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(54) HEAT EXCHANGER

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(57) **ABSTRACT**

The invention relates to a heat exchanger.

This exchanger is of the type which has at least one route for flow of a cooling fluid, such as water, a cooling agent or even air, and at least a second route for flow of a fluid such as air. At least the second route has a number of flow channels. The exchanger is characterized by the fact that it has some means of evacuation of the water which condenses on the walls of the air flow channels by suction.

The invention can be used in heat exchangers.

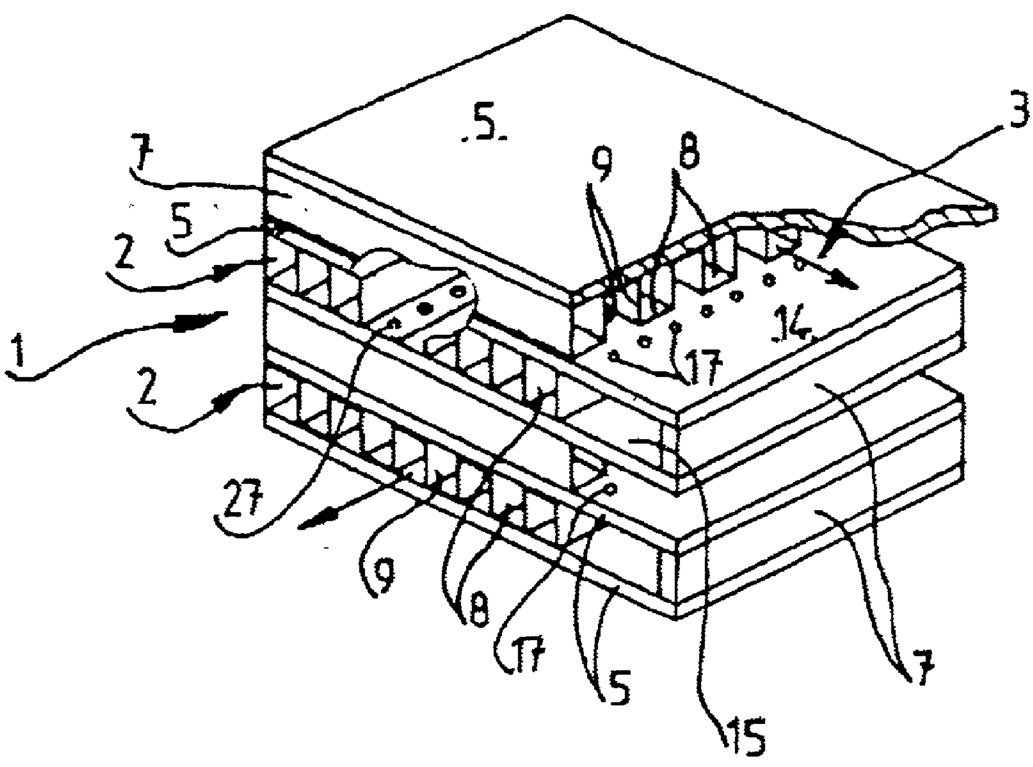


Fig. 1

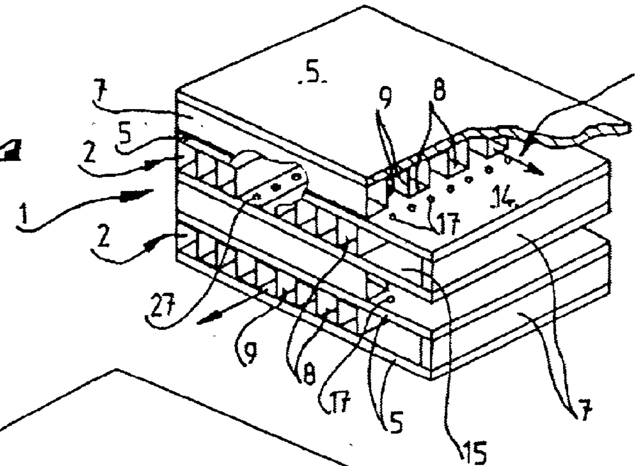


Fig. 2

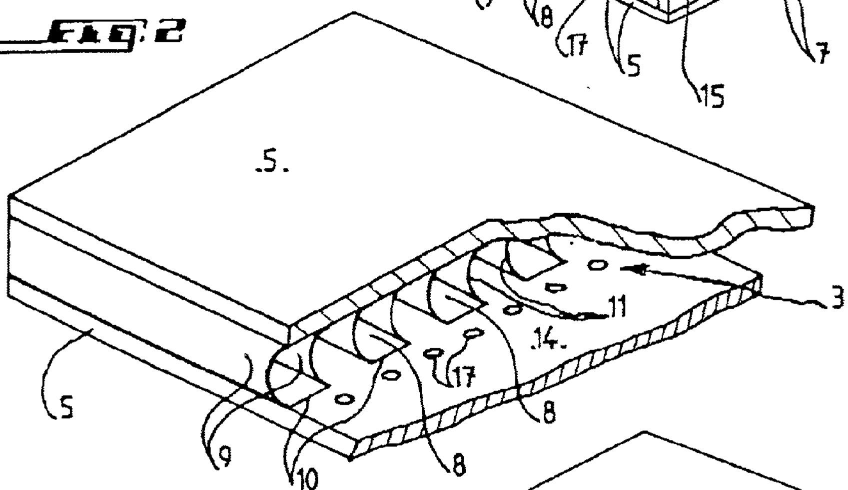


Fig. 3

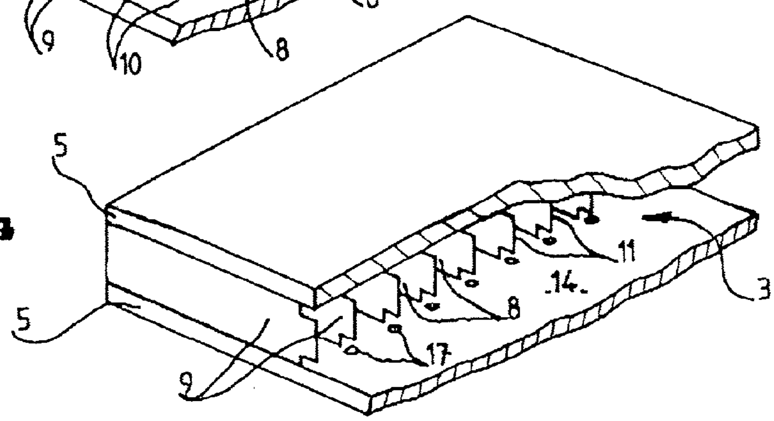


Fig. 4a

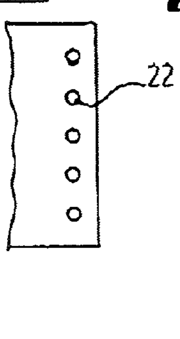


Fig. 4b

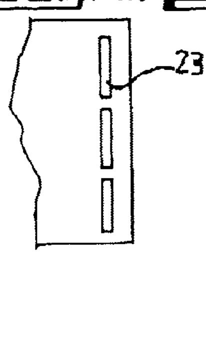


Fig. 4c

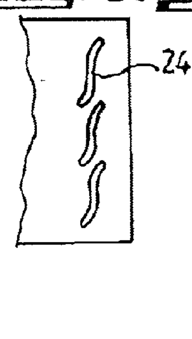
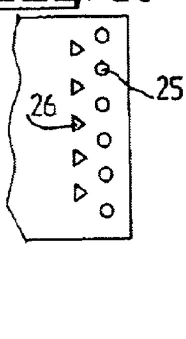


Fig. 4d



HEAT EXCHANGER

[**0001**] The invention relates to a type of heat exchanger that has two fluid flow routes, which in particular are crossed or parallel. A first route having a number of flow channels for a first cooling fluid, such as water, and the second route having a number of flow channels for a gaseous fluid such as air.

[**0002**] In the known heat exchangers of this type, the air which flows through the channels of the second route is cooled by the water to a temperature close to that of the water. Consequently, a part of the moisture contained in the air flow condenses on the walls of the channels. For thermal reasons, the channels can be narrow in at least one of their dimensions, and capillary forces can therefore exert themselves on the condensate which then accumulates on the walls of the channels. The first consequence is that large quantities of condensate can be carried along by the air flow in the case of an increase of air flow rate. This phenomenon, called the "wave" phenomenon, is unacceptable for certain applications. Two other consequences of this accumulation are an increase of the load loss of the exchanger in this circuit and a decrease of the heat exchange because of the thickness of the condensate retained on the fins.

