second end towards the first end of the header.

[0017] In one or more embodiments, the header is oriented vertically upward or inclined at a predefined angle from a vertical axis such that the first end of the header remains at a bottom and the second end of the header remains on top.

[0018] In one or more embodiments, a ratio of a length of the header and a distance between the second open end of the distributor tube and the second end of the header is in a range of 0.5 times an inner diameter of the header to 50% of the length of the header.

[0019] Also described herein is an inlet header for a heat exchanger. The inlet header comprises a housing defining shape of the header and having one or more partitioned compartments, wherein an interior volume of at least one of the compartments of the header is fluidically connected to a plurality of heat exchange tubes associated with the heat exchanger. The inlet header further comprises one or more of the distributor tubes, wherein one of the distributor tubes is configured with one of the compartments of the header such that the first tube segment of each of the distributor tubes remains outside of the corresponding compartment and the second tube segment of each of the distributor tubes extends longitudinally within the corresponding compartment via a first end of the respective compartments, with the hole located at the first end of the respective compartments.

[0020] In one or more embodiments, the first tube segment and the second tube segment of each of the distributor tubes are connected by a substantially curved portion to define the shape of the one or more distributor tubes, each having a first open end located outside of the respective compartments and a second open end located within the respective compartments, wherein the hole is located downstream of the curved portion on the predefined side of the second tube segment or in the curved portion, such that the hole remains at the first end of the respective compartments and adjacent to the curved portion.

[0021] In one or more embodiments, the first open end of each of the distributor tubes is configured to be fluidically connected to an outlet of an external fluid distributor that is configured to receive the two-phase fluid from a refrigerant line and uniformly supply the two-phase fluid into the corresponding distributor tubes.

[0022] Further described herein is an inlet header for a heat exchanger. The inlet header comprises a housing defining shape of the header, wherein a plurality of heat exchange tubes associated with the heat exchanger is fluidically connected to an interior volume of the header. The inlet header further comprises the distributor tube, wherein the distributor tube is configured with the header such that the first tube segment remains outside of the header and the second tube segment extends longitudinally within the header via a first end of the header, with the hole located at the first end of the header.

[0023] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, features, and techniques of the subject disclosure will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The accompanying drawings are included to provide a further understanding of the subject disclosure and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the subject disclosure and, together with the description, serve to explain the principles of the subject disclosure.

[0025] In the drawings, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label with a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

[0026] FIGS. **1**A and **1**B illustrate exemplary cross-sectional side views of an inlet header associated with a heat exchanger, where the header is configured with an internal fluid (refrigerant) distributor in different orientations in accordance with one or more embodiments of the subject disclosure.

[0027] FIG. **1**C illustrates a detailed view of the bottom or first end of the inlet header of FIG. **1**A in accordance with one or more embodiments of the subject disclosure.

[0028] FIG. **2** illustrates an exemplary cross-sectional side view of an embodiment of an inlet header configured with the internal fluid distributor, where an open end of the distributor is fitted with a nozzle in accordance with one or more embodiments of the subject disclosure.

[0029] FIG. **3** illustrates an exemplary cross-sectional side view of another embodiment of an inlet header configured with the internal fluid distributor, where the header is configured with multiple baffles having variable gaps between the distributor and the baffles in accordance with one or more embodiments of the subject disclosure.

[0030] FIG. **4** illustrates an exemplary cross-sectional side view of yet another embodiment of an inlet header configured with the internal fluid distributor, where an interior volume of the header is at least partially filled with a porous media in accordance with one or more embodiments of the subject disclosure.

[0031] FIG. **5** illustrates an exemplary cross-sectional side view of a multi-compartment inlet header associated with a heat exchanger, where each compartment of the header is configured with an internal fluid distributor in accordance with one or more embodiments of the subject disclosure.

DETAILED DESCRIPTION

[0032] The following is a detailed description of embodiments of the subject disclosure depicted in the accompanying drawings. The embodiments are in such detail as to clearly communicate the subject disclosure. However, the amount of detail offered is not intended to limit the anticipated variations of embodiments; on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the subject disclosure as defined by the appended claims.

