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(54) **PLATE HEAT EXCHANGER**

(57) The present disclosure provides a plate heat exchanger comprising: a plurality of heat transfer plates stacked in a first direction, wherein the heat transfer plate is configured to have a heat transfer plate edge on its side in a second direction perpendicular to the first direction; first and second fluid channels formed between adjacent heat transfer plates and fluidly isolated from each other; two first ports formed in the heat transfer plate on the side and an opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the first fluid channel; and a hole formed in the heat transfer plate between one of the two first ports located on the side and the heat transfer plate edge in a second direction, which is fluidly communicated to the first fluid channel and fluidly isolated from the second fluid channel. By disposing the hole in a bottom area of the plate heat exchanger, excessive water remained in the plate heat exchanger when it is not in use is avoided, so as to prevent freezing in the plate heat exchanger.

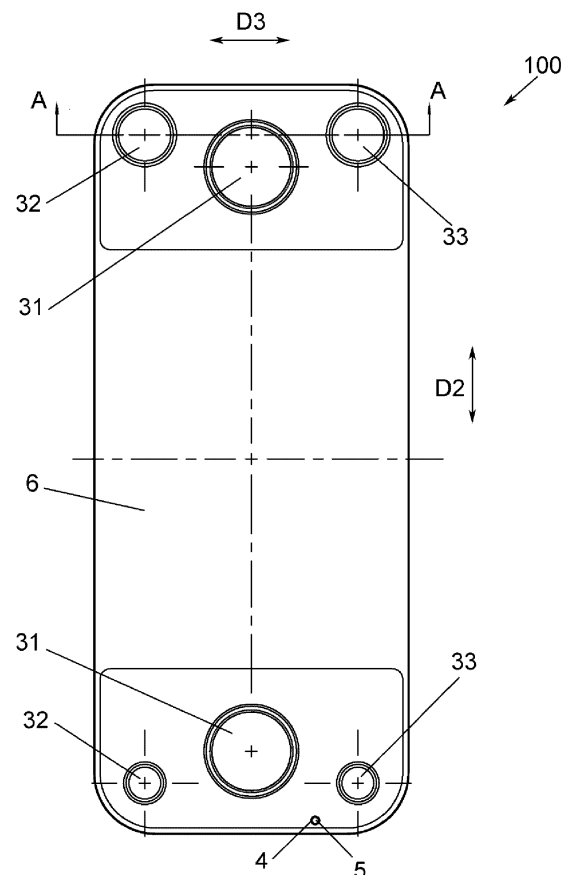


Fig.1

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority of Chinese Application No. CN202310987792.5 filed on August 07, 2023, the whole disclosure of which is incorporated herein by reference.

Technical Field

[0002] The present disclosure relates to a plate heat exchanger.

Background

[0003] A traditional plate heat exchanger comprises a plurality of heat transfer plates. Fluid channels used for two or more fluids are formed between adjacent heat transfer plates so as to conduct heat exchange between two or more fluids.

Summary of the Invention

[0004] A purpose of the embodiments of the present disclosure is to provide a plate heat exchanger, thereby avoiding excessive water being remained in the plate heat exchanger when it is not in use, for example, so as to prevent freezing in the plate heat exchanger.

[0005] An embodiment of the present disclosure provides a plate heat exchanger comprising: a plurality of heat transfer plates stacked in a first direction, wherein the heat transfer plate is configured to have a heat transfer plate edge on its side in a second direction perpendicular to the first direction; first and second fluid channels formed between adjacent heat transfer plates and fluidly isolated from each other; two first ports formed in the heat transfer plate on the side and an opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the first fluid channel; and a hole formed in the heat transfer plate between one of the two first ports located on the side and the heat transfer plate edge in a second direction, which is fluidly communicated to the first fluid channel and fluidly isolated from the second fluid channel.

[0006] According to an embodiment of the present disclosure, the second direction is a vertical direction, and the hole is located in a bottom area of the plate heat exchanger in a state where the plate heat exchanger is being used.

[0007] According to an embodiment of the present disclosure, a distance between a wall portion of the hole proximate to the heat transfer plate edge and the heat transfer plate edge of the plate heat exchanger is in a range from 2 to 30 mm.

[0008] According to an embodiment of the present disclosure, a minimum cross-sectional area of the hole is in a range from 2 to 200 mm².

[0009] According to an embodiment of the present disclosure, the hole is configured for having a temperature sensor installed therein.

[0010] According to an embodiment of the present disclosure, the plate heat exchanger further comprises a connecting tube fluidly communicated to the hole.

[0011] According to an embodiment of the present disclosure, the plate heat exchanger further comprises two cover plates between which the plurality of heat transfer plates are disposed, wherein the connecting tube is connected to each of the cover plates.

[0012] According to an embodiment of the present disclosure, the connecting tube is configured for having a detector installed therein, which is used to detect whether a heat exchange medium in the second fluid channel is leaked.

[0013] According to an embodiment of the present disclosure, the plate heat exchanger further comprises two second ports formed in the heat transfer plate on the side and the opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the second fluid channel; and wherein the hole comprises one hole located between the one of the two first ports and one of the two second ports located on the side in a third direction perpendicular to the first and second directions.

