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(72) Inventors:
• **TIZIANO, Giuseppe**
I-10046 POIRINO (Torino) (IT)
• **SANDRI, Fabio**
I-10046 POIRINO (Torino) (IT)

(74) Representative: **Vanzini, Christian et al**
Jacobacci & Partners S.p.A.
Corso Emilia 8
10152 Torino (IT)

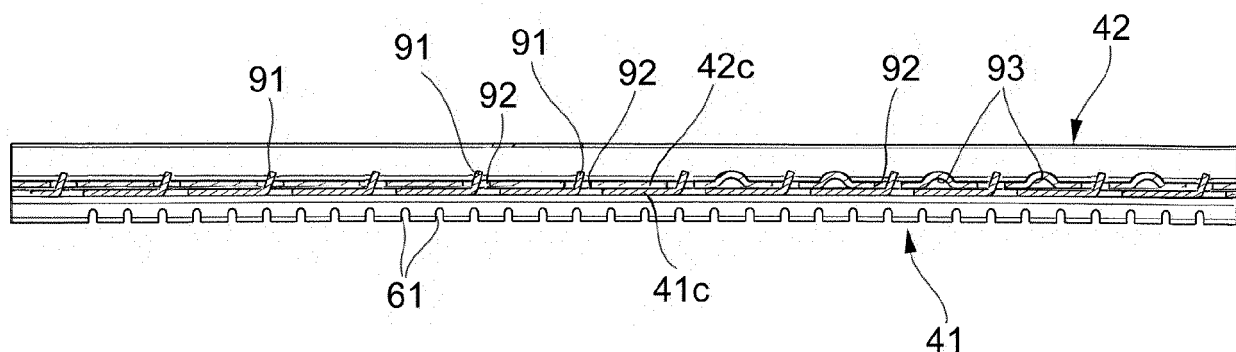
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(71) Applicant: **DENSO THERMAL SYSTEMS S.p.A.**
10046 Poirino (Torino) (IT)

(54) **HEAT EXCHANGER, PARTICULARLY A INNER CONDENSER FOR HEAT PUMP HVAC SYSTEMS**

(57) A heat exchanger comprises a first heat exchange row (10) and a second heat exchange row (20). Two header tanks (42, 52) are provided, wherein each header tank (42, 52) comprises two lateral edges (42a-42b, 52a-52b) fixedly connected to respective lateral edges of a relevant header plate (41, 51), and an intermediate edge (42c, 52c) fixedly connected to an intermediate portion (41c, 51c) of the relevant header plate

(41, 51) in order to separate the respective headers of the first heat exchange row (10) and of the second heat exchange row (20) from each other. The intermediate edge (42c, 52c) of one of the header tanks has a plurality of recesses (93) which establish fluid communication between the respective headers of the first heat exchange row (10) and of the second heat exchange row (20).

FIG.11**EP 4 033 189 A1**

Description

[0001] This invention relates in general to HVAC systems of motor vehicles, more specifically to HVAC systems of electric vehicles.

[0002] Heat pump systems are increasingly being used for air conditioning in electric vehicles. In terms of space requirements, one critical element is the inner condenser.

[0003] The object of the invention is to provide as compact a solution as possible for an inner condenser for a heat pump HVAC system.

[0004] This object is achieved according to the invention by a heat exchanger comprising a first heat exchange row and a second heat exchange row overlapping with each other, wherein each heat exchange row comprises a first header and a second header and a plurality of parallel, coplanar tubes interconnecting the first header and the second header,

wherein the first header of the first heat exchange row and the first header of the second heat exchange row are enclosed between a first header plate and a first header tank that are fixedly connected to each other,

wherein the second header of the first heat exchange row and the second header of the second heat exchange row are enclosed between a second header plate and a second header tank that are fixedly connected to each other,

wherein a plurality of slots is formed in each of said header plates, in each of which slots one end of a relevant tube is inserted,

wherein one of said first header and second header of the first heat exchange row has an inlet of the heat exchanger and one of said first header and second header of the second heat exchange row has an outlet of the heat exchanger,

wherein each header tank comprises two lateral edges fixedly connected to respective lateral edges of the relevant header plate, and an intermediate edge fixedly connected to an intermediate portion of the relevant header plate in order to separate the respective headers of the first heat exchange row and of the second heat exchange row from each other, and

wherein the intermediate edge of one of said first header tank and second header tank has a plurality of recesses which establish fluid communication between the respective headers of the first heat exchange row and of the second heat exchange row, said recesses defining fluid communication passages that are delimited, from opposite sides, by the intermediate edge of one of said first header tank and second header tank and by the intermediate portion of the relevant header plate, wherein the intermediate edge of one of said first header tank and second header tank comprises two header wall portions

which are spaced apart from each other, each of these header wall portions delimiting the relevant header of the first heat exchange row and, respectively, of the second heat exchange row, and an intermediate wall portion which interconnects the header wall portions, said recesses extending through said header wall portions and said intermediate wall portion.

[0005] Although this invention has been designed in particular for use with heat pump HVAC systems, it is evident how it may be applied more generally to double-row heat exchangers, in particular in cases where the heat exchanger needs to have a particularly compact structure.

[0006] Preferred embodiments of the invention are defined in the dependent claims, which are to be understood as an integral part of this description.

[0007] Further features and advantages of the invention will become clearer from the following detailed description of an embodiment of the invention, made with reference to the accompanying drawings, provided purely for illustrative and non-limiting purposes, in which:

- Fig. 1 is a perspective view of a heat exchanger according to the invention;
- Fig. 2 to 4 are, respectively, a perspective view, a plan view and a sectional view of a header plate of the heat exchanger in Fig. 1;
- Fig. 5 to 7 are, respectively, a perspective view, a plan view and a sectional view of a first header tank of the heat exchanger in Fig. 1;
- Fig. 8 to 10 are, respectively, a perspective view, a plan view and a sectional view of a second header tank of the heat exchanger in Fig. 1;
- Fig. 11 is a sectional view which shows the first header tank assembled to the relevant header plate 5;
- Fig. 12 is a sectional view which shows the second header tank assembled to the relevant header plate 5; and
- Fig. 13 is a simplified diagram which shows an example of a heat pump HVAC system.