[0033] Various terms are used herein. To the extent a term used in a claim is not defined below, it should be given the broadest definition persons in the pertinent art have given that term as reflected in printed publications and issued patents at the time of filing.

[0034] In the specification, reference may be made to the spatial relationships between various components and to the spatial orientation of various aspects of components as the devices are depicted in the attached drawings. However, as will be recognized by those skilled in the art after a complete reading of the subject disclosure, the components of the subject disclosure. described herein may be positioned in any desired orientation. Thus, the use of terms such as "above," "below," "upper," "lower," "first", "second" or other like terms to describe a spatial relationship between various components or to describe the spatial orientation of aspects of such components should be understood to describe a relative relationship between the components or a spatial orientation of aspects of such components, respectively, described herein may be oriented in any desired direction.

[0035] As used herein, "substantially" means largely or considerably, but not necessarily wholly, or sufficiently to work for the intended purpose. The term "substantially" thus allows for minor, insignificant variations (such as 10% with respect to numeric values) from an absolute or perfect state, dimension, measurement, result, or the like as would be expected by a person of ordinary skill in the art, but that do not appreciably affect overall performance.

[0036] The distribution of fluid (refrigerant) among multiple ports of microchannel tubes of a heat exchanger plays a significant role in the overall performance of the heat exchanger and the effective utilization of the heat transfer surface. There is, therefore, a need to provide a simple, efficient, and cost-effective fluid distributor for the inlet header of heat exchangers, which uniformly supplies fluid (refrigerant) into the ports of the microchannel tubes while maintaining lower pressure drop in the distributor and preventing formation of liquid pool within the header.

[0037] Referring to FIGS. **1**A to **4**, an inlet header **102** associated with a heat exchanger **100** is disclosed, where the header **102** is configured with an internal (fluid) refrigerant distributor **104** (also referred to as distributor **104**, herein) to uniformly supply (fluid) refrigerant into multiple heat exchange tubes **108** being fluidically connected to the header **102**. As illustrated, the header **102** can include a hollow housing defining the shape of the header **102**, where a plurality of heat exchange tubes **108** associated with the heat exchanger **100** can be fluidically connected to an interior volume of the header **102**. In one or more embodiments, the heat exchange tubes **108** can be microchannel (MCHX) tubes **108** where one or more ports at one end of the MCHX tubes **108** can be embedded or disposed in the header **102**. The other end of the MCHX tubes **108** can then be fluidically connected to an outlet header or a common fluid collector (not shown) associated with the heat exchanger **100**. Further, the fluid distributor **104** can be configured within the header **102** to uniformly supply the (fluid) refrigerant into the MCHX tubes **108**.

[0038] In one or more embodiments, the header **102** can have a substantially cylindrical profile having a curved surface extending between flat circular bases at the first end **102-1** and the second end **102-2** of the header **102**. The curved surface may have any of a circular cross-section, an oval cross-section, or a parabolic cross-section, but is not limited to the like. However, in some embodiments (not shown), the header **102** can also have a prismatic cylindrical profile having noncurved or planar sides extending between flat bases at the first end **102-1** and the second end **102-2** of the header **102**.

[0039] In one or more embodiments, the header **102** can be oriented vertically upward as shown in FIGS. **1**A to **4** or can be inclined at a predefined angle from a vertical axis such that the first end **102-1** of the header **102** remains at the bottom and the second end **102-2** of the header **102** remains on top or above the first end **102-1**.

