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(54) **A HEAT EXCHANGER WITH CONTROLLING MEANS**

(57) A heat exchanger 1 comprising a first manifold 2 and a second manifold 3 connected by a bundle of tubes 4, configured to provide an inlet pass 5, an outlet pass 6 and an intermediate pass 7 for a heat exchange fluid, characterized in that the heat exchanger 1 comprises controlling means 50 adapted to switch between a first state, in which co-flow of the heat exchange fluid in the outlet pass 6 and the intermediate pass 7 with counterflow in the inlet pass 5 is enabled, and a second state in which co-flow of the heat exchange fluid in the inlet pass 5 and the intermediate pass 7 with counterflow in the outlet pass 5 is enabled.

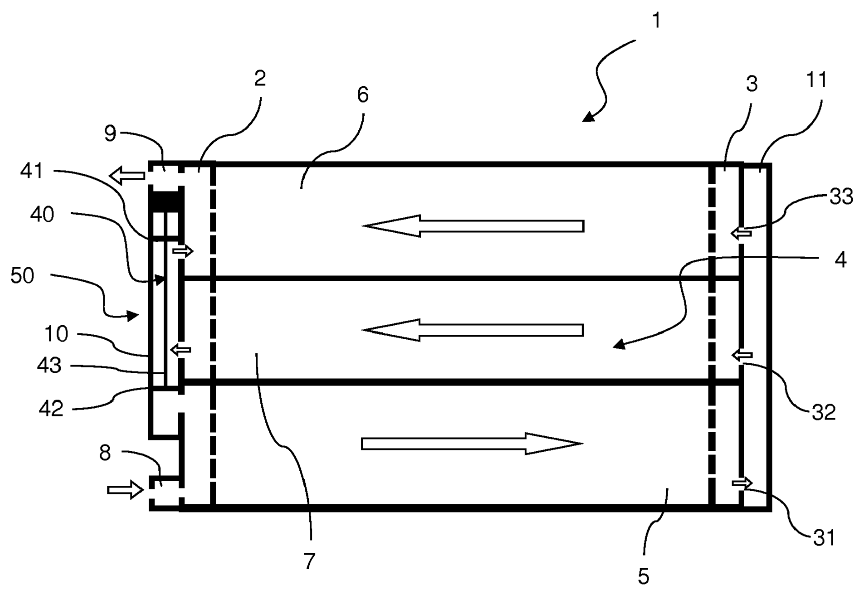

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention relates to heat exchangers for air conditioning and heat pump applications. In particular, it relates to heat exchangers for use in automotive industry.

BACKGROUND OF THE INVENTION

[0002] There are known heat exchangers adapted to work in so-called AC mode (air conditioning mode). In AC mode, the heat exchanger works as an ordinary condenser. The refrigerant at the inlet at a typical operation point is in gaseous state and needs to be cooled inside the core in order to deliver liquid, subcooled refrigerant at outlet. For this mode, the cores are usually configured in manner ensuring that number of tubes in first pass is significantly greater than number of tubes in second pass. Number of tubes in second pass may be usually 8-12 when total number of tubes may be equal or above 60 for some specific application. This solution is beneficial, because it allows decrease in pressure drop in first pass, where density of refrigerant is small and consequently the volumetric flow is significant. At inlet to the second pass the refrigerant is condensed, i.e. it is fluid or mostly fluid, while its density is significantly higher and in connection to that volumetric flow is also significantly lower.

[0003] Such configuration allows a decent compromise in terms of size/performance ratio.

[0004] There are also known heat exchangers adapted to work in a so-called HP mode (heat pump mode). In the HP mode, the temperature of refrigerant at inlet is lower than temperature of air flowing through the core. Refrigerant is heated inside core and in the second pass temperature of refrigerant is higher and due to that density is smaller than in the first pass.

[0005] While it is preferable to enable flow from top to bottom within the heat exchanger adapted for AC mode, it is preferable to enable flow from bottom to top within the heat exchanger adapted for HP mode.