[0008] With reference to Fig. 1, a heat exchanger is shown, indicated as a whole by reference sign 1. In the example shown, the heat exchanger 1 is a heat transfer fluid/air heat exchanger, in particular an inner condenser of a heat pump HVAC system for an electric vehicle. An example of this system is shown in Fig. 13. IC denotes an inner condenser with which a fan B is associated, which fan is provided for supplying heated air to the interior of the passenger compartment of the vehicle. C denotes a compressor for circulating the heat transfer fluid inside the circuit of the heat pump. EV denotes an expansion valve, and OC denotes an outer condenser provided to absorb energy from the outside air. Lastly, WHE denotes a recovery heat exchanger which is provided to recover waste heat from the electronic compo-

nents and the battery of the vehicle.

[0009] With reference again to Fig. 1, the heat exchanger 1 is a double-row heat exchanger; it therefore comprises a first heat exchange row 10 and a second heat exchange row 20 which overlap with each other. The overlapping relationship relates to the direction of the air which flows through the heat exchanger 1 and exchanges heat with the heat transfer fluid inside the heat exchanger 1; this direction is orthogonal to the main faces of the heat exchanger 1. The first heat exchange row 10 comprises a first header 11 and a second header 12 and a plurality of parallel, coplanar tubes 13 interconnecting the first header 11 and the second header 12. Fins 14 are arranged between adjacent tubes 13, which fins are not shown in detail. The second heat exchange row 20 comprises a first header 21 and a second header 22 and a plurality of parallel, coplanar tubes (not shown in the figures) interconnecting the first header 21 and the second header 22. Fins are arranged between adjacent tubes, which fins are not visible in the figures. Two lateral plates 31 and 32 are fixedly connected to the opposite sides of the mass formed by the tubes 13 of the first heat exchange row 10 and by the tubes of the second heat exchange row 20.

[0010] The aforementioned elements are joined to each other in a manner known per se, for example by means of braze-welding.

[0011] The first header 11 of the first heat exchange row 10 and the first header 21 of the second heat exchange row 20 are enclosed between a first header plate 41 (shown in Fig. 2 to 4) and a first header tank 42 (also shown in Fig. 5 to 7). The first header tank 42 in fact constitutes a double tank. The first header plate 41 and the first header tank 42 are fixedly connected to each other, in a manner which will be described in the following. At the opposite ends, respective covers 43 and 44 are provided which are crimped to both the first header plate 41 and the first header tank 42. The join created by means of crimping may be strengthened by means of a subsequent material coupling process, for example braze-welding.

[0012] The second header 12 of the first heat exchange row 10 and the second header 22 of the second heat exchange row 20 are enclosed between a second header plate 51, which is identical to the first header plate 41 and therefore also shown in Fig. 2-4, and a second header tank 52 which is also shown in Fig. 8 to 10. The second header tank 52 in fact constitutes a double tank. The second header plate 51 and the second header tank 52 are fixedly connected to each other, in a manner which will be described in the following. At the opposite ends, respective covers 53 and 54 are provided which are crimped to both the second header plate 51 and the second header tank 52. The join created by means of crimping may be strengthened by means of a subsequent material coupling process, for example braze-welding.

[0013] A plurality of slots 61, more specifically two parallel rows of slots 61, are formed in each of the header

plates 41 and 51. One end of a relevant tube 13 is inserted in each of these slots 61.

[0014] The first header 11 of the first heat exchange row 10 has an inlet I of the heat exchanger 1. The second header 22 of the second heat exchange row 20 has an outlet OUT of the heat exchanger 1. For convenience, hereinafter reference will only be made to this arrangement. However, the arrangement of the inlet and outlet may be different to that described herein.

[0015] A fluid connection is provided between the first header 11 of the first heat exchange row 10 and the second header 21 of the second heat exchange row 20. For convenience, hereinafter reference will only be made to this arrangement. However, the arrangement of the fluid connection may be different to that described herein.

[0016] A partition 70 (shown only in Fig. 6) is arranged within the first header 11 of the first heat exchange row 10, which partition divides the first header 11 of the first heat exchange row 10 into an inlet chamber 11b and an outlet chamber 11c. For convenience, hereinafter reference will only be made to this arrangement. However, the arrangement of the partition may be different to that described herein, or the partition may even be absent.

[0017] The fluid connection, which will be described in the following, connects in particular the outlet chamber 11c of the first header 11 of the first heat exchange row 10 to the first header 21 of the second heat exchange row 20. For convenience, hereinafter reference will only be made to this arrangement. However, the arrangement of the fluid connection element may be different to that described herein.

[0018] Each header tank 42, 52 comprises two lateral edges 42a-42b and 52a-52b fixedly connected to respective lateral edges of the relevant header plate 41, 51. In particular, each of the lateral edges 42a-42b and 52a-52b of each header tank 42, 52 has a plurality of tabs 81 crimped onto the relevant lateral edge of the relevant header plate 41, 51. The join created by means of crimping may be strengthened by means of a subsequent material coupling process, for example braze-welding.

[0019] Each header tank 42, 52 also comprises an intermediate edge 42c, 52c which separates the respective first headers 11, 21 or second headers 12, 22. Each intermediate edge 42c, 52c is fixedly connected to an intermediate portion 41c, 51c of the relevant header plate 41, 51 in order to separate the respective headers of the first heat exchange row 10 and of the second heat exchange row 20 from each other. In particular, the intermediate portion 41c, 51c of each header plate 41, 51 has a plurality of tabs 91 crimped into respective windows 92 formed in the intermediate edge 42c, 52c of the relevant header tank 42, 52 (this may be seen in particular in Fig. 11 and 12). The join created by means of crimping may be strengthened by means of a subsequent material coupling process, for example braze-welding.