[**0003**] The objective of the invention is to propose a heat exchanger which minimizes the just stated disadvantage of the known heat exchangers.

[**0004**] In order to accomplish this purpose, the heat exchanger according to the invention is characterized by the fact that it has some means of evacuation of the condensed water by suction at the outlets of the air flow channels.

[**0005**] According to a characteristic of the invention, the water accumulated at the ends of the channels is drawn through holes which join with a space in which a low pressure predominates.

[**0006**] The invention will be better understood and other aims, characteristics, details and advantages of it will be more clearly shown in the following explanatory description given in reference to the appended schematic drawings which are given only as examples, illustrating an embodiment of the invention and in which:

[**0007**] **FIG. 1** is a schematic perspective view of a heat exchanger according to the present invention;

[**0008**] **FIGS. 2 and 3** are perspective views, with part torn away, of two other embodiments of the heat exchanger according to **FIG. 1**, and

[**0009**] **FIGS. 4***a, d, c, d* are views in the direction of arrow of **FIG. 1** and show four configuration possibilities of water suction holes of the heat exchanger according to the invention.

[**0010**] As shown in the figures, a heat exchanger according to the present invention includes, superposed in an alternating and crossed manner, route **2** for the flow of a cooling fluid, such as water, and route **3** for the flow of a gaseous fluid such as air. Routes **2** and **3** are delimited between two walls **5** in the form of plates, which are parallel and rectangular. These routes are closed by lateral wall elements **7** on two opposite sides, and they are open on the other two parallel sides. The delimited space is subdivided into a number of flow channels **8** by parallel separation fins **9**. In the example represented in the figures, the fins are part of an insert made up of a sheet configured so as to have a zigzag profile. The insert can have any shape in the direction of the flow.

[**0011**] As seen in **FIG. 1**, in a heat exchanger according to the invention, the walls in plate form **5** extend a predetermined distance beyond ends **11** of the air flow channels, which are the ends of the insert delimiting these channels. This part of the plates is therefore free of fins. **FIG. 1** also shows that in water flow route **2**, space **15** between two spaces **14** is also free of fins **9**. This space **15**, delimited laterally by end wall **7** and by exterior fin **9** formed by the end limb of the insert or another end wall, is connected in a manner not shown to a[nother] space, also not shown, in which a low pressure predominates.

[**0012**] An essential characteristic of the invention lies in the fact that walls **5** have, in their fin-free part **14** near ends **11** of the air flow channels, through-holes **17** which then emerge in space **15** in which a low pressure predominates. These holes **17** are intended to permit the suction of the water condensed on the walls of the fins and the arrival [of the condensate] in the channels at ends **11** under the effect of the flow of water. This water is therefore evacuated by suction through-holes **17**. These holes **17** stop the accumulation of the condensate at ends **11** and thus the release of this water in the form of "spontaneous waves". The holes **17** are located a relatively short distance from the ends.

[**0013**] **FIGS. 2 and 3** show two particularly advantageous configurations of the ends of fins **9**. The objective of these configurations is to modify the geometry of the exchanger and to create pressure gradients in order to overcome the capillary forces which tend to retain the water on the fins. In the version represented in **FIG. 2**, the ends are curved or bowed in such a way that the median part of each fin is recessed, and the condensate is pushed by the air flowing in the channel towards the fin-free plate part **14** and thus in the direction of suction holes **17**. In the version according to **FIG. 3**, each fin end **11** is cut out at the top and at the bottom on **19** along an L-shaped line so that the median part has the shape of a U whose base **20** projects in the direction of the flow of the air. Suction holes **17** are made in plate parts **14** in the L-shaped cut-out zone.

[**0014**] This second variant amounts to putting holes **17** at the end of the air channels. It is also possible, however, to consider putting holes **17** farther upstream in the air channels in a line or distributed in such a way as to optimize the suction taking place, either in a separate space from the cooling channels or directly in the channels of the cooling fluid.

[**0015**] As an example, **FIG. 1** shows at **27**, holes which emerge in a cooling fluid channel. Of course, one could provide several lines of holes emerging in cooling channels, which differ and are offset in the direction of flow of the air. Thus, the invention provides suction openings at the site of the flow channel outlets **17** or suction openings emerging either in a cooling fluid channel as at **27** or in a slight low pressure space **15**.