[0006] It is possible to use a single heat exchanger, in particular an evapo-condenser, which operates alternatively in the AC and HP mode. For such application, the flow through this heat exchanger can be reversed between the modes, or can be maintained common for both. From the system point of view, it may be preferable to have a common direction of flow in both modes. An example of such system is described in EP2933586.

[0007] Consequently, it is clear that there may be a conflict between the requirements posed by the system and those related to optimal performance during operation in each of the modes.

[0008] It would be desirable to provide a heat exchanger adapted to work both in the AC mode and the HP mode in an effective manner, without requiring the reversal of the direction of the fluid flow.

SUMMARY OF THE INVENTION

[0009] The object of the invention is, among others, a heat exchanger comprising a first manifold and a second manifold connected by a bundle of tubes, configured to provide an inlet pass, an outlet pass and an intermediate pass for a heat exchange fluid, characterized in that the heat exchanger comprises controlling means adapted to switch between a first state, in which co-flow of the heat exchange fluid in the outlet pass and the intermediate pass with counterflow in the inlet pass is enabled, and a second state in which co-flow of the heat exchange fluid in the inlet pass and the intermediate pass with counterflow in the outlet

[0010] Preferably, the heat exchanger is further comprising an inlet port associated with the inlet pass and an outlet port associated with an outlet pass, wherein both are located on the first manifold.

[0011] Preferably, the flow between the inlet pass, the intermediate pass and the outlet pass is blocked within the second manifold, wherein the heat exchanger further comprises an outside channel, the outside channel being adapted to receive the fluid from and distribute the fluid to the inlet pass, intermediate pass and the outlet pass.

[0012] Preferably, the outside channel is adapted to receive the fluid from and distribute the fluid to the inlet pass, intermediate pass and the outlet pass at places which promote the flow through and from specific tubes within the pass, while hindering the flow through and from the remaining ones.

[0013] Preferably, the outside channel is fluidly connected to the second manifold such that there is a first opening at the level of the inlet pass, a second opening at the level of the intermediate pass, and a third opening at the level of the outlet pass to enable flow between the passes and the manifold.

[0014] Preferably, each of the openings is located in the lower section of respective pass.

[0015] Preferably, the heat exchanger further comprises a tubular body connected fluidically to the first manifold so that it can receive the fluid from and distribute the fluid to the inlet pass, intermediate pass and the outlet pass, wherein the tubular body comprises the controlling means.

[0016] Preferably, the controlling means comprise a valve assembly, the valve assembly comprising two baffles connected to each other and adapted to cooperate with the tubular body so that in the first state they block fluid flow between the inlet pass and the intermediate pass, and in the second state they block fluid flow between the intermediate pass and the outlet pass.

[0017] Preferably, the controlling means are adapted to switch between the first state and the second state based on temperature of the core and/or environment of the heat exchanger.

[0018] Another object of the invention is an air conditioning circuit comprising a heat exchanger as described above.

BRIEF DESCRITPTION OF DRAWINGS

[0019] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows the heat exchanger in heat pump mode;

Fig. 2 shows the heat exchanger in air conditioning mode.

DETAILED DESCRIPTION OF EMBODIMENTS

[0020] Figs. 1 and 2 present heat exchanger according to the invention, wherein Fig. 1 shows the heat exchanger in heat pump mode, while Fig. 2 shows the heat exchanger in air conditioning mode.

[0021] A heat exchanger 1 comprises a first manifold 2 and a second manifold 3 connected by a bundle of tubes 4. The heat exchanger is configured to provide an inlet pass 5, an outlet pass 6 and an intermediate pass 7 for a heat exchange fluid, the intermediate pass 7 being located between the inlet pass 5 and the outlet pass 6. The tubes 4 within the bundle are spaced with respect to each other to enable heat exchange with a second fluid, for example air, travelling through the spaces between the tubes. Said spaces may comprise fins for facilitating the heat exchange. The heat exchanger 1 further comprises an inlet port 8 associated with the inlet pass 5 and an outlet 9 port associated with an outlet pass 6, wherein both are located on the first manifold 2. The heat exchanger 1 further comprises controlling means 50 adapted to switch between a first state, in which co-flow of the heat exchange fluid in the outlet pass 6 and the intermediate pass 7 with counterflow in the inlet pass 5 is enabled, and a second state in which co-flow of the heat exchange fluid in the inlet pass 5 and the intermediate pass 7 with counterflow in the outlet pass 5 is enabled. This may be done by selectively blocking the flow between the passes by the controlling means 50.