[0020] The intermediate edge of one of the first header tank 42 or second header tank 52, in the example shown the intermediate edge 42c of the first header tank 42, has

a plurality of recesses 93 which establish fluid communication between the respective headers of the first heat exchange row 10 and of the second heat exchange row 20, in the example shown between the outlet chamber 11c of the first header 11 of the first heat exchange row 10 and the first header 21 of the second heat exchange row 20. The recesses 93 therefore define fluid communication passages that are delimited, from opposite sides, by the intermediate edge of one of said first header tank and second header tank (in the example shown, the intermediate edge 42c) and by the intermediate portion of the relevant header plate (in the example shown, the intermediate portion 41c). As may be seen more precisely in Fig. 5, the intermediate edge 42c comprises two header wall portions which are spaced apart from each other, each of these header wall portions delimiting the relevant header of the first heat exchange row 10 and, respectively, of the second heat exchange row 20. As may also be seen in Fig. 5, the intermediate edge 42c also comprises an intermediate wall portion which interconnects the aforementioned header wall portions. The recesses or fluid communication passages 93 extend through the header wall portions and the intermediate wall portion interconnecting said header wall portions.

[0021] In the heat exchanger 1 described above, the heat transfer fluid follows a U-shaped path in the first heat exchange row 10, by entering from the inlet IN of the first header 11 of the first heat exchange row 10 and flowing through the inlet chamber 11b of the first header 11 of the first heat exchange row 10, the tubes 13 connected thereto, the second header 12 of the first heat exchange row 10, and the tubes 13 which connect the second header 12 of the first heat exchange row 10 to the outlet chamber 11c of the first header 11 of the first heat exchange row 10. The heat transfer fluid flows from the outlet chamber 11c of the first header 11 of the first heat exchange row 10, through the passages between the plate and tank, which passages are defined by the recesses 93, to the first header 21 of the second heat exchange row 20. The heat transfer fluid thus follows a single-pass path in the second heat exchange row 20, by flowing through the first header 21 of the second heat exchange row 20, the tubes of the second heat exchange row 20, and the second header 22 of the second heat exchange row 20, and finally exiting from the outlet OUT of the second header 22 of the second heat exchange row 20.

Claims

1. A heat exchanger comprising a first heat exchange row (10) and a second heat exchange row (20) overlapping with each other, wherein each heat exchange row (10, 20) comprises a first header (11, 21) and a second header (12, 22) and a plurality of parallel, coplanar tubes (13) interconnecting the first header (11, 21) and the second header (12, 22),

wherein the first header (11) of the first heat exchange row (10) and the first header (21) of the second heat exchange row (20) are enclosed between a first header plate (41) and a first header tank (42) that are fixedly connected to each other,

wherein the second header (12) of the first heat exchange row (10) and the second header (22) of the second heat exchange row (20) are enclosed between a second header plate (51) and a second header tank (52) that are fixedly connected to each other,

wherein a plurality of slots (61) is formed in each of said header plates (41, 51), in each of which slots one end of a relevant tube (13) is inserted, wherein one of said first header and second header of the first heat exchange row (10) has an inlet (IN) of the heat exchanger and one of said first header and second header of the second heat exchange row (20) has an outlet (OUT) of the heat exchanger,

wherein each header tank (42, 52) comprises two lateral edges (42a-42b, 52a-52b) fixedly connected to respective lateral edges of the relevant header plate (41, 51), and an intermediate edge (42c, 52c) fixedly connected to an intermediate portion (41c, 51c) of the relevant header plate (41, 51) in order to separate the respective headers of the first heat exchange row (10) and of the second heat exchange row (20) from each other, and

wherein the intermediate edge (42c, 52c) of one of said first header tank and second header tank has a plurality of recesses (93) establishing fluid communication between the respective headers of the first heat exchange row (10) and of the second heat exchange row (20), said recesses defining fluid communication passages that are delimited, from opposite sides, by the intermediate edge (42c, 52c) of one of said first header tank and second header tank and by the intermediate portion (41c, 51c) of the relevant header plate (41, 51), wherein the intermediate edge (42c, 52c) of one of said first header tank and second header tank comprises two header wall portions which are spaced apart from each other, each of these header wall portions delimiting the relevant header of the first heat exchange row (10) and, respectively, of the second heat exchange row (20), and an intermediate wall portion which interconnects the header wall portions, said recesses (93) extending through said header wall portions and said intermediate wall portion.

2. The heat exchanger according to claim 1, wherein the first header (11) of the first heat exchange row (10) has the inlet (IN) of the heat exchanger,

wherein the second header (22) of the second heat exchange row (20) has the outlet (OUT) of the heat exchanger,

wherein a partition (70) is arranged within the first header (11) of the first heat exchange row (10), which partition divides the first header (11) of the first heat exchange row (10) into an inlet chamber (11b) and an outlet chamber (11c), wherein said recesses (93) establish fluid communication between the outlet chamber (11c) of the first header (11) of the first heat exchange row (10) and the first header (21) of the second heat exchange row (20).

3. The heat exchanger according to claim 1 or 2, wherein each of the lateral edges (42a-42b, 52a-52b) of each header tank (42, 52) has a plurality of tabs (81) crimped onto the relevant lateral edge of the relevant header plate (41, 51).
4. The heat exchanger according to any of the preceding claims, wherein the intermediate portion (41c, 51c) of each header plate (41, 51) has a plurality of tabs (91) crimped into respective windows (92) formed in the intermediate edge (42c, 52c) of the relevant header tank (42, 52).
5. A heat pump HVAC system for a vehicle, comprising an inner condenser (IC), wherein said inner condenser is a heat exchanger according to any of the preceding claims.
6. The system according to claim 5, also comprising a compressor (C) for circulating the heat transfer fluid inside a circuit of the heat pump, an expansion valve (EV), an outer condenser (OC) provided to absorb energy from the outside air, and a recovery heat exchanger (WHE) provided to recover waste heat from electronic components and the battery of the vehicle.

