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(71) Applicant: **Valeo Autosystemy SP. Z.O.O.**
32-050 Skawina (PL)

(72) Inventors:
- **ROMANSKI, Grzegorz**
  PL 32-050 Skawina (PL)
- **PEDRAS, Maciej**
  PL 32-050 Skawina (PL)
- **CISAK, Bartlomiej**
  PL 32-050 Skawina (PL)
- **TYRALA, Pawel**
  PL 32-050 Skawina (PL)

(74) Representative: **Bialkowski, Adam**
Valeo Systèmes Thermiques
ZA l'Agiot
8 rue Louis Lormand
CS 80517 La Verrière
78322 Le Mesnil Saint Denis Cedex (FR)

(54) A HEAT EXCHANGER

(57) A high pressure heat exchanger 1 comprising a first manifold 10a and a second manifold 10b connected fluidly by a plurality of tube sets 20 arranged in a spaced manner along the manifolds 10a, 10b, each tube set 20 comprising a first tube 11 and a second tube 12, wherein each of the first and the second tubes 11, 12 comprises an intermediate tube section 11a between two opposing tube end sections 11b, and wherein the manifolds 10a, 10b comprise slots 13 receiving the tube end sections 11b in a fluid-tight manner, wherein in 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, so that the intermediate tube sections 11a of the first and second tubes 11, 12 run substantially in a parallel and spaced manner to each other, while the tube end tube sections 11b are stacked on each other within a single slot 13.

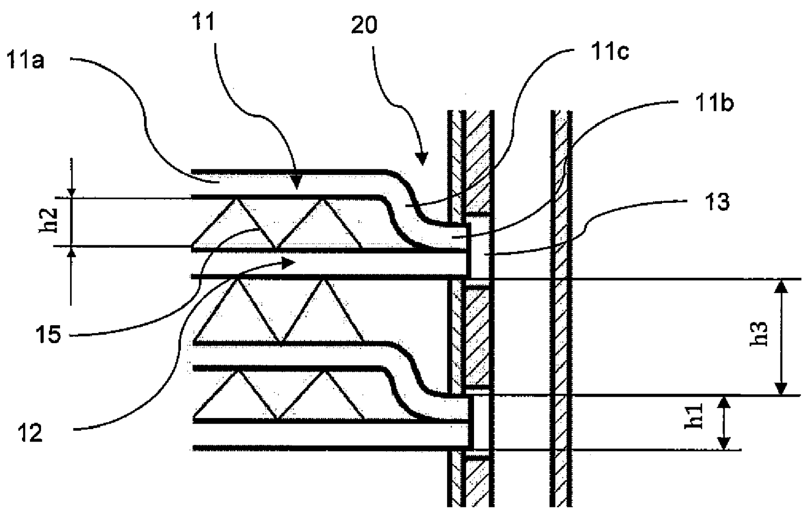

Fig. 3

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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 a example 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 (CO_2), the heat exchanger has to be adapted accordingly. In particular, high pressure fluid imposes additional design constrains on the heat exchanger, as the pressure of the fluid necessitates higher mechanical resistance of its components. This pressure can exceed 120 bars.

[0004] However, at the same time, efficiency requirements pose further demands on the heat exchanger, and consequently render an optimal design even more problematic to achieve.

[0005] 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.

[0006] It is therefore an object of the invention to provide a high pressure heat exchanger which would offer efficient operation without sacrificing its mechanical resistance, and which thus would be safe to operate.

SUMMARY OF THE INVENTION

[0007] 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, each tube set comprising 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 wherein the manifolds comprise slots receiving the tube end sections in a fluid-tight manner, wherein 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.

[0008] Preferably, the bent tube section comprises two opposing turns.

[0009] Preferably, both the first tube and the second tube comprise bent tube sections.

[0010] Preferably, the spaces between the tubes in a tube set have equal height to the spaces between the tube sets.

[0011] Preferably, a flow disruptor is arranged in a space between the first tube and the second tube in the tube set.

[0012] Preferably, a flow disruptor is arranged in a space between the tube sets.

[0013] Preferably, a tube height h1 of flat tubes is between 2 mm and 3 mm, a flow disruptor height h2 is between 1,7mm and 2,5 mm, and a material height h3 between consecutive slots is (2*h2)-a, a being between 0,4 and 0,8 mm.