[0022] The controlling means 50 are adapted to receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and the outlet pass 6. One example of implementation of controlling means adapted for switching between the first state and the second state may be integrating them into or with a tubular body 10 connected fluidically to the first manifold 2 so that it can receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and outlet pass 6. The controlling means 50 may comprise a valve assembly with two baffles 41, 42 connected to each other (for example by a rod 43), and adapted to cooperate with the tubular body 10 so that in the first state they block fluid flow between the inlet pass 5 and the intermediate pass 7, and in the second state they block fluid flow between the intermediate pass 7 and the outlet pass 6. The switching between the first and second states may be controlled automatically or manually. Other ways of effecting the blocking and enabling the flow as explained above are also possible as long as they allow to execute reliably the functioning of the heat exchanger.

[0023] The flow between the inlet pass 5, the intermediate pass 7 and the outlet pass 6 may be blocked within the second manifold 3. The heat exchanger then further may comprise an outside channel 11, the outside channel 11 being adapted to receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and the outlet pass 6. The outside channel 11 then is fluidly connected to the second manifold 3 such that there is a first opening 31 at the level of the inlet pass 5, a second opening 32 at the level of the intermediate pass 7, and a third opening 33 at the level of the outlet pass 6. Preferably, the outside channel 11 is adapted to receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and the outlet pass 6 at places which promote the flow through and from specific tubes within the pass, while hindering the flow through and from the remaining ones of said pass. For example, each of the openings 31, 32, 33 is located in the lower section of respective pass 5, 7, 6.

[0024] For the heat exchanger according to the invention, in HP mode the controlling means 50 are set to the first state. The refrigerant enters the heat exchanger through the inlet port 8 and then travels through the inlet pass 5. The fluid then is turned and flows in the intermediate pass 7 as well as the outlet pass 6, as allowed by the controlling means 50, both in a direction opposite to the direction within the inlet pass 5. The fluid then may exit the heat exchanger through the outlet port 9.

[0025] In AC mode the controlling means are set in the second state. The refrigerant enters the heat exchanger through the inlet port 8 and then travels through the inlet pass 5, as well as the intermediate pass 7 in the same direction, as allowed by the controlling means 50. The fluid then is turned and flows in the outlet pass 6 in a direction opposite to the direction within the inlet and intermediate passes 5, 7. The fluid then may exit the heat exchanger through the outlet port 9.

[0026] In both AC and HP mode, the switching between the first state and the second state allows to achieve optimal performance, connected to the amount of tubes within passes, without reversing the flow within the same heat exchanger.

[0027] The controlling means 50 can be driven based on temperature, e.g. thermostatic valve or pressure e.g. pressure valve. Thermostatic valve can be beneficial due to fact that with system in a switch of state, it will adjust its position according to more probable position. For example, it will switch to AC mode in summer when temperature of the environment and/or core will be high, or HP mode when temperature of the environment and/or the core will be low, for example in winter.

[0028] Others configurations of valves e.g. rotating valve, actuators e.g. driven by various factors, including solenoid, core, repartition of tubes, number of passes etc. can be used.

[0029] It is also envisaged for the invention to pertain to heat exchangers with more than three passes as explained above. In such scenarios, the inlet, intermediate and outlet passes may be neighbored by further passes, and necessarily be directly connected to inlet and/or outlet ports. Nevertheless, the general concept can still be applicable.

[0030] 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 heat exchanger 1 comprising a first manifold 2 and a second manifold 3 connected by a bundle of tubes 4, configured to provide an inlet pass 5, an outlet pass 6 and an intermediate pass 7 for a heat exchange fluid, **characterized in that** the heat exchanger 1 comprises controlling means 50 adapted to switch between a first state, in which co-flow of the heat exchange fluid in the outlet pass 6 and the intermediate pass 7 with counterflow in the inlet pass 5 is enabled, and a second state in which co-flow of the heat exchange fluid in the inlet pass 5 and the intermediate pass 7 with counterflow in the outlet pass 5 is enabled.