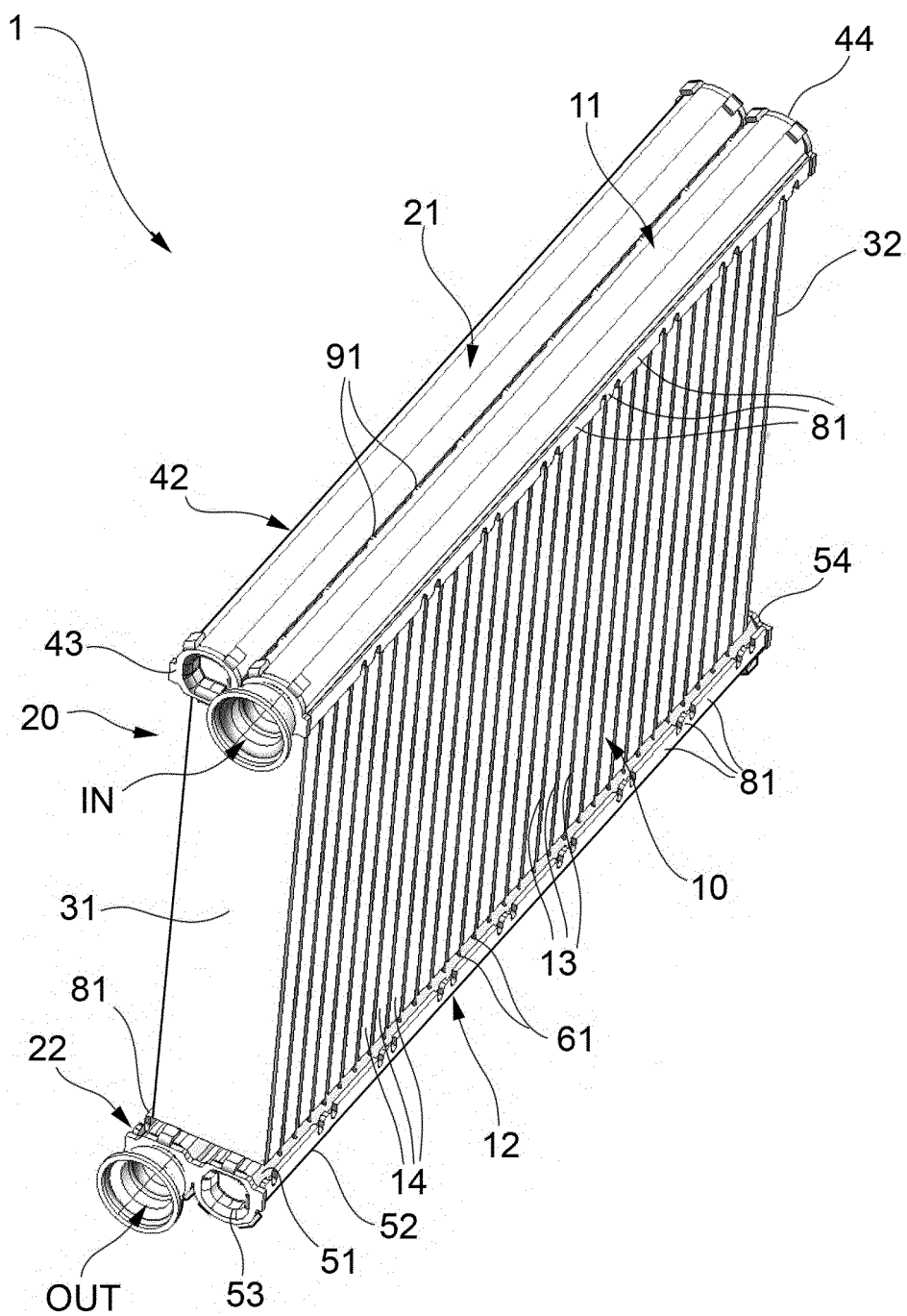


FIG.1

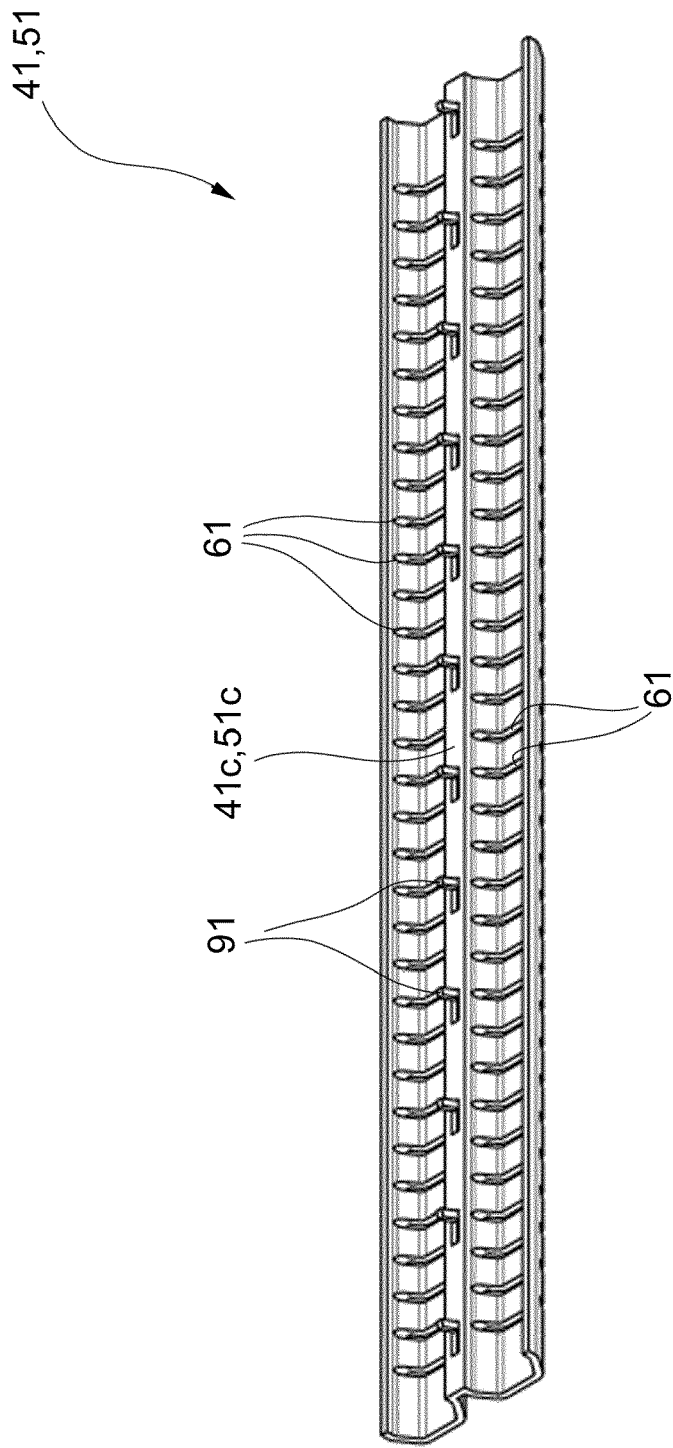


