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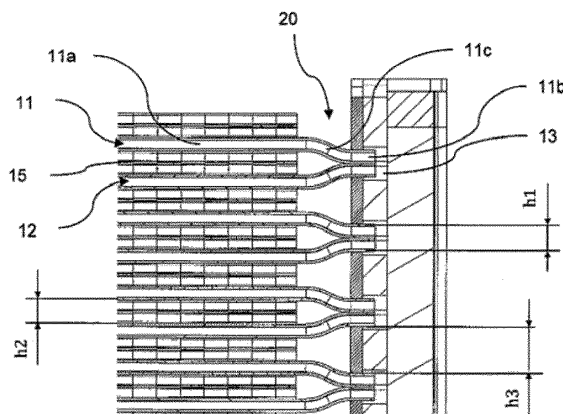
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(54) A HEAT EXCHANGER

(57) A high pressure heat exchanger (100) comprising a first manifold (101) and a second manifold connected fluidly by a plurality of tube sets (20) arranged in a spaced manner along the manifolds, wherein at least one of the manifold comprises a rear cover (102), a header (103) with slots (104) receiving tube end sections (11b) of the tube sets and several internal plates (105) interposed between the header and the rear cover and configured to create a flow path within the manifold, this flow

path being in fluid connection with the tubes to allow a circulation of a refrigerant in the tubes and the manifold, and wherein the header (103) has preferably at least a first area (110) adjacent to at least one of the slots and having a first thickness w_1 and at least a second area (111) surrounding at least partially the first area and having a second thickness w_2 , first thickness w_1 being smaller than second thickness w_2 .

**Fig. 5****EP 3 907 459 A1**

Description

FIELD OF THE INVENTION

[0001] The invention relates to a heat exchanger, especially to a high pressure heat exchanger for automotive industry.

BACKGROUND OF THE INVENTION

[0002] In known heat exchangers, configured to exchange heat between two fluids, it is common to provide two manifolds connected fluidly by plurality of tubes. One of the fluids is guided between said manifolds via these tubes, while the second fluid is guided around and in a space between the tubes to enable heat exchange. The tubes can be for example a flat tubes. The tubes are secured in the manifolds in a fluid-tight manner.

[0003] When the fluid traveling between the manifolds and in the tubes is a high pressure fluid, like R744 (CO₂), the heat exchanger has to be adapted accordingly. In particular, high pressure fluid imposes additional design constraints on the heat exchanger, as the pressure of the fluid necessitates higher mechanical resistance of its components. This pressure can exceed 120 bars.

[0004] In case of heat exchangers comprising flat tubes, the manifolds have slots with shape corresponding to the cross-section of the tubes. The flat tubes are mounted in these slots. As the number of tubes is linked to the efficiency of the heat exchange, it is generally preferable to increase the number of tubes to improve the heat exchange between fluids. However, as the number of tubes grows, the distance between the consecutive slots in the manifold decreases. At some point, the distance becomes too small to ensure a proper mechanical resistance of the manifold, given that the fluid which travels through the tubes and which enters said manifold operates at high pressure.

[0005] It is therefore an object of the invention to provide an improved high-pressure heat with satisfying mechanical resistance.

SUMMARY OF THE INVENTION

[0006] The object of the invention is a high pressure heat exchanger comprising a first manifold and a second manifold connected fluidly by a plurality of tube sets arranged in a spaced manner along the manifolds, wherein at least one of the manifold comprises a rear cover, a header with slots receiving tube end sections of the tube sets and at least one internal plate interposed between the header and the rear cover and configured to create a flow path within the manifold, this flow path being in fluid connection with the tubes to allow a circulation of a refrigerant in the tubes and the manifold, and wherein the header has preferably at least a first area adjacent to at least one of the slots and having a first thickness w1 and at least a second area surrounding at least par-

tially the first area and having a second thickness w2, first thickness w1 being smaller than second thickness w2.

[0007] According to one aspect of the invention, each slot of the header is adjacent to first areas with first thickness so that that the thickness of the header is locally smaller, around the slots, than in the rest of the header.

[0008] According to one aspect of the invention, in the first area, the thickness has a minimum value w1 min on the side adjacent with the slot.

[0009] According to one aspect of the invention, first thickness w1 may be variable from a minimum value w1 min at the contact with the tube in the slot up to the second thickness w2. This may be advantageous to form the tapered guiding shape.

[0010] According to one aspect of the invention, the heat exchanger has the following ratios:

$3 < h/w1 < h/(c*60\%)$, in particular $3 < h/w1 < h/c$ where h is the height of the distribution channel of the manifold and w1 is the wall thickness of the header in the first zone, where thickness w1 is minimum in the first area, and c is smallest wall thickness in tubes.