[0014] According to an embodiment of the present disclosure, the plate heat exchanger further comprises a third fluid channel formed between adjacent heat transfer plates and fluidly isolated from the first and second fluid channels; two second ports formed in the heat transfer plate on the side and the opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the second fluid channel; and two third ports formed in the heat transfer plate on the side and the opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the third fluid channel.

[0015] According to an embodiment of the present disclosure, the hole is also fluidly isolated from the third fluid channel.

[0016] According to an embodiment of the present disclosure, the hole comprises two holes disposed on opposite sides of the one of the two first ports in a third direction perpendicular to the first and second directions, respectively, and between one of the two second ports located on the side and one of the two third ports located on the side.

[0017] According to an embodiment of the present disclosure, the first fluid channel is configured to use a refrigerating medium as the heat exchange medium, and the second fluid channel is configured to use a refrigerant as the heat exchange medium.

[0018] According to an embodiment of the present disclosure, by disposing the hole in the bottom area of the plate heat exchanger, for example, it is possible to avoid excessive water being remained in the plate heat exchanger when it is not in use, so as to prevent freezing

in the plate heat exchanger.

Brief Description of the Drawings

[0019]

FIG. 1 is a schematic front view of a plate heat exchanger according to an embodiment of the present disclosure.

FIG. 2 is a side view of the plate heat exchanger shown in FIG. 1;

FIG. 3 is a cross-sectional view of the plate heat exchanger shown in FIG. 1 taken along the AA line; FIG. 4 is a cross-sectional view of the plate heat exchanger shown in FIG. 1 taken along a straight line passing through an axis of the hole;

FIG. 5 is a view showing a state of a temperature sensor being installed in the hole of the plate heat exchanger shown in FIG. 4;

FIG. 6 is a front view of a heat transfer plate of the plate heat exchanger shown in FIG. 1; and

FIG. 7 is a front view of a heat transfer plate of a plate heat exchanger according to an embodiment of the present disclosure.

Detailed Description of the Invention

[0020] The present invention will be described below in further detail in conjunction with the drawings and specific embodiments.

[0021] Referring to FIGS. 1 to 7, a plate heat exchanger 100 according to an embodiment of the present disclosure comprises: a plurality of heat transfer plates 2 stacked in a first direction D1, wherein the heat transfer plate 2 is configured to have a heat transfer plate edge 20 on its side in a second direction D2 perpendicular to the first direction D1 (FIGS. 6 and 7); first and second fluid channels 11, 12 formed between adjacent heat transfer plates 2 and fluidly isolated from each other; and two first ports 31 formed in the heat transfer plate 2 on the side and an opposite other side of the heat transfer plate 2 in the second direction D2, respectively, and fluidly communicated to the first fluid channel 11.

[0022] Referring to FIGS. 1-3 and 6, in an embodiment of the present disclosure, the plate heat exchanger 100 may further comprise: a third fluid channel 13 formed between adjacent heat transfer plates 2 and fluidly isolated from the first and second fluid channels 11, 12; two second ports 32 formed in the heat transfer plate 2 on the side and the opposite other side of the heat transfer plate 2 in the second direction D2, respectively, and fluidly communicated to the second fluid channel 12; and two third ports 33 formed in the heat transfer plate 2 on the side and the opposite other side of the heat transfer plate 2 in the second direction D2, respectively, and fluidly communicated to the third fluid channel 13. The plate heat exchanger 100 may also comprise a connecting tube connected to the first port 31, the second port 32,

and the third port 33, respectively.

[0023] Referring to FIGS. 6 to 7, the plate heat exchanger 100 according to an embodiment of the present disclosure further comprises a hole 5, which is formed in the heat transfer plate 2 between the one of the two first ports 31 and the heat transfer plate edge 20 in the second direction D2. Referring to FIG. 5, the hole 5 is fluidly communicated to the first fluid channel 11 and is fluidly isolated from the second fluid channel 12. For the plate heat exchanger shown in FIGS. 1-3, the hole 5 is also fluidly isolated from the third fluid channel 13. The hole 5 is proximate to the heat transfer plate edge 20 in the second direction D2.

[0024] According to an embodiment of the present disclosure, the first fluid channel 11 is used for a first heat exchange medium, the second fluid channel 12 is used for a second heat exchange medium, and the third fluid channel 13 is used for a third heat exchange medium. The first heat exchange medium may be a refrigerating medium, such as water, salt water, ethylene glycol, propylene glycol, and other liquids, while the second and third heat exchange media may be a refrigerant. The second and third heat exchange media may be the same as each other. According to an embodiment of the present disclosure, the first heat exchange medium may also be a refrigerant.

[0025] Plate heat exchanger 100 may be a soft brazed plate heat exchanger, a hard brazed plate heat exchanger, a gasket plate heat exchanger, or any other types of plate heat exchangers. The plate heat exchanger 100 may also comprise two cover plates 6 between which the plurality of heat transfer plates 2 are disposed; and a reinforcing plate disposed on each of the cover plates 6, wherein the connecting tube is installed on the reinforcing plate.