FIG.2

FIG.3

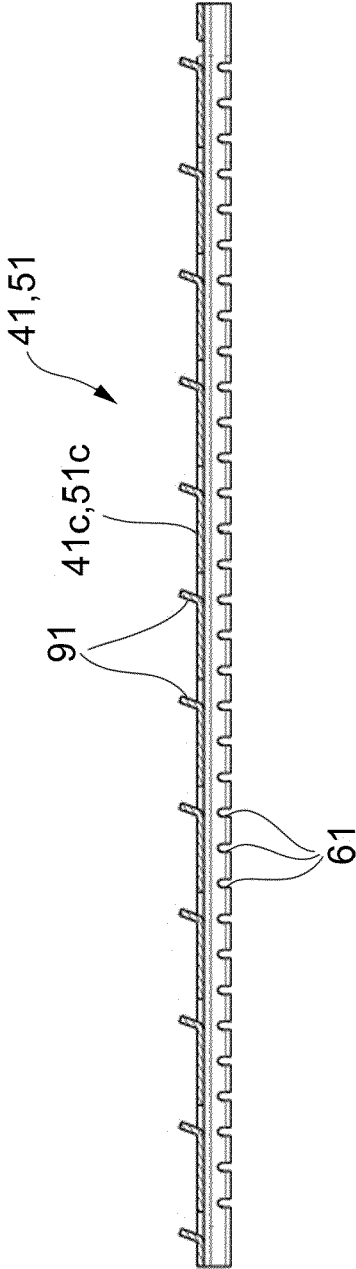
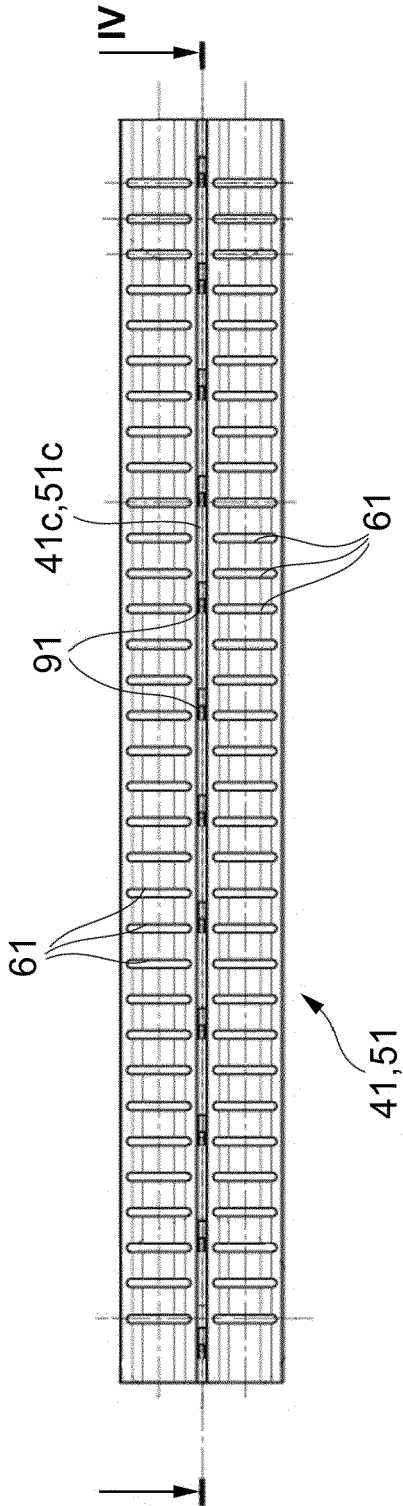