[0014] Preferably, 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.

[0015] Preferably, a tube height h1 of flat tubes is between 2 mm and 3 mm, a flow disruptor height h2 is between 1,7mm and 2,5 mm, and a material height h3 between consecutive slots is (3*h2)-a, a being between 0,4 and 0,8 mm.

BRIEF DESCRITPTION OF DRAWINGS

[0016] 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.

DETAILED DESCRIPTION OF EMBODIMENTS

[0017] 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.

[0018] 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 h1 is slightly smaller than manifold material height h3 between consecutive slots 13. The flow disruptor 15 has a height h2. As the height of the disruptor 15 approaches the h1 value, h3 also decreases, which is detrimental to the manifolds strength. The following embodiments propose avoiding this negative dependency.

[0019] 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 11 a 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 11 a. The intermediate tube sections 11 a 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 11 b 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 11 c is located close to the tube end section 11 b. 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 11 a and a tube end section 11 b, the tube end section 10b being placed in the slot 13.

[0020] The arrangement according to the invention improves mechanical resistance of the header, and at the same time allows application of known, standard flow disrupters 15. The number of tubes applied along the manifold consequently can also be greater.

[0021] 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.

[0022] For embodiment with three tubes in one header slot, the tube height h1 is preferably between 3 mm and 4,5 mm, the flow disruptor height h2 is between 1,7mm and 2,5 mm, and the material height h3 between the consecutive tube slots 13 is (3*h2)-a, which is between 0,4 and 0,8 mm.

[0023] For the above examples the boundary values of the ranges are understood to be not excluded.

[0024] 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 11 c, 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.

[0025] For embodiments with two tubes in one header slot, the tube height h1 is preferably between 2 mm and 3 mm, the flow disruptor height h2 is between 1,7mm and 2,5 mm, and the material height h3 between the consecutive tube slots 13 is (2*h2)-a, which is between 0,4 and 0,8 mm.

[0026] For the above examples the boundary values of the ranges are understood to be not excluded.

[0027] 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.

[0028] 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.

Claims

1. A high pressure heat exchanger 1 comprising a first manifold 10a and a second manifold 10b connected fluidly by a plurality of tube sets 20 arranged in a spaced manner along the manifolds 10a, 10b, each

tube set 20 comprising a first tube 11 and a second tube 12, wherein each of the first and the second tubes 11, 12 comprises an intermediate tube section 11 a between two opposing tube end sections 11 b, and wherein the manifolds 10a, 10b comprise slots 13 receiving the tube end sections 11b in a fluid-tight manner, **characterized in that** in the tube set 20, at least the first tube 11 comprises a bent tube section 11c between the tube end section 11 b and the intermediate tube section 11a, so that the intermediate tube sections 11a of the first and second tubes 11, 12 run substantially in a parallel and spaced manner to each other, while the tube end tube sections 11 b are stacked on each other within a single slot 13.

2. A heat exchanger according to any preceding claim, wherein the bent tube section 11c comprises two opposing turns.

3. A heat exchanger according to any preceding claim, wherein both the first tube 11 and the second tube 12 comprise bent tube sections 11c.

4. A heat exchanger according to any preceding claim, wherein the spaces between the tubes in a tube set 20 have equal height to the spaces between the tube sets 20.

5. A heat exchanger according to any preceding claim, wherein a flow disruptor 15 is arranged in a space between the first tube 11 and the second tube 12 in the tube set 20.

6. A heat exchanger according to any preceding claim, wherein a flow disruptor 15 is arranged in a space between the tube sets 20.

7. A heat exchanger according to any preceding claim, wherein a tube height h1 of flat tubes 11, 12 is between 2 mm and 3 mm, a flow disruptor height h2 is between 1,7mm and 2,5 mm, and a material height h3 between consecutive slots 13 is (2*h2)-a, a being between 0,4 and 0,8 mm.

8. A heat exchanger according to any of claims 1 to 6, wherein a third tube 16 is located between the first tube 11 and the second tube 12, so that the end sections 11 b of the tubes 11, 12, 16 are stacked on each other within a single slot 13.