[0011] Dimensions h and w1 and w2 are measured relatively to the same axis.

[0012] According to one aspect of the invention, the manifold comprises a plurality of internal plates stacked together, which may be in number of 2, 3, 4 or 5 or even more plates.

[0013] According to one aspect of the invention, at least some of the internal plates have slots extending in different directions, in particular perpendicular directions so as to create U form flow paths.

[0014] According to one aspect of the invention, at least one plate has parallel longitudinal slots in particular forming group of two slots, these two slots being aligned.

[0015] According to one aspect of the invention, two of the internal plates have parallel slots and one of the internal plate has slots perpendicular to slots of the two other plates.

[0016] According to one aspect of the invention, internal plates are flat stamped plates.

[0017] According to one aspect of the invention, internal plates create internal channels for distribution of refrigerant.

[0018] According to one aspect of the invention, the plates may have different shapes in order to create manifolds with more sophisticated flow paths for instance for more than two passes.

[0019] According to one aspect of the invention, each rear plate is working like a closing plate, preventing from leak of refrigerant outside manifold region.

[0020] According to one aspect of the invention, the rear plate is configured to close the slots of the adjacent internal plate.

[0021] According to one aspect of the invention, the header is configured to stick together all internal plates in position before and during brazing process.

[0022] According to one aspect of the invention, the

header comprises two lateral walls, in particular two lateral folded walls, to stack the internal plates and the rear cover all together. The slots are formed on a main wall of the header, said main wall being flat. The lateral walls are connected to this main wall.

[0023] According to one aspect of the invention, each header forms a part with an accurate shape with slots in order to create a brazing connection with the tubes.

[0024] According to one aspect of the invention, the header is configured with a shape ensuring proper guiding of tubes into the slots during assembly of core.

[0025] According to one aspect of the invention, each slot having a tapered shape to guide the tubes during their insertion.

The guiding shape may rectilinear or rounded.

[0026] An advantage of the invention is to use a header with globally small thickness in order to easier bend it around other plates and to have as small radiiuses in the corners as possible.

[0027] In parallel the invention makes it possible not to increase the thickness of the manifold too much in order to cut the slots precisely without creating major deformations.

[0028] According to one aspect of the invention, the headers are made in stamping process.

[0029] According to one aspect of the invention, the distance between slots on the header is sufficient, for instance above 7 mm, and the size of the slots is relatively small, so that it is possible to punch slots in a way to create drafted angles whose are guiding tubes during assembly of the tubes.

[0030] According to one aspect of the invention, the internal plates which are added are configured to support the structure between the slots.

[0031] According to one aspect of the invention, an internal plate is brazed with the header.

[0032] According to one aspect of the invention, the internal plates enable to withstand high pressure despite limited thickness of header in order to create the guiding surfaces in the first area of small thickness.

[0033] According to one aspect of the invention, the internal plates have slots to form flow paths within the manifold, these slots communicating each with another in a certain manner to form the flow paths.

[0034] The invention, in particular thanks to internal plates, enables to create a robust structure of manifold, for instance which is able to withstand pressure up to 26 MPa or even bigger for other applications. The invention also enables to use an assembly of parts made in reasonably cheap for serial processes such as stamped components instead of machining components. Each manifold is assembled for instance from few internal plates together with a header.

[0035] According to one aspect of the invention, the heat exchanger comprises rows of tubes connecting the manifolds forming an inlet row and an outlet row for refrigerant.

[0036] According to one aspect of the invention, the

refrigerant is flowing from an inlet through the manifold to first row of the tubes. Then the refrigerant is flowing through the tubes to opposite manifold where the refrigerant is transferred from first row of the tubes to the second row of the tubes. Then the refrigerant is flowing through the second row to the manifold forming IN/OUT and to the connecting block 30 ensuring tight hydraulic connection with the rest of the system.

[0037] According to one aspect of the invention, the heat exchanger for cooling a heat source of a motor vehicle has coolant channels forming a coolant flow path and refrigerant channels forming a refrigerant flow path.

[0038] According to one aspect of the invention, the refrigerant flow path is deviated at least once in the shape of a U.

According to one aspect of the invention, the refrigerant channels in the tubes have a ratio of at least 0.3 between their wall thickness and the diameter.

According to one aspect of the invention, a web is placed between two refrigerant channels in the tubes and has a width b equal to at least 40% of the diameter of the refrigerant channel.

[0039] According to one aspect of the invention, the heat exchanger is a chiller.

[0040] According to one aspect of the invention, the refrigerant is CO₂, also called R744. However the invention is not limited to such a refrigerant.