FIG.4

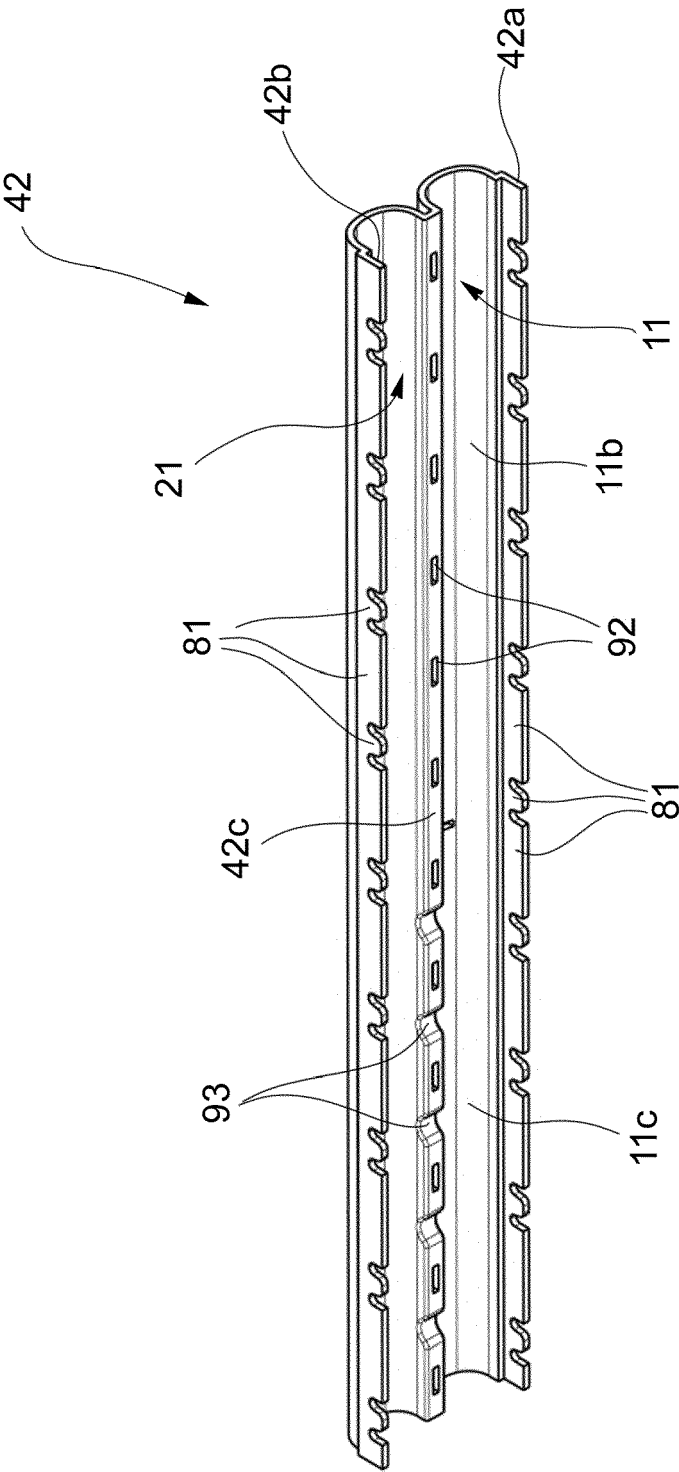


FIG.5

FIG.6

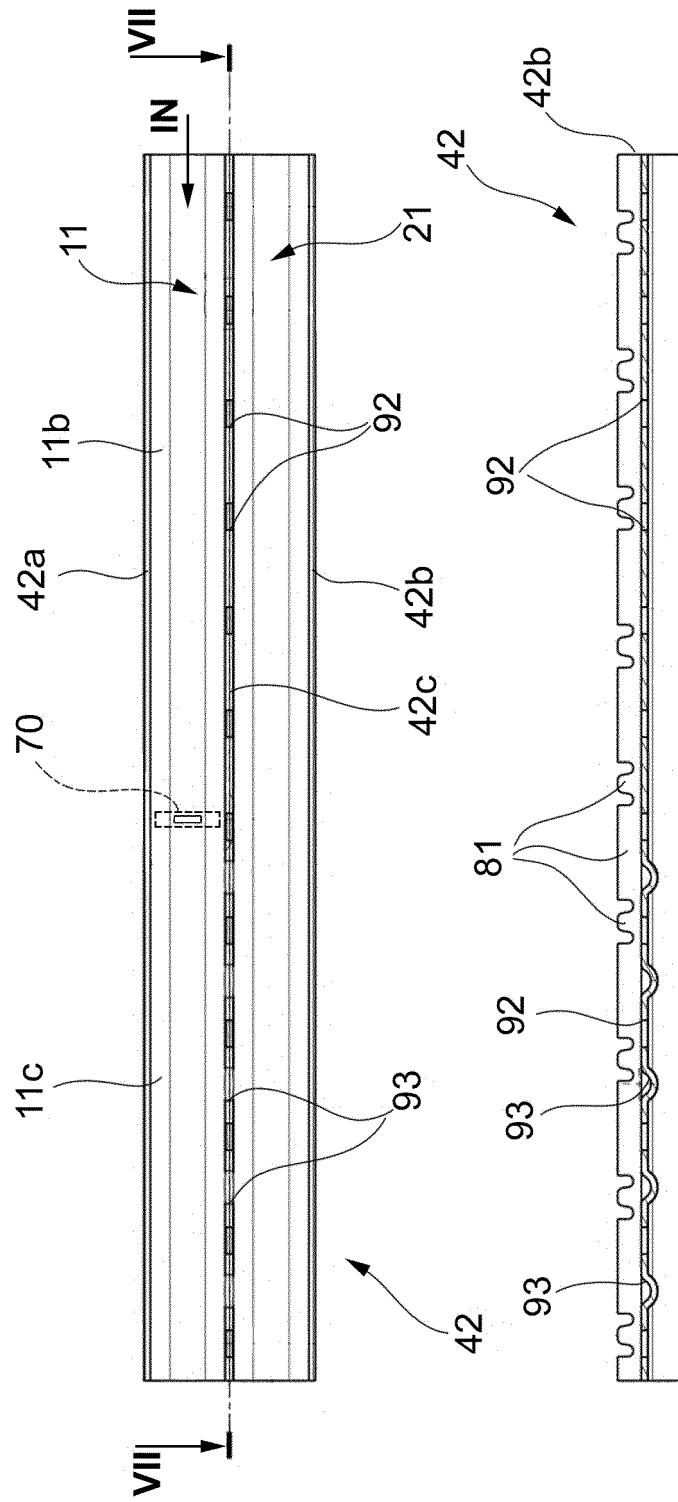


FIG.7