9. A heat exchanger according to claim 8, a tube height h1 of flat tubes 11, 12, 16 is between 2 mm and 3 mm, a flow disruptor height h2 is between 1,7mm and 2,5 mm, and a material height h3 between consecutive slots 13 is (3*h2)-a, a being between 0,4 and 0,8 mm.

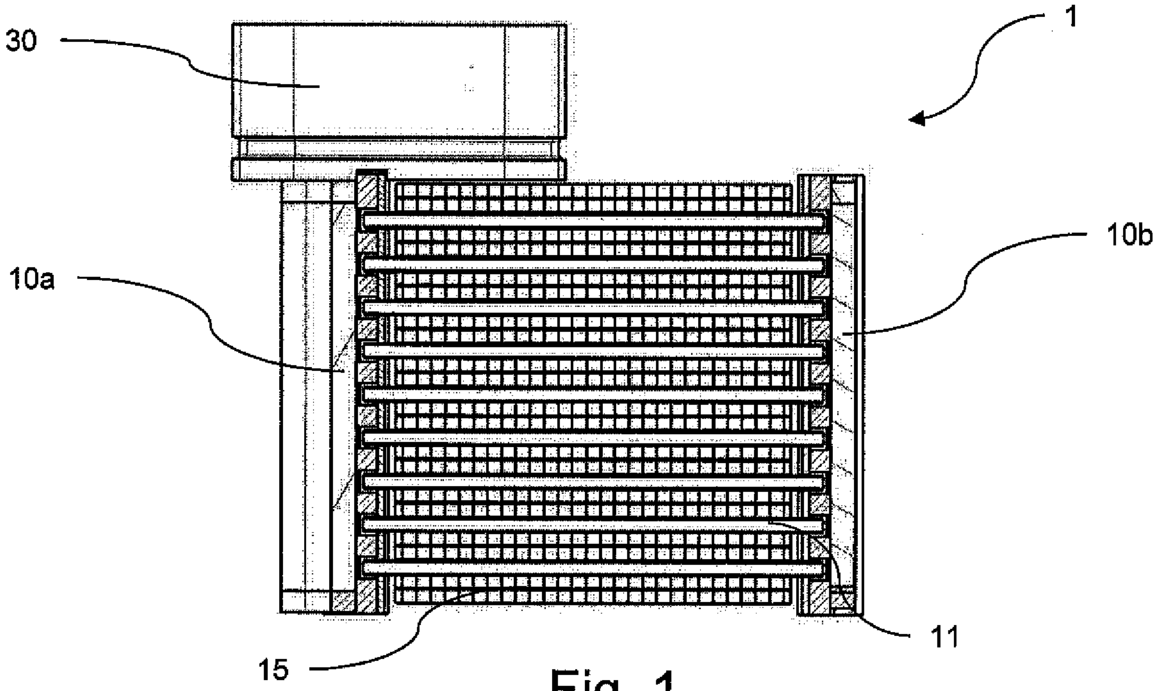

Fig. 1