[**0016**] **FIGS. 4***a* to **4***d* illustrate several embodiments of suction holes **17** to **27**. In **FIG. 4***a*, holes **17** are in the form of circular holes **22**. In **FIG. 4***b*, each hole has the shape of a roughly rectangular slit **23**. Three slits are aligned over the width of suction part **14**. In the version represented in **FIG. 4***c*, hole **17** has the shape of an S-shaped slit **24**. Over the width of suction part **14**, three slits **24** are aligned and arranged in such a way that their ends overlap in height. One thus obtains a suction effect over the whole width without interruption while avoiding mechanical weakening of the resistance of the wall.

[**0017**] The hole version according to **FIG. 4***d* has the particular characteristic that two parallel rows of holes are made in suction part **14**. The two series of holes are offset in such a way that a hole of one row is between two holes of the other row. These holes can of course have any suitable shape which can differ in the two rows. Thus, in **FIG. 4***d*, one row has circular holes **25**, and one row has triangular holes **26**.

[**0018**] Generally, the shapes of the ends of the fins and the shapes of the holes, which are represented in the figures, are only given as examples and can be modified provided that the suction of the water is ensured on the wall of the channels all along these channels and/or which would accumulate without evacuation through the holes at the ends of the fins. Of course, the cooling fluid could be of any other suitable nature and could be a cooling agent, any liquid other than water or even air.

1. A heat exchanger of the type which has at least one route for flow of a cooling fluid, such as water, a cooling agent or even air, and at least a second route for flow of a fluid such as air, at least the second route having a number of flow channels, characterized by the fact that it has some means of evacuation by suction of the water which condensed on the walls of the air flow channels.

2. A heat exchanger according to claim 1, characterized by the fact that the means of evacuation have suction openings **(17)** which join with the channels for flow of the cooling fluid.

3. A heat exchanger according to claim 1, characterized by the fact that the means of suction are provided at outlets **(11)** of gaseous fluid flow channels **(8)**.

4. A heat exchanger according to claim 3, characterized by the fact that the means of evacuation of the water have suction openings **(17)** provided at the site of outlets **(11)** of air flow channels **(8)**.

5. A heat exchanger according to claim 4, characterized by the fact that suction openings **(17)** join with space **(15)** in which a low pressure predominates.

6. A heat exchanger according to one of claims 1 to 5, in which air flow channels **(8)** are juxtaposed and formed between two roughly parallel plates **(5)**, characterized by the fact that these plates **(5)** extend at **(14)** beyond ends **(11)** of air flow channels **(8)** and by the fact that suction openings **(17)** are formed by through-holes which join with said low pressure space **(15)**.

7. A heat exchanger according to claim 6, characterized by the fact that the aforementioned space **(15)** is delimited in cooling water flow route **(2)** and by the fact that suction holes **(17)** emerge in this space **(15)**.

8. A heat exchanger according to either of claims **6** and **7**, characterized by the fact that ends **(11)** of walls **(9)** delimiting air flow channels **(8)** between two plates **(5)** have a shape which ensures routing of the condensate towards suction openings **(17)**.

9. A heat exchanger according to one of claims 6 to 8, characterized by the fact that ends **(11)** of delimiting walls **(9)** of flow channels **(8)** between two plates **(5)** have a curved shape so that the end is recessed in its median part.

10. A heat exchanger according to one of claims 6 to 8, characterized by the fact that end **(11)** of delimiting wall **(9)** of the air flow channels between two plates **(5)** is configured so that the median part projects in the direction of the flow of the air with respect to the parts adjacent to plates **(5)** and by the fact that suction openings **(17)** are provided roughly under the projecting parts.

11. A heat exchanger according to one of claims 6 to 10, characterized by the fact that suction holes **(17)** are formed by at least one series of holes **(22)** distributed over the width of projecting part **(14)** of plates **(5)**.

12. A heat exchanger according to one of claims 6 to 10, characterized by the fact that suction holes **(17)** are formed by at least one row of slits **(23)** aligned over the width of part **(14)** of plates **(5)**.

13. A heat exchanger according to claim 12, characterized by the fact that slit **(23)** has the shape of an S **(24)** and by the fact that the slits are aligned so that their ends overlap in height.

14. A heat exchanger according to claim 11, characterized by the fact that it has at least two rows of holes **(25, 26)**, of different shape if necessary, a hole of one row being in the middle of a hole two holes of another row.

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