[0040] In one or more embodiments, the distributor **104** can include a distributor tube (also designated as **104**, herein) that comprises a first tube segment **104**-A, and a second tube segment **104**-B extending at a predefined angle from an end of the first tube segment **104**-A, such that a bend **104**-C is created between the first tube segment **104**-A and the second tube segment **104**-B. Further, in one or more embodiments, the first tube segment **104**-A and the second tube segment **104**-B can be connected by a substantially curved portion **104**-C to define the shape of the distributor tube **104** having a first open end **104-1** located outside of the header **102** and a second open end **104-2** located within the header **102** towards the second end **102-2** of the header **102**. Further, in one or more embodiments, the first open end **104-1** can be configured to be fluidically connected to an expansion device.

[0041] In one or more embodiments, the distributor tube **104** can have a substantially L-shaped profile or a substantially J-shaped profile, where the second tube segment **104**-B extends at (the predefined angle of) 90 degrees or substantially perpendicular from the first tube segment **104**-A. However, in one or more embodiments (not shown), the second tube segment **104**-B can extend at the predefined angle greater than 10 degrees from the first tube segment **104**-A.

[0042] In addition, the distributor tube **104** can include a hole **106** at a predefined position on a predefined side (also referred to as the inner side of the bend), facing toward the first tube segment **104**-A, of the second tube segment **104**-B. The size of the hole **106** can be 0.05 to 0.5 times of an inner diameter of the distributor tube **104**, but is not limited to the like. For instance, as shown in FIG. **1**A, the predefined side or inner side can be on the left side of the first tube segment **104**-A such that the hole **106** or the inner side remains on the first tube segment side **102**-A. Consequently, the outer side of the distributor tube **104** can be on the right side, opposite to the first tube segment **104**-A. Similarly, as shown in FIG. **1**B, the predefined side or inner side can be on the right side of the first tube segment **104**-A such that the hole **106** or the inner side remains on the first tube segment side **102**-A. Consequently, the outer side of the distributor tube **104** can be on the left side, opposite to the first tube segment side **102**-A.

[0043] The distributor tube **104** can be configured with the header **102** such that the first tube segment **104**-A remains outside of the header **102** and the second tube segment **104**-B extends longitudinally within the header **102** via the first end **102-1** of the header **102**, with the hole **106** located at the first end **102-1** of the header **102**. In one or more embodiments, the hole **106** can be located in or downstream of the curved portion **104**-C on the predefined (inner) side of the second tube segment **104**-B, such that the hole **106** remains at the first end **102-1** of the header **102** and in the curved portion or adjacent to (or just after) the curved portion **104**-C or the bend **104**-C.

[0044] It is to be appreciated that the distributor tube **104** having a J-shaped or L-shaped profile mentioned in various embodiments and as shown in FIGS. **1**A to **5** are only exemplary, and the distributor tube **104** can have any other predefined angle greater than 10 degrees between the first tube segment **104**-A and the second tube segment **104**-B without any limitation whatsoever as long as the hole **106** remains on the inner side of the bend in the second tube segment **104**-B or after the bend or the curved portion **104**-C of the distributor tube **104**, and all such implementations are well within the scope of the subject disclosure.

[0045] Accordingly, the distributor **104** can be configured to receive a two-phase fluid within the distributor tube **104** from a refrigerant line or supply tube via the first open end **104-1** (not illustrated here) of the distributor tube **104**, where the curved portion or the bend **104**-C can cause the two-phase fluid and/or a liquid phase associated with the two-phase fluid to flow into the second tube segment **104**-B, and a part of vapor phase associated with the two-phase fluid to flow into the inlet header **102** via the hole **106**. As a result, the liquid phase or the two-phase fluid can then flow out of the second open end **104-2** of the distributor tube **104** and further flow into the ports associated with the heat exchange or MCHX tubes **108** while flowing from top to bottom or from the second end **102-2** to the first end **102-1** of the inlet header **102**.

[0046] It is to be appreciated that the vapor phase flowing out of the hole **106** into the inlet header **102** can facilitate the stirring of any pool of the liquid phase formed within the inlet header **102**. The vapor phase can then move the stirred liquid phase in an upward direction within the header **102** to enable uniformly mixed liquid and vapor phases e within the header **102** and further into the ports of the heat exchange or MCHX tubes **108**.