[0026] The plate heat exchanger 100 may be the heat exchanger shown in FIGS. 1-3, or a heat exchanger with only two first ports 31 and two second ports 32 (see FIG. 7), or other types of plate heat exchangers. Plate heat exchanger 100 may also be a double wall plate heat exchanger.

[0027] Referring to FIGS. 1-2 and 4-7, according to an embodiment of the present disclosure, the second direction D2 is a vertical direction, and the hole 5 is located in a bottom area of the plate heat exchanger 100 in a state where the plate heat exchanger 100 is being used.

[0028] Referring to FIGS. 1-4, according to an embodiment of the present disclosure, the plate heat exchanger 100 further comprises a connecting tube 4, which is fluidly communicated to the hole 5. The connecting tube 4 is connected to the cover plate 6. The hole 5 is configured for having a temperature sensor 9 installed therein. The connecting tube 4 may also be configured for having a detector installed therein, which is used to detect whether the heat exchange medium in the second fluid channel 12 is leaked, or which is used to detect whether the heat exchange medium in each of the second fluid channel 12 and the third fluid channel 13 is leaked.

[0029] Referring to FIGS. 6 and 7, according to an embodiment of the present disclosure, a distance between a wall portion 50 of the hole 5 proximate to the heat transfer plate edge 20 (or the lowest portion of a wall of the hole 5 in use) and the heat transfer plate edge 20 of the heat transfer plate 2 is in a range from 2 mm to 30 mm or 2 mm to 10 mm, etc. The minimum cross-sectional area of the hole 5 is in a range from 2 to 200 mm² or in a range from 2 to 50 mm².

[0030] Referring to FIG. 7, according to an embodiment of the present disclosure, the hole 5 comprises one hole 5 located between the one of the two first ports 31 and one of the two second ports 32 located on the side in a third direction D3 perpendicular to the first and second directions D1, D2. That is, the hole 5 is disposed between the first port 31 and the second port 32 located on the same side in the third direction D3.

[0031] Referring to FIG. 6, according to an embodiment of the present disclosure, the hole 5 comprises two holes 5 disposed on opposite sides of the one of the two first ports 31 in a third direction D3 perpendicular to the first and second directions D1, D2, respectively, and the two holes 5 are located between one of the two second ports 32 located on the side and one of the two third ports 33 located on the side. That is, the two holes 5 are disposed between the first port 31 and the second port 32 located on the same side, and between the first port 31 and the third port 33 located on the same side in the third direction D3, respectively. The two holes 5 may be disposed symmetrically.

[0032] In the case where the first heat exchange medium in the first fluid channel 11 of the plate heat exchanger 100 is water or saline, in some low-temperature environments such as below 0°C, if a level of the water or saline is higher than a safety limit, there is a risk that the water or saline may be frozen. By providing the hole 5, it is possible to avoid excessive water being remained in the first fluid channel 11 of the plate heat exchanger 100, resulting in a decrease in the level of the water remained in the first fluid channel 11 of the plate heat exchanger 100. Therefore, the risk of the plate heat exchanger 100 being frozen and failed is relatively low. In addition, the temperature sensor 9 may be installed in the hole 5 so as to more accurately measure a temperature of the heat exchange medium in the first fluid channel 11 of the plate heat exchanger 100, thereby making a system associated with the plate heat exchanger 100 react more accurately. Furthermore, the detector may be installed in the connecting tube 4 so as to detect any leakage of the heat exchange medium in the second fluid channel 12. Therefore, it is possible to avoid polluting the environment with leaked harmful heat exchange medium. Additionally, in applications of some harmful refrigerants or drinking water, the connecting tube 4 may be connected to a harmful refrigerant collection bag or any system so as to prevent the harmful refrigerant from entering an atmosphere or a room, thereby avoiding further harm. Due to the installation of the detector in

the connecting tube 4, it is possible to quickly detect a leakage of the harmful refrigerant.

[0033] According to an embodiment of the present disclosure, the connecting tube 4 is fluidly communicated to the hole 5. The connecting tube 4 is connected to the cover plate 6. A manual valve may be installed on the connecting tube 4 for manual drainage, or an electric control valve may be installed on the connecting tube 4 for an automatic control of drainage through operation of the system.

[0034] According to an embodiment of the present disclosure, any number of the holes 5 may be provided, for example, one, two, three, four or more holes 5, and the connecting tube 4 may be connected to any one or both of the two cover plates 6. The shape of the hole may be a circle, rectangle, triangle, trapezoid, square, ellipse, or any other shape.

[0035] According to an embodiment of the present disclosure, when the plate heat exchanger 100 is in an evaporator operation, a temperature sensor is usually installed in the connecting tube connected to the first port 31 so as to avoid dynamic frozen problems. However, a temperature of the water in the connecting tube connected to the first port 31 is usually not the lowest temperature, while a temperature of the water in the hole 5 is much lower. Therefore, by installing the temperature sensor 9 in the hole 5 through the connecting tube 4, a lower temperature may be detected as a system logic input so as to avoid frozen risks.