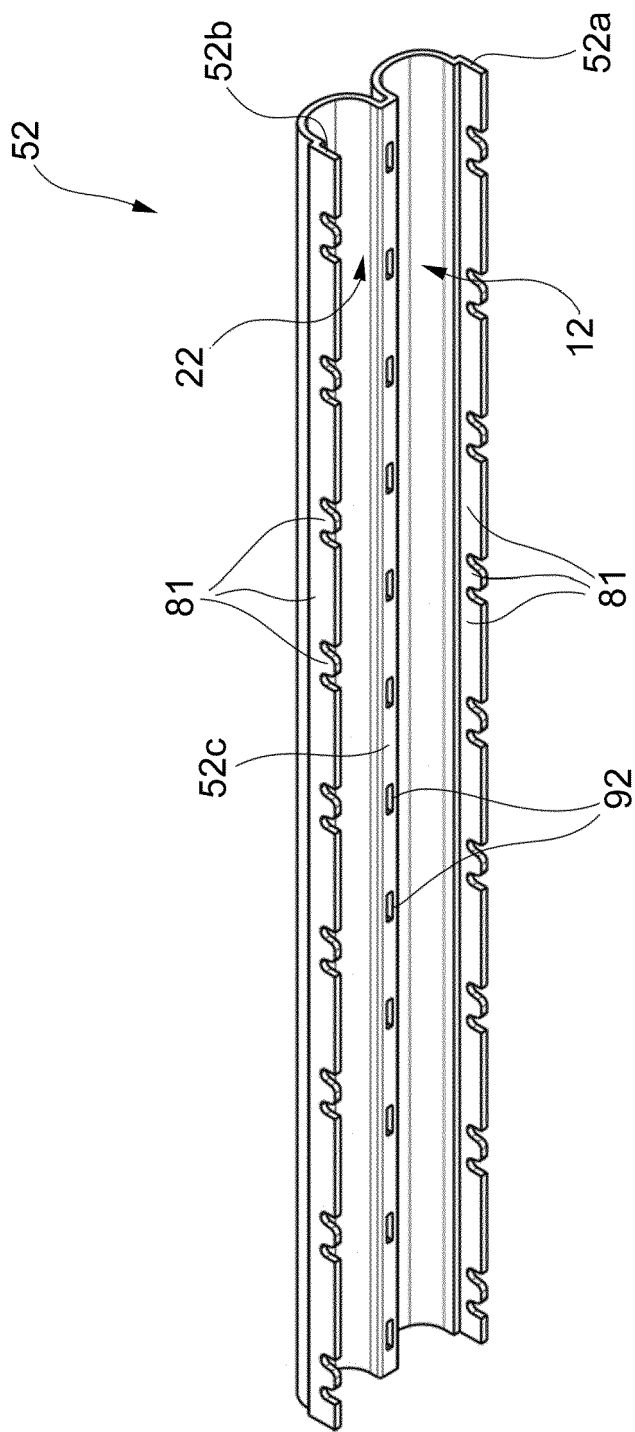


FIG.8

FIG.9

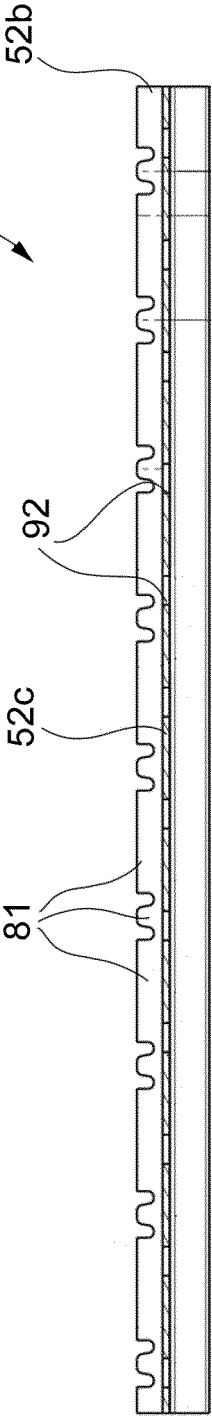
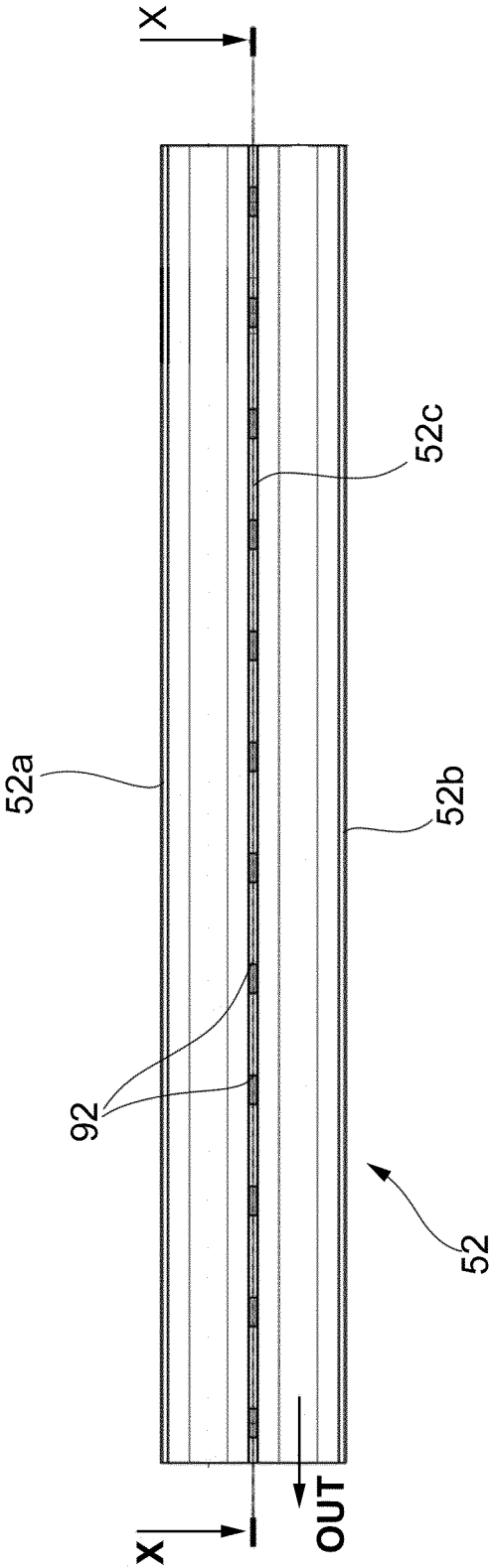