[0047] It is to be further appreciated that when a static pressure created in the header **102** due to any liquid pool formed within the inlet header **102** increases above a pressure created in an interior of the curved portion **104**-C of the distributor tube **104** due to high velocity of the vapor phase therein, the hole **106** can facilitate automated suction of the liquid phase from the formed liquid pool back into the distributor tube **104** and further allowing the two-phase fluid and/or the liquid phase to flow out of the second open end **104-2** into the inlet header **102**. This recirculation capability provided by the design of the distributor tube **104** can help achieve a uniform supply of fluid (refrigerant) into the ports of the heat exchange or MCHX tubes **108** while maintaining a lower pressure drop in the distributor **104** and preventing the formation of a liquid pool within the header **102**.

[0048] Referring to FIG. **2**, in one or more embodiments, the distributor **104** can include a nozzle **110** configured at the second open end **104-2** of the distributor tube **104**. The nozzle **110** can be a flat nozzle that can include an inlet connected to the second open end **104-2** of the distributor tube **104**, and an outlet having a substantially flat profile facing an inner wall at the second end **102-2** of the header **102**. The nozzle **110** accordingly creates high velocity and flat liquid sheet, where the higher velocity may help in breaking the liquid sheet into smaller droplets which can then be uniformly supplied to the ports of the MCHX tubes **108**.

[0049] In one or more embodiments, referring to FIGS. **1**A to **4**, a ratio of the length (internal) of the header **102** and the distance between the second open end **104-2** of the distributor tube **104** and the second end **102-2** of the header **102** can be in a range of 0.5 times the diameter of the header to 50% of the length of the header **102**. For instance, as shown in FIGS. **1**A, **1**B, **3**, and **4**, when the nozzle **110** is not present, the second open end **104-2** of the tube can be close to the second end **102-2** of the header **102**. However, as shown in FIG. **2**, where the nozzle **110** is present at the second open end **104-2** of the distributor tube **104**, the gap or distance between the nozzle **110** and the second end **102-2** of the header **102** can be larger than the embodiments of FIGS. **1**A, **1**B, **3**, and **4**.

[0050] Referring back to FIG. **2**, the nozzle **110** can include a first hollow portion having a round cross-section that can be adapted to be fluidically connected to the second open end **104-2** of the distributor tube **104**. The nozzle **110** can further include a second hollow portion having an oval, elliptical, or rectangular cross-section, that can be fluidically connected to the first portion such that the nozzle **110** gradually transitions from the first portion to the second portion and the flow area of the nozzle **110** reduces in a direction from the first portion to the second portion. The first portion of the nozzle **110** can have a predefined inner diameter equal to the diameter of the second open end **104-2** of the distributor tube **104**. The second portion can have a predefined height less than the inner diameter of the first portion and a predefined width greater than the inner diameter of the first portion, thereby forming the oval, elliptical, or rectangular section, where the nozzle **110** can have a flat second portion in a horizontal orientation or a vertical orientation forming a wide flat nozzle **110**. The flat open area of the nozzle **110** results in an area reduction that may be in the range of 25% to 75% of flow area of the distributor tube **104**.

[0051] Referring to FIG. **3**, in one or more embodiments, the header **102** can include one or more baffles **112** (collectively referred to as baffles **112** or separators), each having an opening of a predefined size, which may be the same or different. The baffles **112** can be coaxially disposed within the header **102** with a predefined separation distance between two adjacent baffles **112**. However, the baffles **112** can also be off-centered within the header **102** with the predefined separation distance between two adjacent baffles **112**. In one or more embodiments, the predefined separation distance between two adjacent baffles **112** may be same or may also be different. Further, the second tube segment **104**-B of the distributor tube **104** can extend longitudinally through the openings of the baffles **112** such that a predefined gap remains between the rim of the corresponding openings and an outer surface of the distributor tube **104** to allow the flow of the two-phase fluid therethrough while flowing from top to bottom or from the second end **102-2** towards the first end **102-1** of the header **102**.