2. A heat exchanger according to claim 1, further comprising an inlet port 8 associated with the inlet pass 5 and an outlet 9 port associated with an outlet pass 6, wherein both are located on the first manifold 2.

3. A heat exchanger according to any preceding claim, wherein the flow between the inlet pass 5, the intermediate pass 7 and the outlet pass 6 is blocked within the second manifold 3, wherein the heat exchanger further comprises an outside channel 11, the outside channel 11 being adapted to receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and the outlet pass 6.

4. A heat exchanger according to claim 3, wherein the outside channel 11 is adapted to receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and the outlet pass 6 at places which promote the flow through and from specific tubes within the pass, while hindering the flow through and from the remaining ones.

5. A heat exchanger according to claim 4, wherein the outside channel 11 is fluidly connected to the second manifold 3 such that there is a first opening 31 at the level of the inlet pass 5, a second opening 32 at the level of the intermediate pass 7, and a third opening 33 at the level of the outlet pass 6 to enable flow between the passes and the manifold 3.

6. A heat exchanger according to claim 5, wherein each of the openings 31, 32, 33 is located in the lower section of respective pass 5, 7, 6

7. A heat exchanger according to any preceding claim, wherein it further comprises a tubular body 10 connected fluidically to the first manifold 2 so that it can receive the fluid from and distribute the fluid to the inlet pass 5, intermediate pass 7 and the outlet pass 6, wherein the tubular body comprises the controlling means 50.

8. A heat exchanger according to any preceding claim, wherein the controlling means 50 comprise a valve assembly, the valve assembly comprising two baffles 41, 42 connected to each other and adapted to cooperate with the tubular body 10 so that in the first state they block fluid flow between the inlet pass 5 and the intermediate pass 7, and in the second state they block fluid flow between the intermediate pass 7 and the outlet pass 6.

9. A heat exchanger according to any preceding claim, wherein the controlling means 50 are adapted to switch between the first state and the second state based on temperature of the core and/or environment of the heat exchanger.

10. An air conditioning circuit comprising a heat exchanger according to any preceding claim.

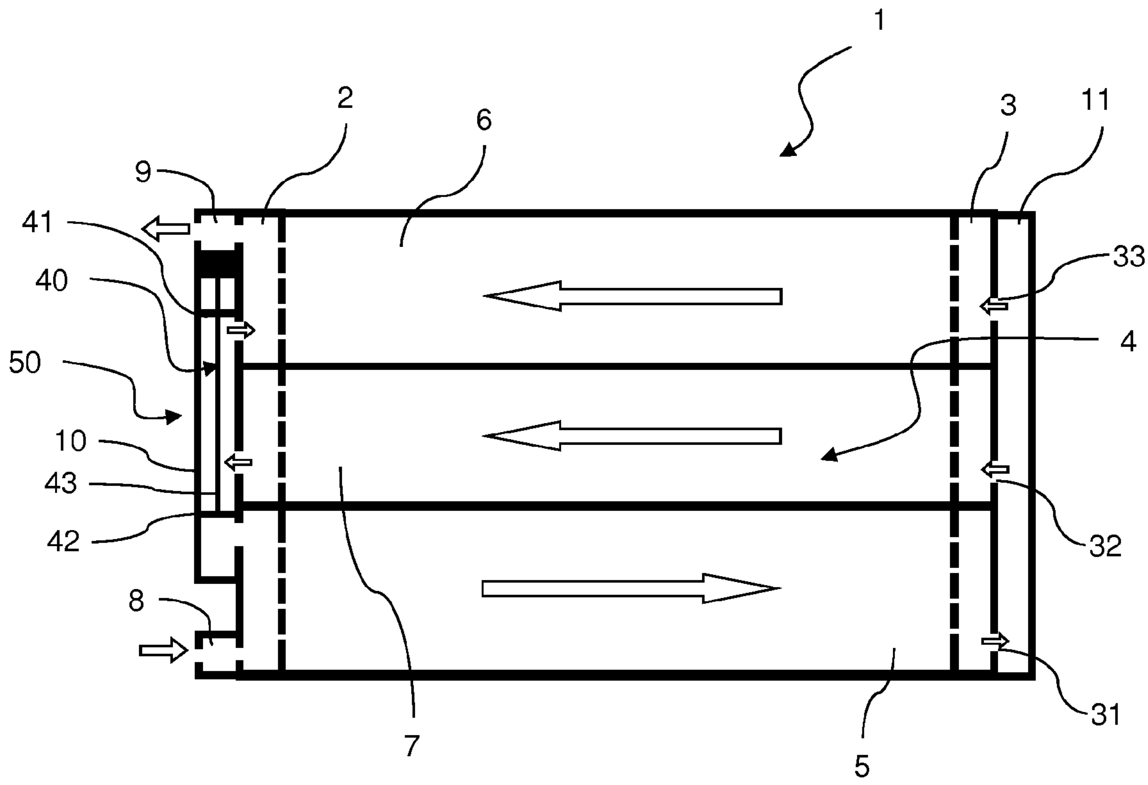
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Fig. 1