[0036] Due to the installation of the temperature sensor 9 in the hole 5, dynamic frozen problems may be avoided. However, the temperature of the water at the water outlet is usually not the lowest temperature, while the temperature of the water at the drainage hole is much lower. Therefore, if the temperature sensor is installed in the hole 5 through the connecting tube, the lower temperature may be detected as the system logic input so as to avoid frozen risks.

[0037] Although the present disclosure has been described in conjunction with embodiments, it is not limited to the aforementioned embodiments. For example, some embodiments and some technical features in all embodiments may be combined so as to form new embodiments.

Claims

1. A plate heat exchanger comprising:

- a plurality of heat transfer plates stacked in a first direction, wherein the heat transfer plate is configured to have a heat transfer plate edge on its side in a second direction perpendicular to the first direction;
- first and second fluid channels formed between adjacent heat transfer plates and fluidly isolated from each other;
- two first ports formed in the heat transfer plate on

- the side and an opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the first fluid channel; and
a hole formed in the heat transfer plate between one of the two first ports located on the side and the heat transfer plate edge in a second direction, which is fluidly communicated to the first fluid channel and fluidly isolated from the second fluid channel.
2. The plate heat exchanger according to claim 1, wherein the second direction is a vertical direction, and the hole is located in a bottom area of the plate heat exchanger in a state where the plate heat exchanger is being used.
 3. The plate heat exchanger according to claim 1, wherein a distance between a wall portion of the hole proximate to the heat transfer plate edge and the heat transfer plate edge of the plate heat exchanger is in a range from 2 to 30 mm.
 4. The plate heat exchanger according to claim 1, wherein a minimum cross-sectional area of the hole is in a range from 2 to 200 mm².
 5. The plate heat exchanger according to claim 1, wherein the hole is configured for having a temperature sensor installed therein.
 6. The plate heat exchanger according to claim 1, further comprising a connecting tube fluidly communicated to the hole.
 7. The plate heat exchanger according to claim 6, further comprising two cover plates between which the plurality of heat transfer plates are disposed, wherein the connecting tube is connected to each of the cover plates.
 8. The plate heat exchanger according to claim 6, wherein the connecting tube is configured for having a detector installed therein, which is used to detect whether a heat exchange medium in the second fluid channel is leaked.
 9. The plate heat exchanger according to claim 1, further comprising:
 - two second ports formed in the heat transfer plate on the side and the opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the second fluid channel; and
 - wherein the hole comprises one hole located between the one of the two first ports and one of the two second ports located on the side in a
 10. The plate heat exchanger according to claim 1, further comprising:
 - a third fluid channel formed between adjacent heat transfer plates and fluidly isolated from the first and second fluid channels;
 - two second ports formed in the heat transfer plate on the side and the opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the second fluid channel; and
 - two third ports formed in the heat transfer plate on the side and the opposite other side of the heat transfer plate in the second direction, respectively, and fluidly communicated to the third fluid channel.
 11. The plate heat exchanger according to claim 10, wherein the hole is also fluidly isolated from the third fluid channel.
 12. The plate heat exchanger according to claim 10, wherein the hole comprises two holes disposed on opposite sides of the one of the two first ports in a third direction perpendicular to the first and second directions, respectively, and between one of the two second ports located on the side and one of the two third ports located on the side.
 13. The plate heat exchanger according to claim 1, wherein the first fluid channel is configured to use a refrigerating medium as the heat exchange medium, and the second fluid channel is configured to use a refrigerant as the heat exchange medium.