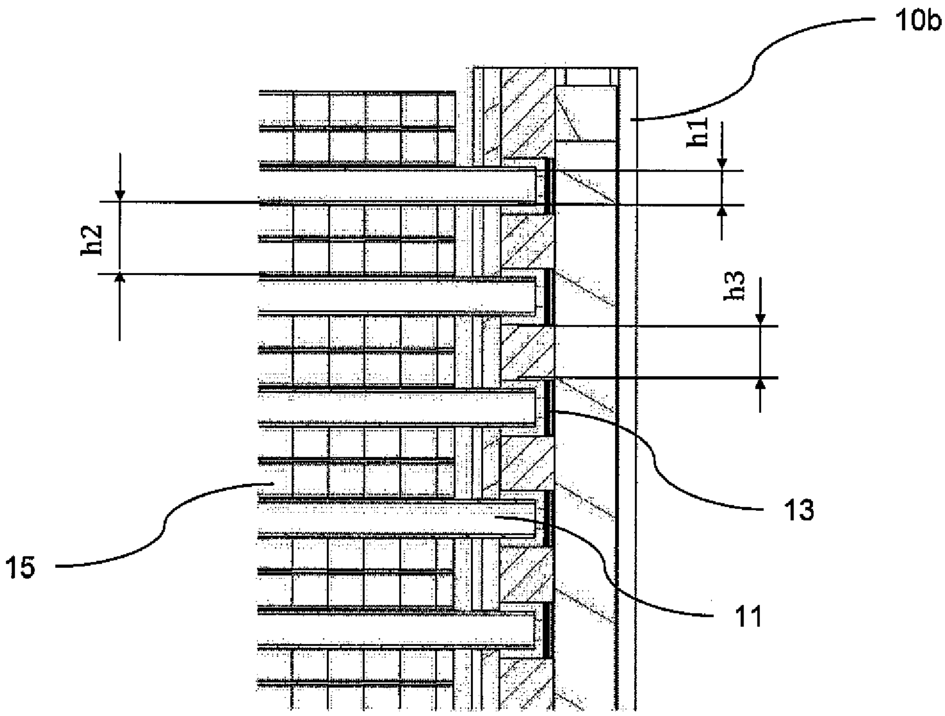

Fig. 2

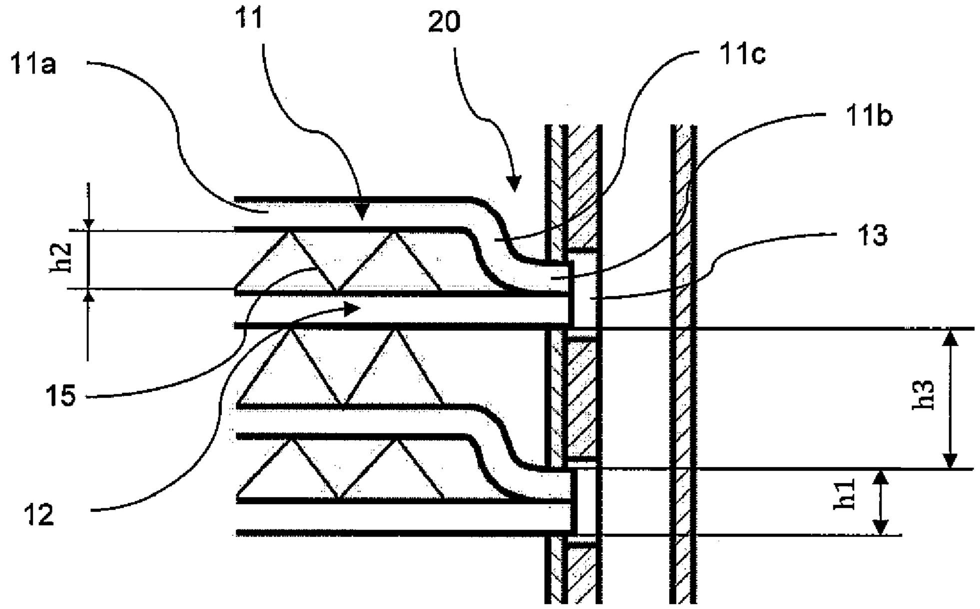
11
20
11a
11c
11b
13
h2
15
h3
12
h1

Fig. 3

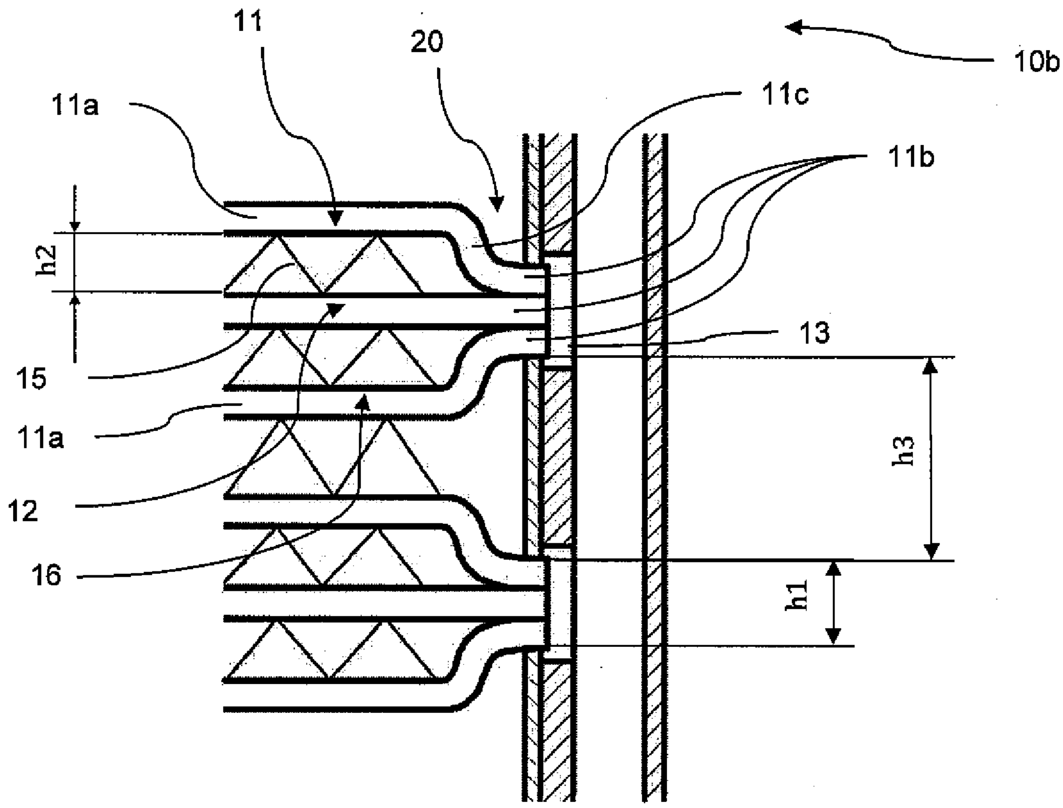
11
20
10b
11a
11c
11b
h2
13
15
11a
h3
12
16
h1

Fig. 4

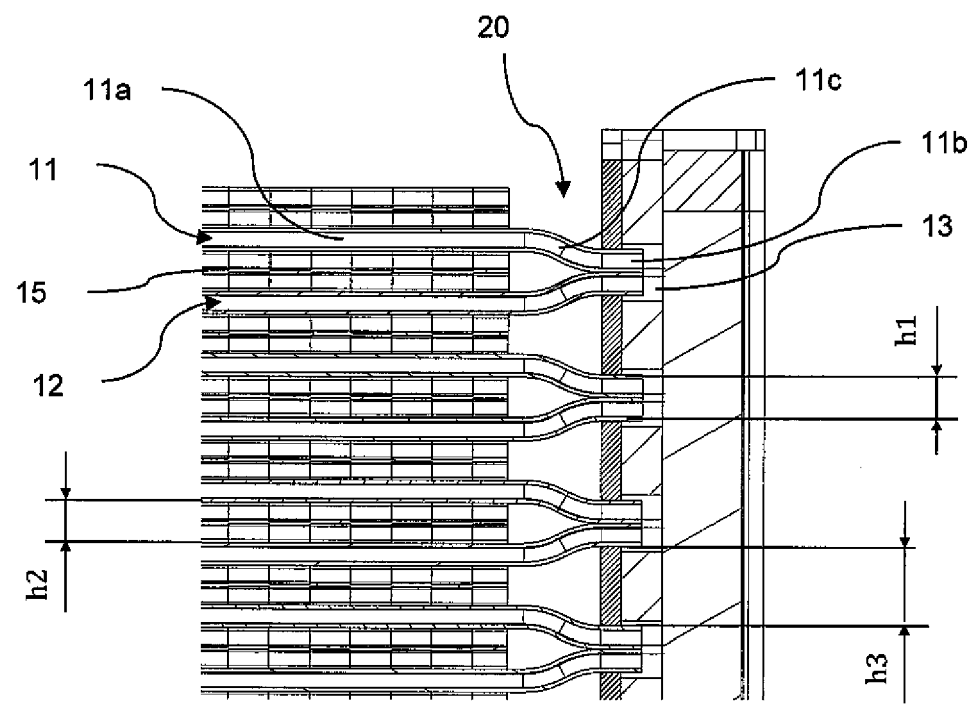

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 18 46 1523

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TECHNICAL FIELDS SEARCHED (IPC)

F28F
F28D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	30 August 2018	Jessen, Flemming

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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