[0041] According to one aspect of the invention, the connecting block is attached to one the manifolds.

[0042] According to one aspect of the invention, each tube set comprises a first tube and a second tube, wherein each of the first and the second tubes comprises an intermediate tube section between two opposing tube end sections, and the manifolds comprise slots receiving the tube end sections in a fluid-tight manner.

[0043] According to one aspect of the invention, in the tube set, at least the first tube comprises a bent tube section between the tube end section and the intermediate tube section, so that the intermediate tube sections of the first and second tubes run substantially in a parallel and spaced manner to each other, while the tube end tube sections are stacked on each other within a single slot.

[0044] According to one aspect of the invention, the bent tube section comprises two opposing turns.

[0045] According to one aspect of the invention, both the first tube and the second tube comprise bent tube sections.

[0046] According to one aspect of the invention, the spaces between the tubes in a tube set have equal height to the spaces between the tube sets.

[0047] According to one aspect of the invention, a flow disruptor is arranged in a space between the first tube and the second tube in the tube set.

[0048] According to one aspect of the invention, a flow disruptor is arranged in a space between the tube sets.

[0049] According to one aspect of the invention, a tube height h1 of flat tubes is between 2 mm and 3 mm, a flow

disruptor height h_2 is between 1,7mm and 2,5 mm, and a material height h_3 between consecutive slots is $(2 \cdot h_2) - a$, a being between 0,4 and 0,8 mm.

[0050] According to one aspect of the invention, a third tube is located between the first tube and the second tube, so that the end sections of the tubes 11, 12, 16 are stacked on each other within a single slot

[0051] According to one aspect of the invention, a tube height h_1 of flat tubes is between 2 mm and 3 mm, a flow disruptor height h_2 is between 1,7mm and 2,5 mm, and a material height h_3 between consecutive slots is $(3 \cdot h_2) - a$, a being between 0,4 and 0,8 mm.

BRIEF DESCRIPTION OF DRAWINGS

[0052] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

- Fig. 1 shows a known heat exchanger with flat tubes in partial cross-section;
- Fig. 2 shows the heat exchanger of Fig. 1 in greater detail;
- Fig. 3 shows a heat exchanger according to the invention in a first embodiment;
- Fig. 4 shows a heat exchanger according to the invention in a second embodiment;
- Fig. 5 shows a heat exchanger according to the invention in a third embodiment.
- Fig. 6 to 9 disclose other embodiments of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0053] Fig. 1 shows a known heat exchanger with flat tubes 11 in partial cross-section. The heat exchanger 1 comprises a plurality of flat tubes 11 for guiding the first fluid, in particular a fluid operating at high pressure, for example R744. These tubes 11 are connected at their end portions with manifolds 10a, 10b. The flat tubes 11 are arranged in horizontally parallel rows so that the first fluid can enter through the block 30 into the first manifold 10a, travel through the first column of tubes 11, reach the second manifold 10b and make a U-turn, returning to the first manifold 10a via second column of tubes 11, and then exit through outlet channel in the manifold 10a and the connecting block 30.

[0054] Fig. 2 shows the heat exchanger of Fig. 1 in greater detail. The flat tubes 11 are placed in slots 13 of the manifold 10b (in a consecutive manner along the vertical direction). The other ends of the tubes 11 are situated in manifold 10a in an analogous manner. The heat exchanger further comprises flow disruptors 15, which

disrupt the flow of the second fluid, in order to improve the heat exchange with the first fluid. The tube height h_1 is slightly smaller than manifold material height h_3 between consecutive slots 13. The flow disruptor 15 has a height h_2 . As the height of the disruptor 15 approaches the h_1 value, h_3 also decreases, which is detrimental to the manifolds strength. The following embodiments propose avoiding this negative dependency.

[0055] Fig. 3 shows a heat exchanger according to the invention in a first embodiment. The invention differs from the heat exchanger discussed in relation to Figs. 1 and 2 in The example is explained relative to manifold 10b, but this description applies to manifold 10a in an analogous manner. A plurality of tube sets 20, each comprising a first tube 11 and a second tube 12, is arranged along the manifold 10b in a spaced manner. Each of the first and the second tubes 11, 12 comprises an intermediate tube section 11a between two opposing tube end sections 11b. The manifolds 10a, 10b comprise slots 13, in which the tube end sections 11b of tubes 11, 12 are mounted in a fluid-tight manner. Within the tube set 20, at least the first tube 11 comprises a bent tube section 11c between the tube end section 11b and the intermediate tube section 11a. The intermediate tube sections 11a of the first and second tubes 11, 12 then run substantially in a parallel and spaced manner to each other, while the tube end sections 11b are stacked on each other within a single slot 13. Because at least one of the tubes 11, 12 is bent in this manner, the distance between the consecutive slots 12 is enlarged. It is therefore clear that by the term 'bent' it is understood any shape which allows providing two sections of the tube, preceding the bend and following the bend, which would run in parallel but in shifted relation, as shown in the drawings. For example, the first tube 11 is bent so that it has two opposing bends (i.e. forms a chicane). Preferably, the tube bent section 11c is located close to the tube end section 11b. Consequently, the disruptors 15 can occupy most of the space between the tubes and prevent excessive bypassing of the second fluid. In the example of Fig. 3, the second tube 12 is a straight (i.e. non bent) flat tube, which nevertheless comprises an intermediate portion 11a and a tube end section 11b, the tube end section 10b being placed in the slot 13.