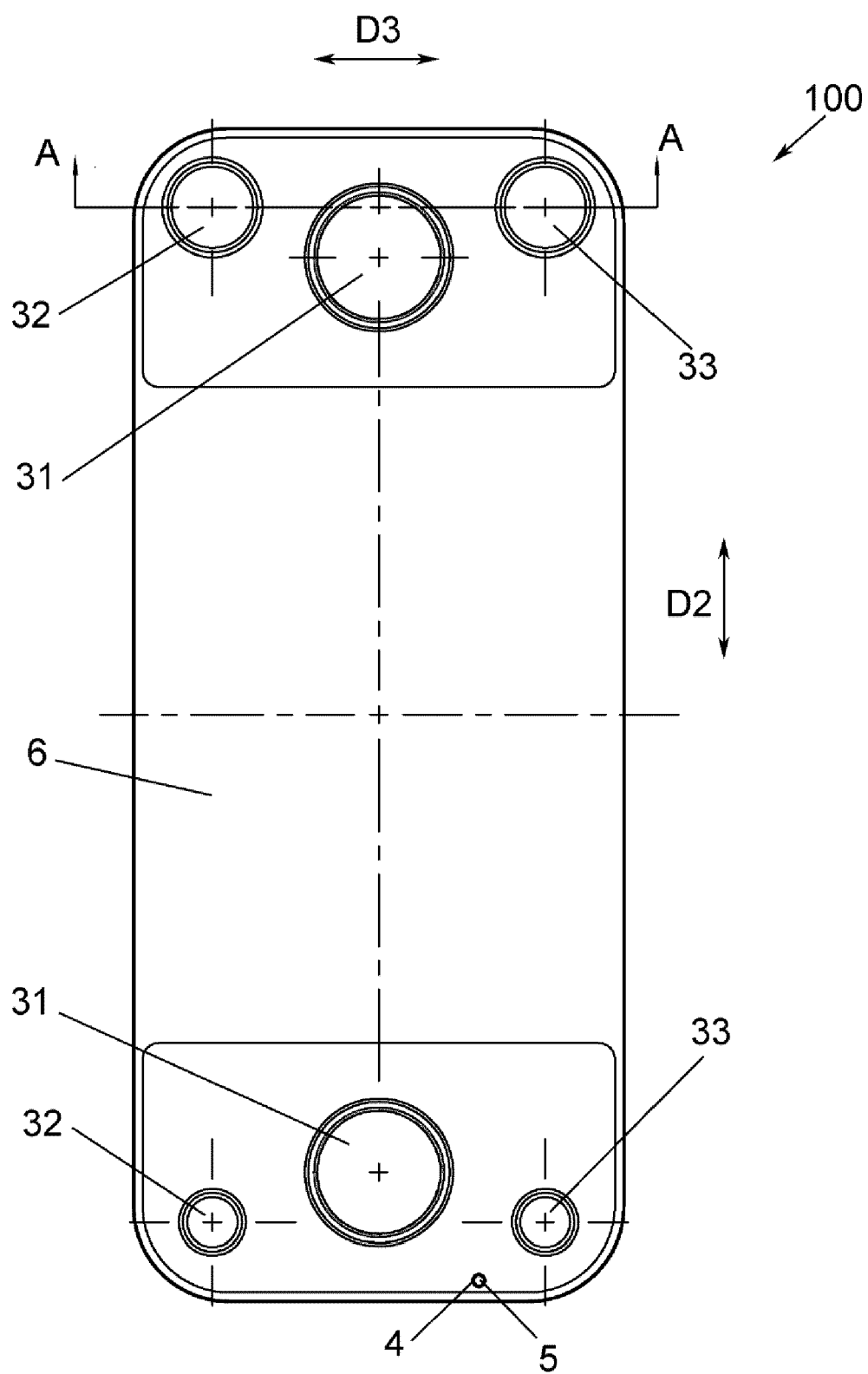


Fig.1

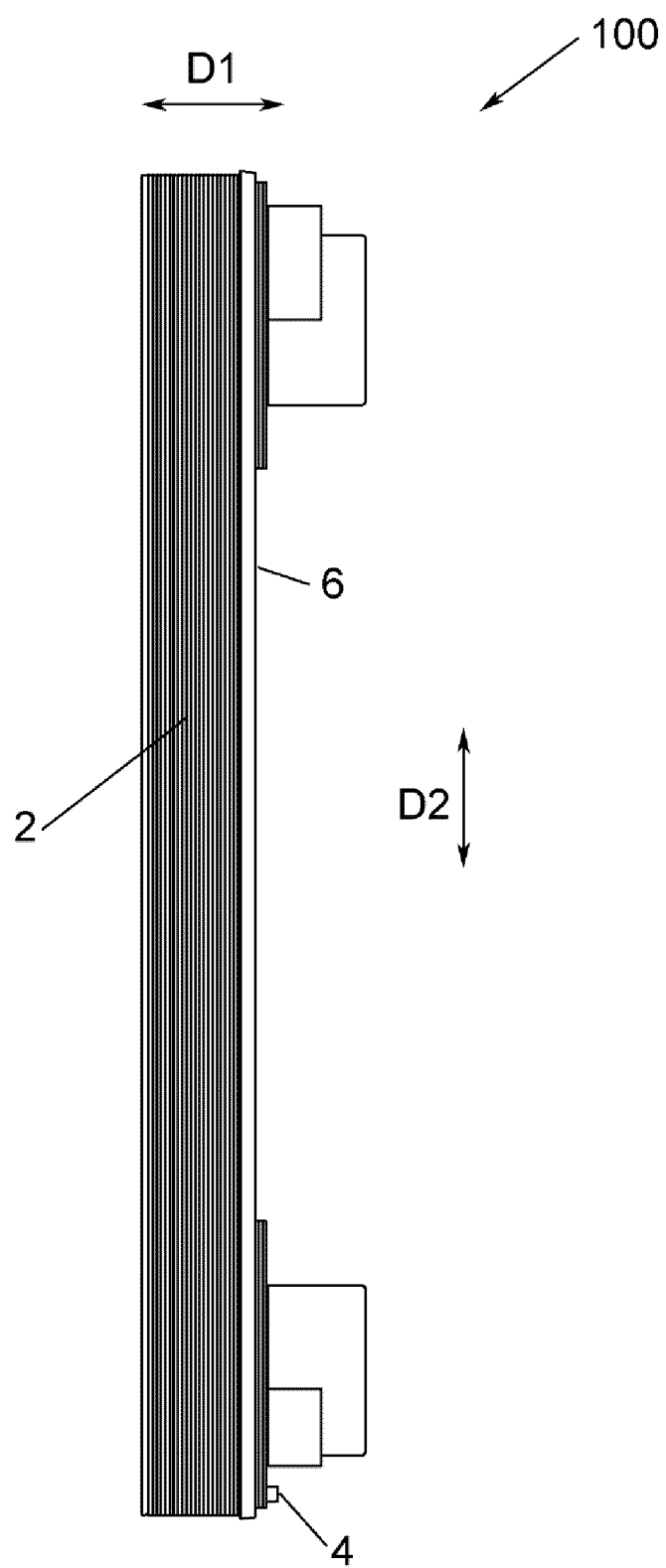


Fig.2