[0052] In one or more embodiments, the size of the openings of the baffles **112** and/or the predefined gap between the rim of the corresponding openings and an outer surface of the distributor tube **104** can decrease or increase while moving in a direction from the second end **102-2** towards the first end **102-1** of the header **102**, thereby allowing the flow of a predetermined volume flow of the two-phase fluid through each of the gaps while flowing from top to bottom or from the second end **102-2** towards the first end **102-1** of the header **102**. The gap size can be set to ensure choked flow which may help in metering refrigerant to each compartment. This allows the liquid phase or the two-phase fluid to uniformly and effectively enter into the ports of each of the heat exchange or MCHX tubes **108** while preventing the formation of a liquid pool at the bottom (first end **102-1**) of the header **102**.

[0053] In one or more embodiments, the openings of the baffles **112** can have a circular profile based on a profile of the outer cylindrical surface of the distributor tube **104**. However, in some embodiments, the openings of the baffles **112** can also have a non-circular profile based on the profile of the outer prismatic cylindrical surface of the distributor tube **104**.

[0054] Referring to FIG. **4**, in one or more embodiments, the header **102** can include a porous media **114** disposed at least partially within the header **102** around the distributor tube **104**. The porous media **114** can facilitate the liquid phase/two-phase fluid flowing out of the second open end **104-2** or nozzle **110** to be supplied into the ports associated with the heat exchange or MCHX tubes **108**. In one or more embodiments, the porous media **114** can be disposed within the header **102** along an entire length of the header **102**. However, the porous media **114** can only be configured on top section or top and middle sections of the header **102**. In one or more embodiments, the porous media **114** can be selected from a group comprising sponge, and metal foam, but is not limited to the like.

[0055] Further, in one or more embodiments, the pore size or density of the porous media **114** can decrease or increase while moving in a direction from the second end **102-2** toward the first end **102-1** of the header **102**. This allows the liquid phase or the two-phase fluid to uniformly enter into the ports of each of the heat exchange or MCHX tubes **108**.

[0056] Referring to FIG. **5**, in one or more embodiments, the header **102** can include multiple compartments **102**A, **102**B partitioned by one or more partition walls, where an interior volume of at least one of the compartments **102**A, **102**B of the header **102** remains fluidically connected to the heat exchange MCHX tubes **108** associated with the heat exchanger **500**. Accordingly, based on the number of compartments, the heat exchanger **500** can include one or more distributor tubes **104** of FIGS. **1**A to **4**, being configured with each of the compartments **102**A, **102**B of the header **102**.

[0057] Each of the distributor tubes **104** can include a first tube segment **104**-A, and a second tube segment **104**-B extending at a predefined angle from an end of the first tube segment **104**-A such that a bend **104**-C is created between the first tube segment **104**-A and the second tube segment **104**-B. Further, each of the distributor tubes **104** can include the hole **106** at a predefined position on a predefined side or inner side, facing towards the first tube segment **104**-A, of the second tube segment **104**-B. In one or more embodiments, there may be a gap between adjacent compartments **102**A, **102**-B to allow insertion of the distribution tube **104** within the corresponding compartment without entering into the other compartment.

[0058] As illustrated, one of the distributor tubes **104** can be configured with one of the compartments **102**A, **102**-B of the header **102** such that the first tube segment **104**-A of each of the distributor tubes **104** remains outside of the corresponding compartment and the second tube segment **104**-B of each of the distributor tubes **104** extends longitudinally within the corresponding compartment **102**A, **102**-B via the (bottom) first end of the respective compartments **102**A, **102**-B, with the hole **106** located within the respective compartments in the bend or just after the bend **104**-C in the distribution tube **104**.