[0056] The arrangement according to the invention improves mechanical resistance of the header, and at the same time allows application of known, standard flow disruptors 15. The number of tubes applied along the manifold consequently can also be greater.

[0057] Fig. 4 shows a heat exchanger according to the invention in a second embodiment. This embodiment differs from the first embodiment in that a third tube 16 is present in the tube set 20. It has the same shape as the first tube 11, but is arranged inversely and stacked below the second tube 12.

[0058] For embodiment with three tubes in one header slot, the tube height h_1 is preferably between 3 mm and 4,5 mm, the flow disruptor height h_2 is between 1,7mm

and 2,5 mm, and the material height h_3 between the consecutive tube slots 13 is $(3 \cdot h_2) - a$, which is between 0,4 and 0,8 mm.

[0059] For the above examples the boundary values of the ranges are understood to be not excluded.

[0060] Fig. 5 shows a heat exchanger according to the invention in a third embodiment. It differs from the previous embodiments in that both the first tube 11 and the second tube 12 comprise tube bent sections 11c, and there is no flat tube between them. The disruptors 15 can be located between the tubes 11, 12 and/or between the consecutive tube sets 20.

[0061] For embodiments with two tubes in one header slot, the tube height h_1 is preferably between 2 mm and 3 mm, the flow disruptor height h_2 is between 1,7 mm and 2,5 mm, and the material height h_3 between the consecutive tube slots 13 is $(2 \cdot h_2) - a$, which is between 0,4 and 0,8 mm.

[0062] For the above examples the boundary values of the ranges are understood to be not excluded.

[0063] The spaces between the tubes in a tube set 20 can have equal height to the spaces between the tube sets 20. This can enable applying identical flow distributors 15.

[0064] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to the advantage.

[0065] Figures 6 to 8 disclose an embodiment of the invention.

[0066] A high pressure heat exchanger 100 is shown on Figures 6 to 8 which comprises a first manifold 101 and a second manifold connected fluidly by a plurality of tube sets 20 arranged in a spaced manner along the manifolds, wherein the manifold 101 comprises a rear cover 102, a header 103 with slots 104 receiving tube end sections 11b of the tube sets and internal plates 105 interposed between the header 103 and the rear cover 102 and configured to create a flow path 106 within the manifold, this flow path being in fluid connection with the tubes 11 to allow a circulation of a refrigerant in the tubes and the manifold 101.

The header 103 has preferably a first area 110 adjacent to each slot 104 and having a first thickness w_1 and at a second area 111 surrounding the first area 110 and having a second thickness w_2 , first thickness w_1 being smaller than second thickness w_2 .

[0067] Each slot 104 of the header 103 is adjacent to first areas 110 with first thickness so that the thickness of the header is locally smaller, around the slots, than in the rest of the header 103.

[0068] In the first area 110, the thickness has a minimum value w_{1min} on the side adjacent with the slot 104.

[0069] First thickness w_1 may be variable from a min-

imum value w_{1min} at the contact with the tube in the slot up to the second thickness w_2 . This may be advantageous to form the tapered guiding shape 125.

[0070] The heat exchanger has the following ratios:
 5 $3 < h/w_1 < h/(c \cdot 60\%)$, in particular $3 < h/w_1 < h/c$ where h is the height of the distribution channel of the manifold and w_1 is the wall thickness of the header in the first zone, where thickness w_1 is minimum in the first area, and c is smallest wall thickness in tubes 11.

10 **[0071]** When w_1 is variable in area 110, w_1 is taken as its smallest value w_{1min} in area 110.

[0072] Dimensions h and w_1 and w_2 are measured relatively to the same axis perpendicular to the plane of the internal plates 105.

15 **[0073]** The manifold 101 comprises a plurality of internal plates stacked together, which may be in number of 3.

[0074] Internal plates 105 have slots 115 extending in different directions, in particular perpendicular directions so as to create U form flow paths.