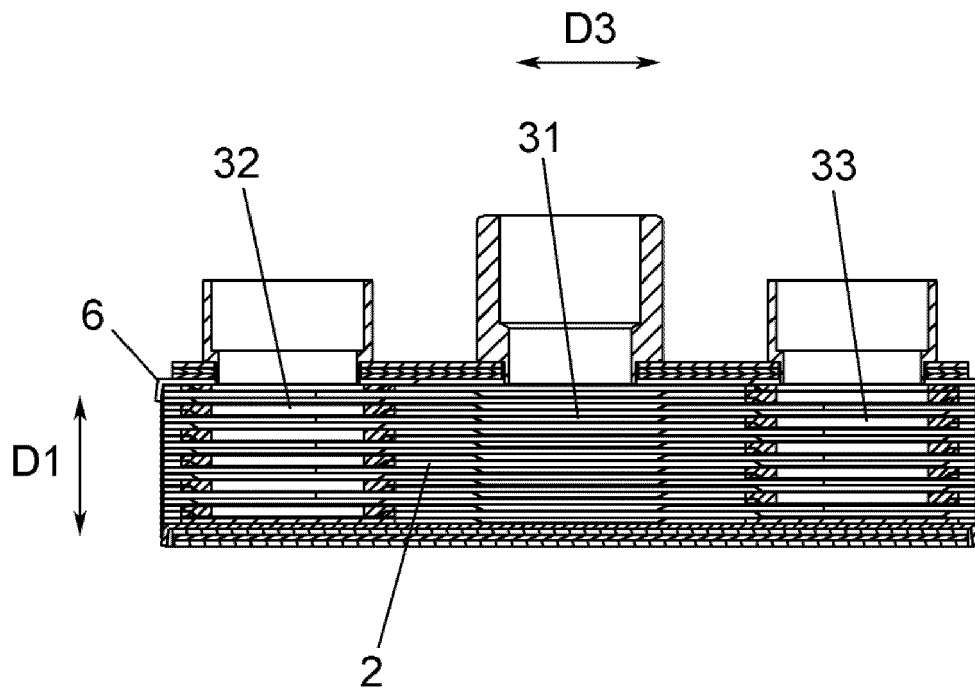


Fig.3

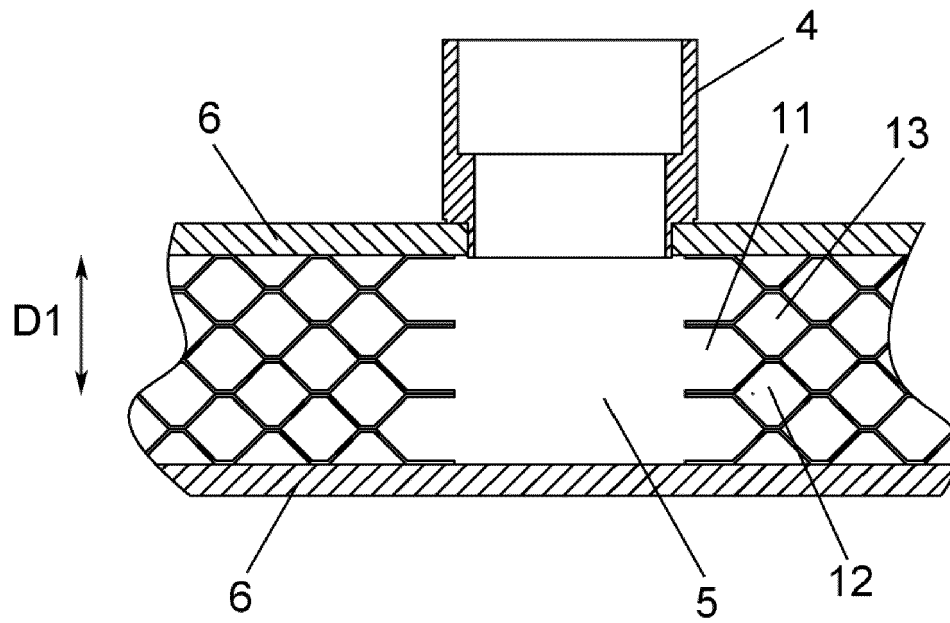


Fig.4