[0059] Further, in one or more embodiments, the first open end **104-1** of each of the distributor tubes **104** can be fluidically connected to an outlet of an external fluid distributor (not shown). The external fluid distributor can be configured to receive the two-phase fluid from a refrigerant line via a supply tube and further uniformly supply the two-phase fluid into the corresponding distributor tubes **104**. In one or more embodiments, the external fluid distributor can have a shower head profile having an inlet and multiple outlets internally connected to the inlet via multiple fluidic passages, however, the external fluid distributor can have other profiles as well. The inlet of the external fluid distributor can be fluidically connected to the refrigerant line via the supply tube. Further, each of the outlets of the external fluid distributor can be fluidically connected to one of the distributor tubes **104**.

[0060] Furthermore, in one or more embodiments (not shown), each compartment **102**A, **102**-B of the header **102** can be configured with the baffles **112** and/or the porous media **114** as explained in FIGS. **3** and **4**, and the second open end **104-2** of each of the distributor tubes **104** can be configured with the nozzle **110** as explained in FIG. **2**.

[0061] Thus, the subject disclosure overcomes the challenges associated with existing microchannel heat exchangers, by providing a simple, efficient, and cost-effective fluid distributor for the inlet header of heat exchangers. The distributor uniformly supplies the fluid (refrigerant) into the ports of each of the MCHX tubes while maintaining a lower pressure drop in the distributor, thereby improving the performance and efficiency of the overall heat exchanger. In addition, the simple design of the distributor makes it easier to manufacture as well as cost-effective.

[0062] While the subject disclosure has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the subject disclosure as defined by the appended claims. Modifications may be made to adopt a particular situation or material to the teachings of the subject disclosure without departing from the scope thereof. Therefore, it is intended that the subject disclosure not be limited to the particular embodiment disclosed, but that the subject disclosure includes all embodiments falling within the scope of the subject disclosure as defined by the appended claims.

[0063] In interpreting the specification, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Where the specification claims refer to at least one of something selected from the group consisting of A, B, C . . . and N, the text should be interpreted as requiring only one element from the group, not A plus N, or B plus N, etc.

1. A fluid distributor for a header associated with a heat exchanger, the distributor comprising:

a distributor tube comprising a first tube segment, and a second tube segment extending at a predefined angle from an end of the first tube segment, wherein the distributor tube comprises a hole at a predefined position on a predefined side, facing towards the first tube segment on an inner side of a bend of the second tube segment,

wherein the distributor tube is configured with the header such that the first tube segment remains outside of the header and the second tube segment extends longitudinally within the header via a first end of the header, with the hole located at the first end of the header.

2. The distributor of claim **1**, wherein the first tube segment and the second tube segment are connected by a curved portion to define the shape of the distributor tube having a first open end located outside of the header and a second open end located within the header, and wherein the hole is located downstream of the curved portion on the predefined side of the second tube segment, such that the hole remains at the first end of the header and adjacent to the curved portion.

3. The distributor of claim **2**, wherein the distributor is configured to receive a two-phase fluid within the distributor tube via the first open end, causing the two-phase fluid and/or a liquid phase associated with the two-phase fluid to flow out of the distributor into the header via the second open end and a vapor phase associated with the two-phase fluid to flow into the header via the hole, and wherein the liquid phase flowing out of the second open end flows into one or more ports associated with a plurality of heat exchange tubes being fluidically connected to the header.

4. The distributor of claim **3**, wherein the vapor phase flowing out of the hole into the header facilitates stirring of any pool of the liquid phase formed within the header while moving the stirred liquid phase in an upward direction to enable homogeneous flow of the liquid phase within the header and further into the one or more ports.

5. The distributor of claim **3**, wherein when a static pressure created in the header due to a liquid pool formed within the header increases above a pressure created in an interior of the curved portion of the distributor tube due to velocity of the vapor phase therein, and wherein the hole facilitates automated suction of the liquid phase from the formed liquid pool back into the distributor tube and further allowing the two-phase fluid and/or the liquid phase to flow out of the second open end into the header.

6. The distributor of claim **1**, wherein the distributor tube has a L-shaped profile or a J-shaped profile, and wherein the second tube segment extends at the predefined angle of 90 degrees from the first tube segment.