20 **[0075]** Some plates 105 have parallel longitudinal slots 115 in particular forming group of two slots, these two slots 115 being aligned.

[0076] Two of the internal plates 105 have parallel slots 115 and one of the internal plate 105 has slots 115 perpendicular to slots of the two other plates.

25 **[0077]** Internal plates 105 are flat stamped plates.

[0078] Internal plates 105 create internal channels for distribution of refrigerant.

30 **[0079]** Rear plate or rear cover 102 is working like a closing plate, preventing from leak of refrigerant outside manifold region.

[0080] The rear plate 102 is configured to close the slots 115 of the adjacent internal plate 105.

35 **[0081]** The header 103 is configured to stick together all internal plates 105 in position before and during brazing process.

[0082] The header 103 comprises two folded lateral walls 117, to stack the internal plates 105 and the rear cover 102 all together. The slots are formed on a flat main wall 118 of the header, said main wall being flat. The lateral walls 117 are connected to this main wall 118.

40 **[0083]** The header 103 forms a part with an accurate shape with slots 104 in order to create a brazing connection with the tubes.

45 **[0084]** The header 103 is configured with a shape ensuring proper guiding of tubes 11 into the slots during assembly of core.

[0085] Each slot 104 having a tapered shape 125 to guide the tubes 11 during their insertion. The guiding shape may be rectilinear shape 126 on the bottom of figure 9, or rounded as shape 125 on the top of Figure 9.

[0086] An advantage of the invention is to use a header 103 with globally small thickness in order to easier bend it around other plates and to have as small radiiuses in the corners as possible.

55 **[0087]** In parallel the invention makes it possible not to increase the thickness of the manifold too much in order to cut the slots 104 precisely without creating major

deformations.

[0088] The header 103 are made in stamping process.

[0089] The distance between slots 104 on the header 103 is sufficient, for instance above 7 mm, and the size of the slots is relatively small, so that it is possible to punch slots in a way to create drafted angles whose are guiding tubes during assembly of the tubes.

[0090] The internal plates 105 which are added are configured to support the structure between the slots.

[0091] An internal plate 105 is brazed with the header 103.

[0092] The internal plates 105 enable to withstand high pressure despite limited thickness of header in order to create the guiding surfaces in the first area of small thickness.

[0093] The internal plates 105 have slots 115 to form flow paths within the manifold, these slots 115 communicating each with another in a certain manner to form the flow paths.

[0094] The invention, in particular thanks to internal plates 105, enables to create a robust structure of manifold 101, for instance which is able to withstand pressure up to 26 MPa or even bigger for other applications. The invention also enables to use an assembly of parts made in reasonably cheap for serial processes such as stamped components instead of machining components.

[0095] The heat exchanger 100 comprises rows of tubes connecting the manifolds forming an inlet row and an outlet row for refrigerant.

[0096] The refrigerant is flowing from an inlet through the manifold to first row of the tubes. Then the refrigerant is flowing through the tubes to opposite manifold where the refrigerant is transferred from first row of the tubes to the second row of the tubes. Then the refrigerant is flowing through the second row to the manifold forming IN/OUT and to the connecting block 30 ensuring tight hydraulic connection with the rest of the system.

[0097] The heat exchanger 100 for cooling a heat source of a motor vehicle has coolant channels forming a coolant flow path and refrigerant channels forming a refrigerant flow path.

[0098] The refrigerant flow path is deviated at least once in the shape of a U.

The refrigerant channels 120 in the tubes 11 have a ratio of at least 0.3 between their wall thickness and the diameter.

A web 121 is placed between two refrigerant channels in the tubes and has a width b equal to at least 40% of the diameter of the refrigerant channel.

[0099] Internal plates, header and rear cover can be made of metal.

[0100] The heat exchanger is a chiller.

[0101] According to one aspect of the invention, the refrigerant is CO₂. However the invention is not limited to such a refrigerant.

[0102] According to one aspect of the invention, the connecting block 30 is attached to one the manifolds 101.