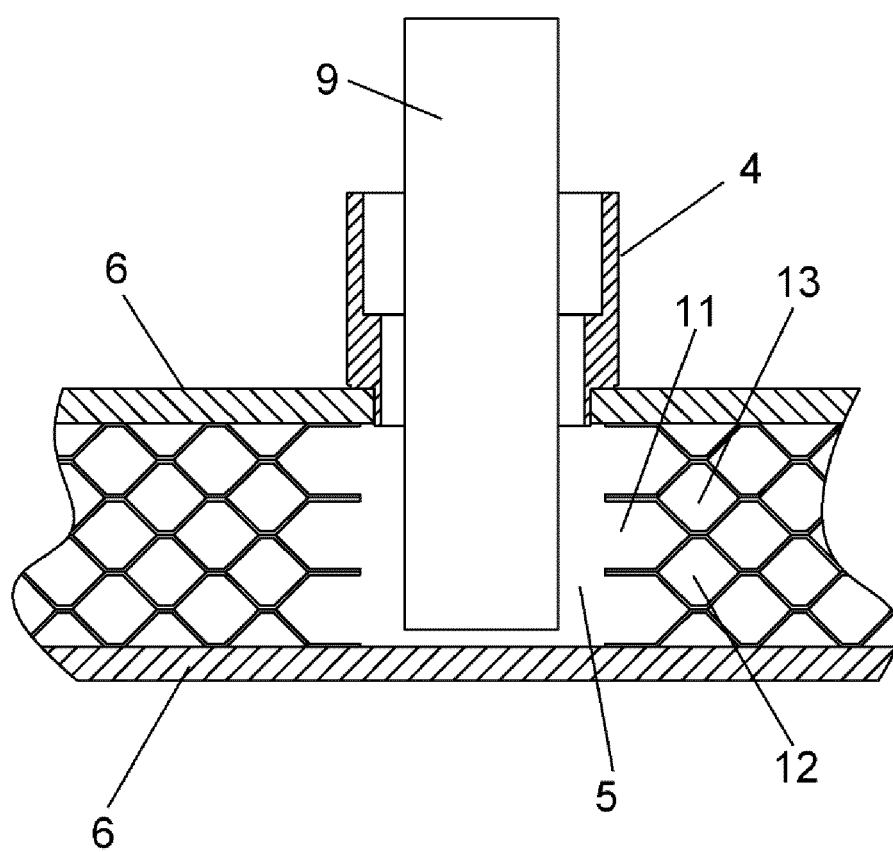


Fig.5

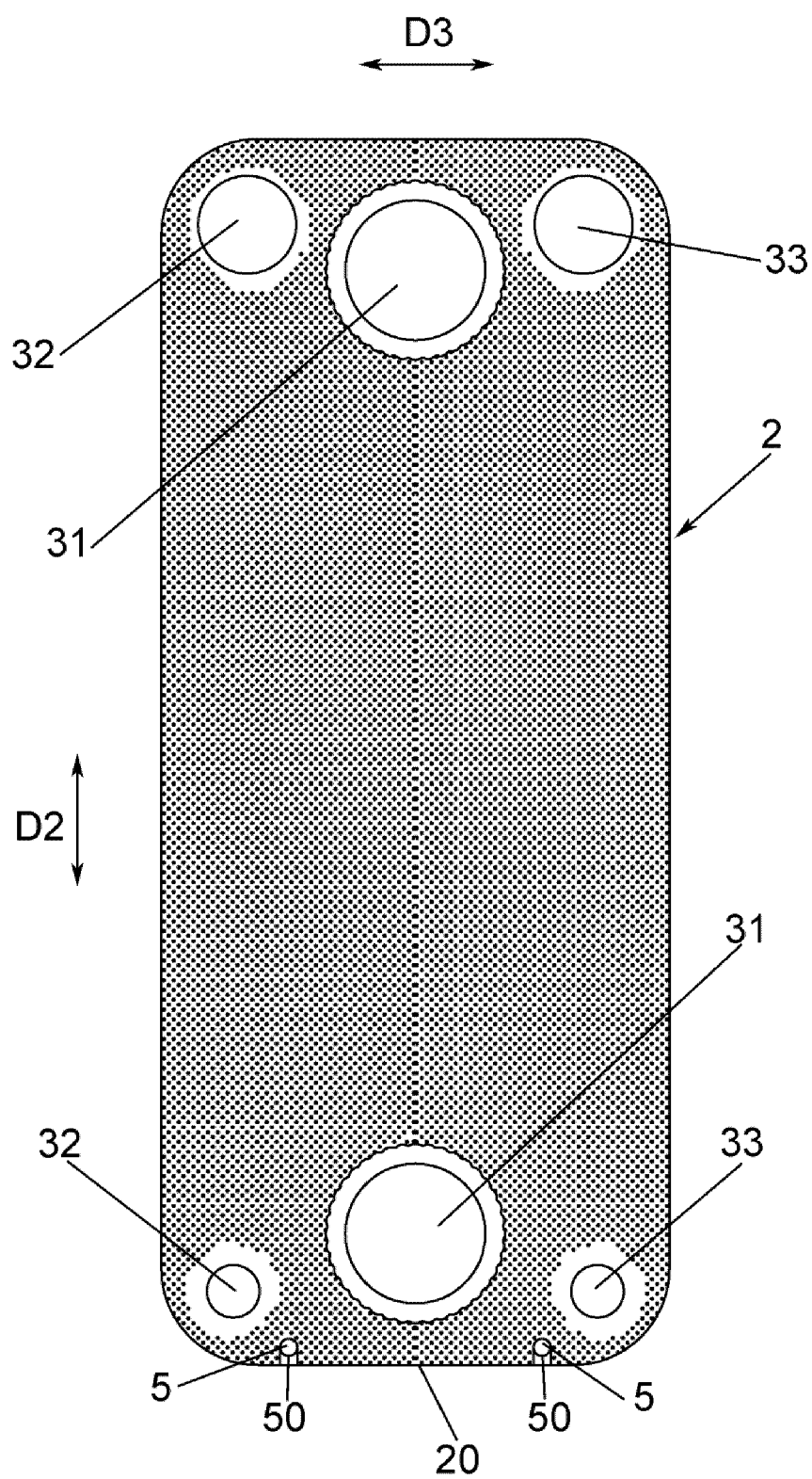


Fig.6