7. The distributor of claim **1**, wherein the second tube segment extends at the predefined angle greater than 10 degrees from the first tube segment.

8. The distributor of claim **1**, wherein the distributor further comprises a nozzle configured at the second open end of the distributor tube.

9. The distributor of claim **8**, wherein the nozzle is a flat nozzle comprising an inlet connected to a second open end of the distributor tube, and an outlet having a flat profile facing an inner wall at the second end of the header, and wherein the nozzle has an area reduction in a range of 25% to 75% of a flow area of the distributor tube.

10. The distributor of claim **1**, wherein the header comprises one or more baffles, each having an opening of predefined sizes, disposed coaxially or off-centered within the header, and wherein the second tube segment of the distributor tube extends longitudinally through the openings of the one or more baffles such that a predefined gap remains between a rim of the corresponding openings and an outer surface of the distributor tube to allow flow of a two-phase fluid therethrough.

11. The distributor of claim **10**, wherein the size of the openings of the one or more baffles and/or the predefined gap between the rim of the corresponding openings and an outer surface of the distributor tube decreases or increases while moving in a direction from the second end towards the first end of the header, thereby allowing flow of a predetermined volume flow of the two-phase fluid through each of the gaps.

12. The distributor of claim **1**, wherein the header comprises a porous media disposed at least partially within the header around the distributor tube, and wherein the porous media facilitates the liquid phase flowing out of a second open end of the distributor tube to be supplied into one or more ports associated with a plurality of heat exchange tubes being fluidically connected to the header.

13. The distributor of claim **12**, wherein the porous media is disposed within the header along an entire length of the header.

14. The distributor of claim **12**, wherein density or pore size of the porous media increases while moving in a direction from the second end toward the first end of the header.

15. The distributor of claim **1**, wherein the header is oriented vertically upward or inclined at a predefined angle from a vertical axis such that the first end of the header remains at a bottom and the second end of the header remains on top.

16. The distributor of claim **1**, wherein a ratio of a length of the header and a distance between a second open end of the distributor tube and the second end of the header is in a range of 0.5 times an inner diameter of the header to 50% of the length of the header.

17. An inlet header for a heat exchanger, the inlet header comprising:

a housing defining shape of the inlet header and comprising one or more partitioned compartments, wherein an interior volume of at least one of the compartments of the inlet header is fluidically connected to a plurality of heat exchange tubes associated with the heat exchanger; and

one or more distributor tubes according to claim **1**,

wherein one of the distributor tubes is configured with one of the compartments of the inlet header such that a first tube segment of each of the distributor tubes remains outside of the corresponding compartment and a second tube segment of each of the distributor tubes extends longitudinally within the corresponding compartment via a first end of the respective compartments, with a hole located at the first end of the respective compartments.

18. The inlet header of claim **17**, wherein the first tube segment and the second tube segment of each of the distributor tubes are connected by a curved portion to define the shape of the one or more distributor tubes, each having a first open end located outside of the respective compartments and a second open end located within the respective compartments, and wherein the hole is located downstream of the curved portion on the predefined side of the second tube segment or in the curved portion, such that the hole remains at the first end of the respective compartments and adjacent to the curved portion.

19. The inlet header of claim **18**, wherein the first open end of each of the distributor tubes is configured to be fluidically connected to an outlet of an external fluid distributor that is configured to receive the two-phase fluid from a refrigerant line and uniformly supply the two-phase fluid into the corresponding distributor tubes.

20. An inlet header for a heat exchanger, the inlet header comprising:

a housing defining shape of the inlet header, wherein a plurality of heat exchange tubes associated with the heat exchanger is fluidically connected to an interior volume of the inlet header; and

the distributor tube according to claim **1**,

wherein the distributor tube is configured with the inlet header such that the first tube segment remains outside of the inlet header and the second tube segment extends longitudinally within the inlet header via a first end of the header, with the hole located at the first end of the inlet header.

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