Claims

1. A high pressure heat exchanger (100) comprising a first manifold (101) and a second manifold connected fluidly by a plurality of tube sets (20) arranged in a spaced manner along the manifolds, wherein at least one of the manifold comprises a rear cover (102), a header (103) with slots (104) receiving tube end sections (11b) of the tube sets and several internal plates (105) interposed between the header and the rear cover and configured to create a flow path within the manifold, this flow path being in fluid connection with the tubes to allow a circulation of a refrigerant in the tubes and the manifold, and wherein the header (103) has preferably at least a first area (110) adjacent to at least one of the slots and having a first thickness w1 and at least a second area (111) surrounding at least partially the first area and having a second thickness w2, first thickness w1 being smaller than second thickness w2.
2. A heat exchanger according to the preceding claim, wherein each slot (104) of the header is adjacent to first areas (110) with first thickness so that the thickness of the header is locally smaller, around the slots, than in the rest of the header.
3. A heat exchanger according to the preceding claim, wherein first thickness w1 is variable from a minimum value at the contact with the tube in the slot up to the second thickness w2.
4. A heat exchanger according to any preceding claim, wherein $3 < h/w1 < h/(c*60\%)$, in particular $3 < h/w1 < h/c$ where h is the height of the distribution channel of the manifold and w1 is the wall thickness of the header in the first zone, where thickness w1 is minimum in the first area, and c is smallest wall thickness in tubes.
5. A heat exchanger according to any preceding claim, wherein the manifold comprises a plurality of internal plates stacked together, which may be in number of 2, 3, 4 or 5 or even more plates.
6. A heat exchanger according to the preceding claim, wherein at least some of the internal plates (105) have slots (115) extending in different directions, in particular perpendicular directions so as to create U form flow paths.
7. A heat exchanger according to any preceding claim, wherein the header (103) comprises two lateral walls, in particular two lateral folded walls (117), to stack the internal plates (105) and the rear cover all together.
8. A heat exchanger according to any preceding claim,

wherein each slot (104) of the header (103) has a tapered shape (125) to guide the tubes during their insertion.

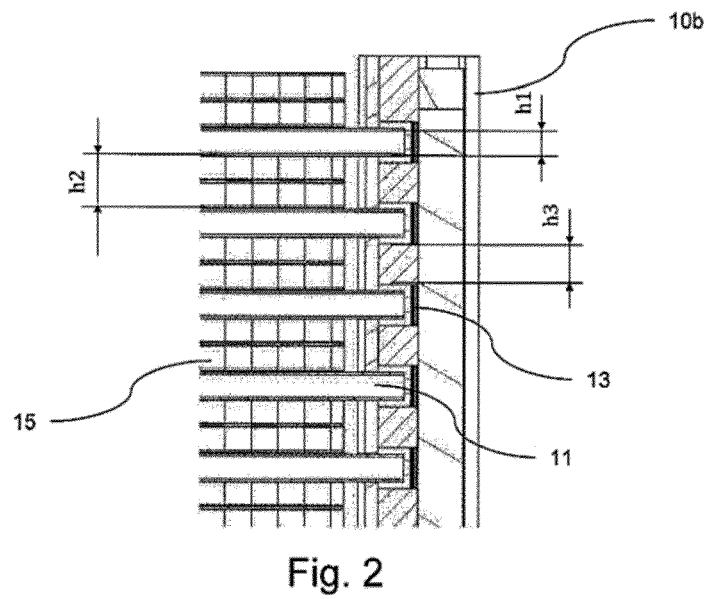
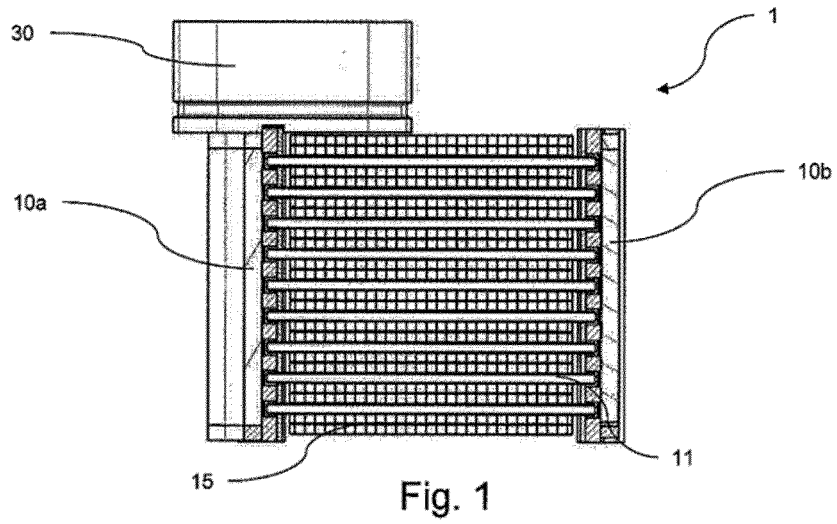
9. A heat exchanger according to any preceding claim, wherein an internal plate (105) is brazed with the header. 5
10. A heat exchanger according to any preceding claim, wherein the internal plates (105) have slots (115) to form flow paths within the manifold, these slots communicating each with another in a certain manner to form the flow paths. 10
11. A heat exchanger according to any preceding claim, wherein the refrigerant flow path is deviated at least once in the shape of a U. 15
12. A heat exchanger according to any preceding claim, wherein the refrigerant channels in the tubes have a ratio of at least 0.3 between their wall thickness and the diameter. 20
13. A heat exchanger according to any preceding claim, wherein a web is placed between two refrigerant channels in the tubes and has a width b equal to at least 40% of the diameter of the refrigerant channel. 25
14. A heat exchanger according to any preceding claim, wherein the heat exchanger is a chiller. 30
15. A heat exchanger according to any preceding claim, wherein a connecting block (30) is attached to one the manifolds. 35