FIG.10

FIG.11

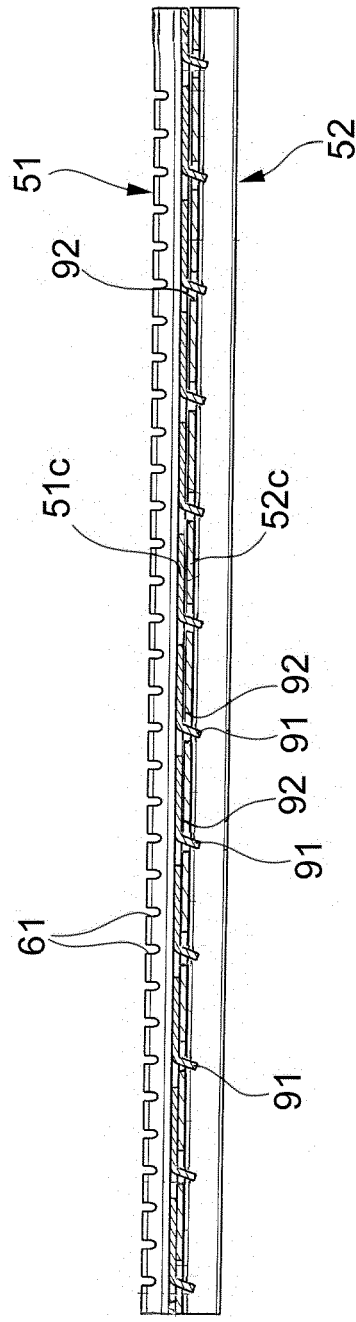
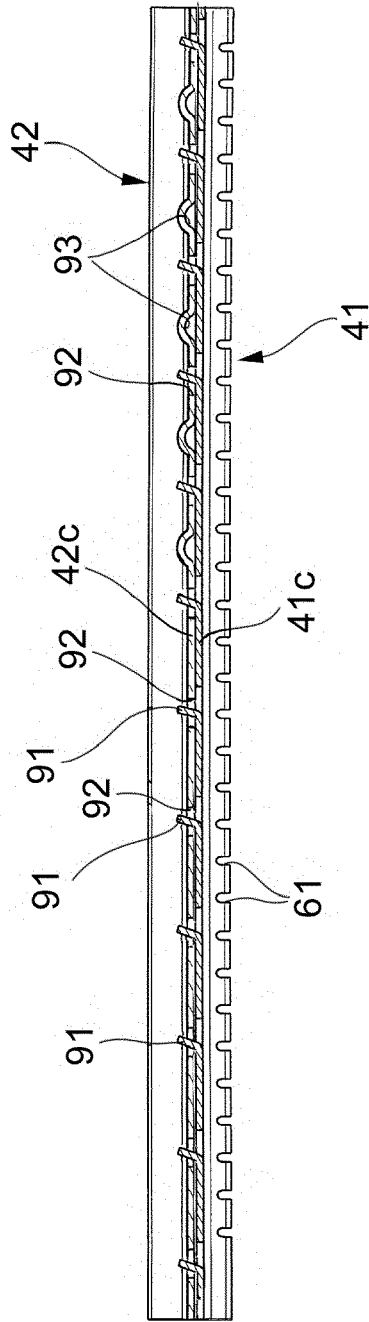


FIG.12

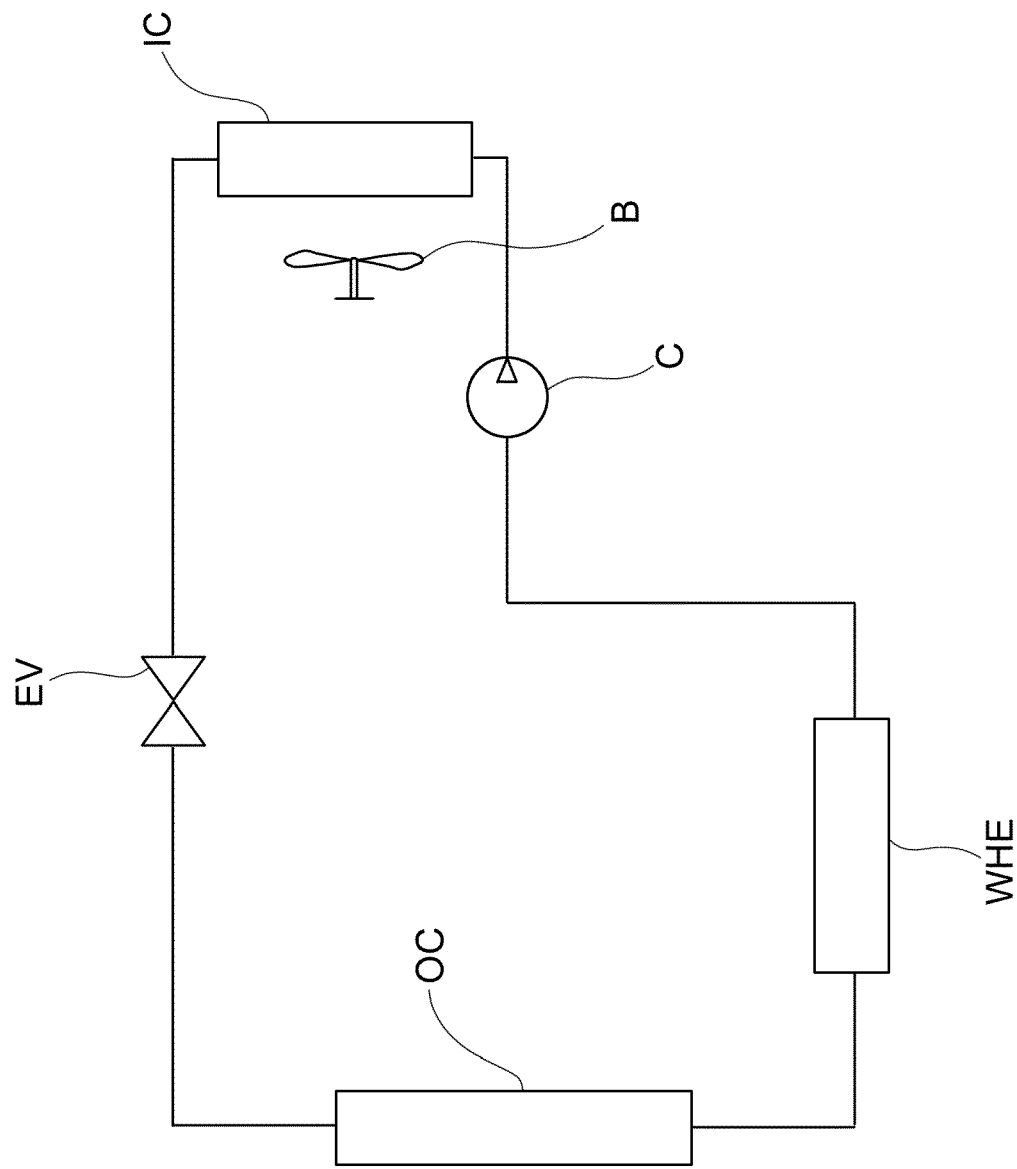


FIG.13



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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 3 April 2022	Examiner Mellado Ramirez, J
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