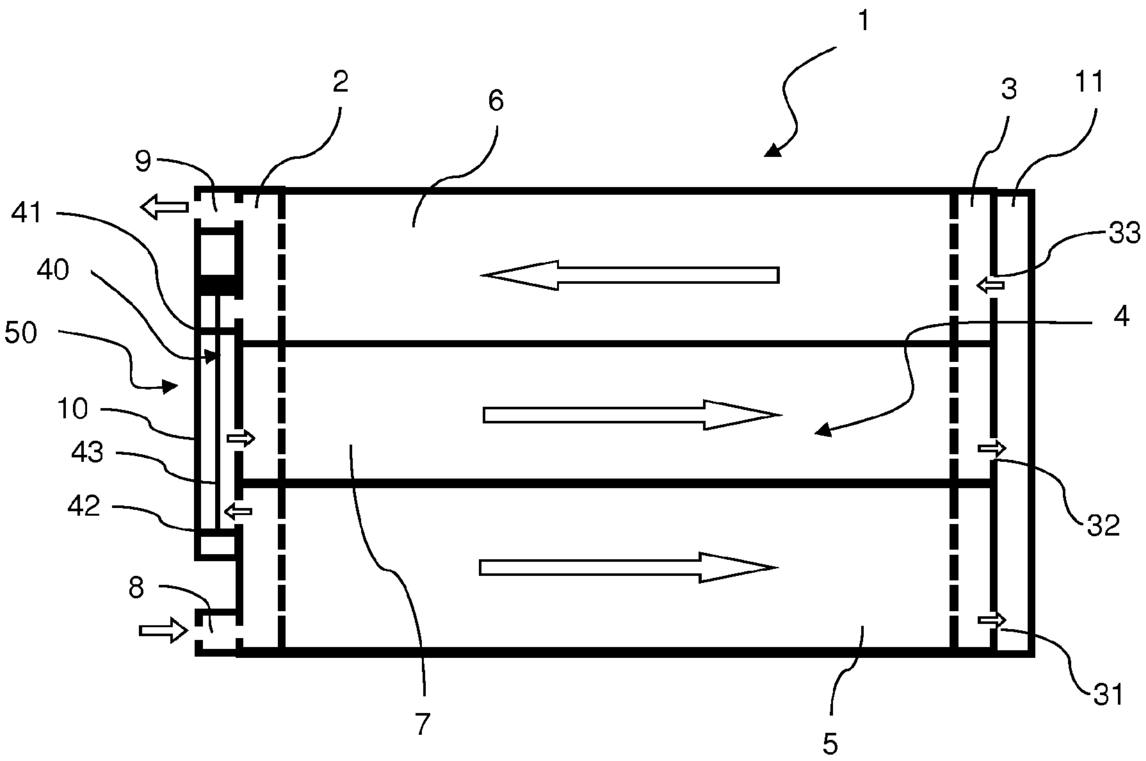
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Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 19 46 1599

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 April 2020	Bloch, Gregor

CATEGORY OF CITED DOCUMENTS

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