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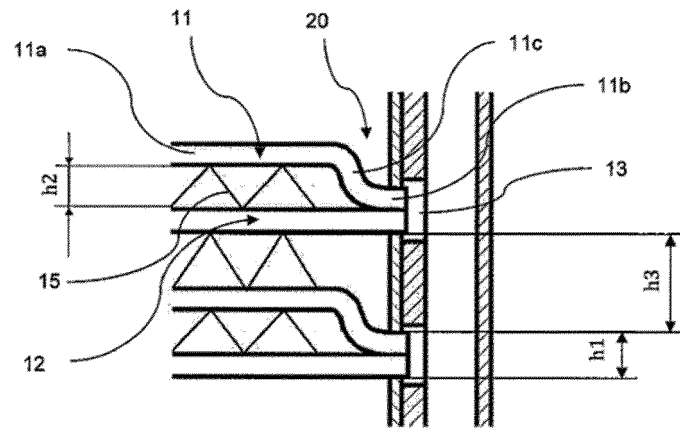


Fig. 3

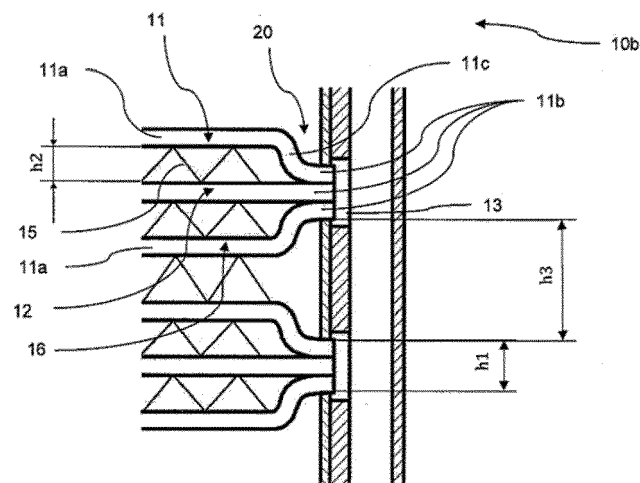


Fig. 4

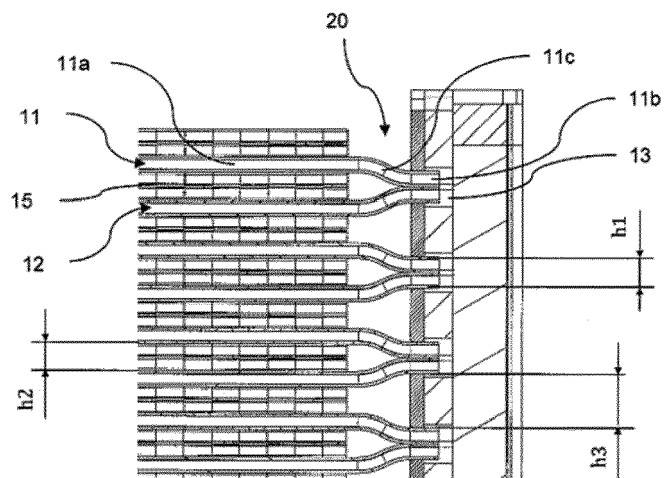


Fig. 5

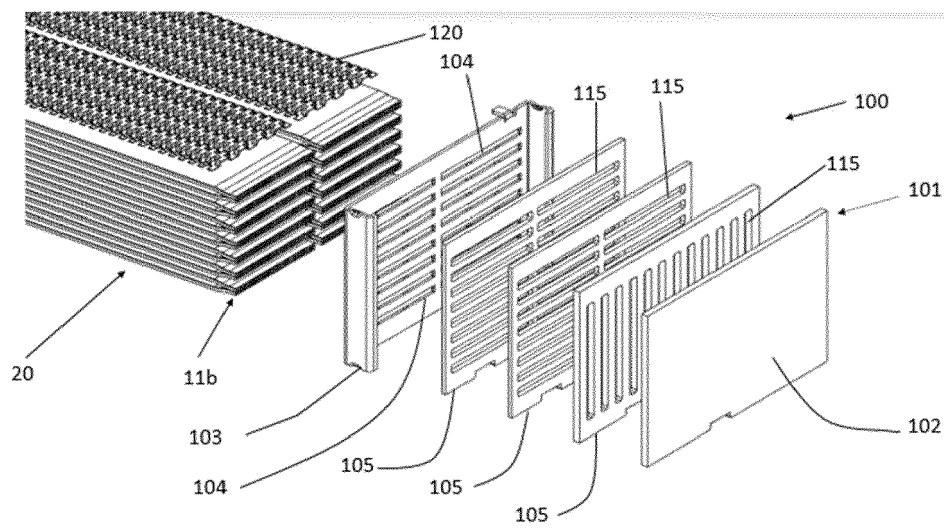


Fig. 6

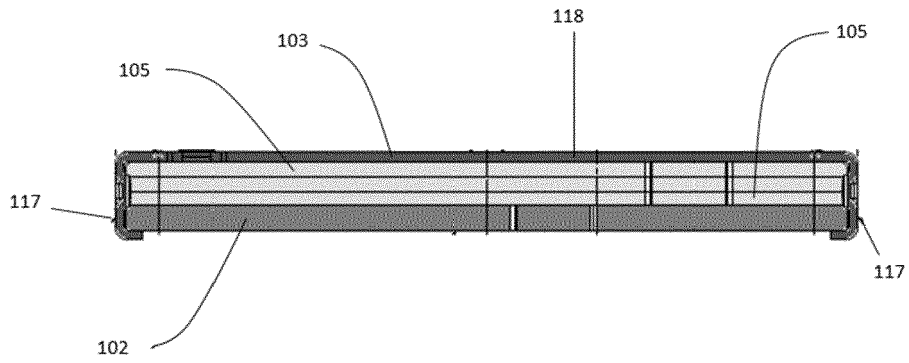


Fig. 7

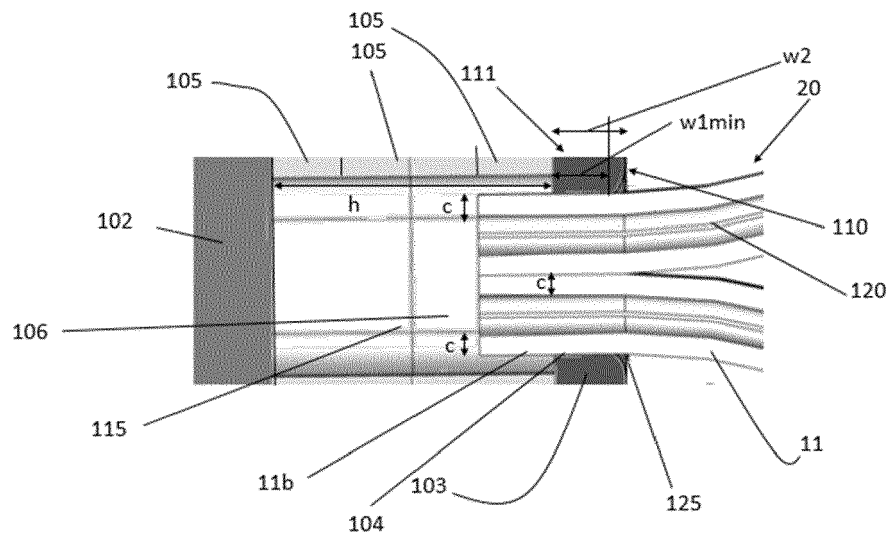


Fig. 8

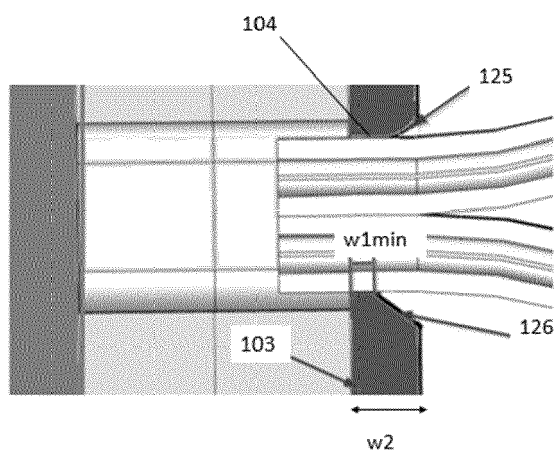


Fig. 9



EUROPEAN SEARCH REPORT

Application Number
EP 20 46 1532

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 03/054467 A1 (BEHR GMBH & CO [DE]; DEMUTH WALTER [DE] ET AL.) 3 July 2003 (2003-07-03) * figures 1,14 *	1,2,4-6, 9-15	INV. F28F1/02 F28F9/02
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