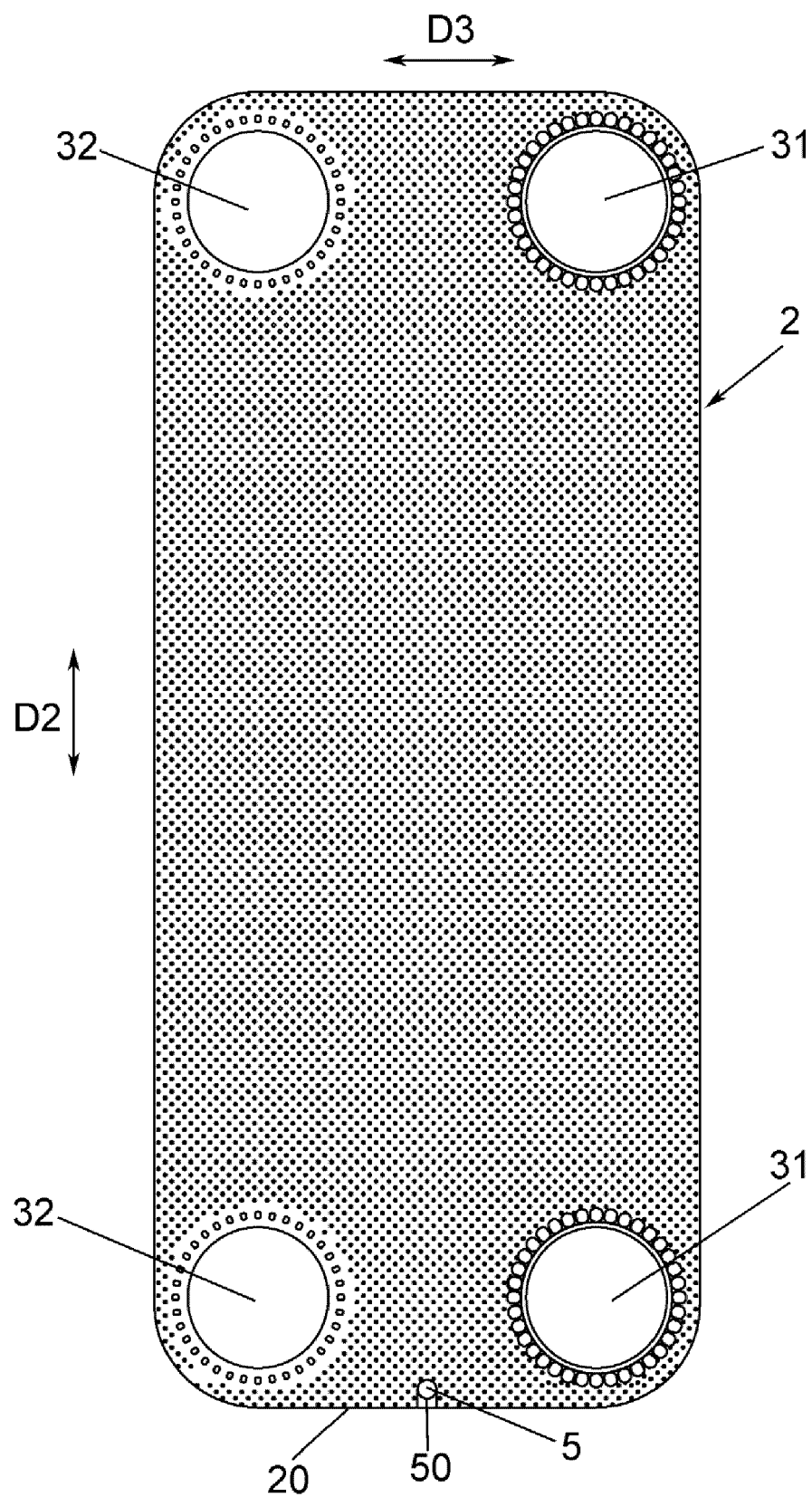


Fig.7



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