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(54) **A heat exchanger**

(57) The invention relates to a heat exchanger 20 comprising a first set of tubes 23 enclosing a second set of fins 24, the first set of tubes cooperating with a manifold 21, characterized in that the fins of the second set are substantially meander-shaped having a number of substantially mutually parallel surfaces 22a, ...22n in a direction transverse to the meander propagation direction, wherein a depth profile 25 is provided in the said mutually parallel surfaces.

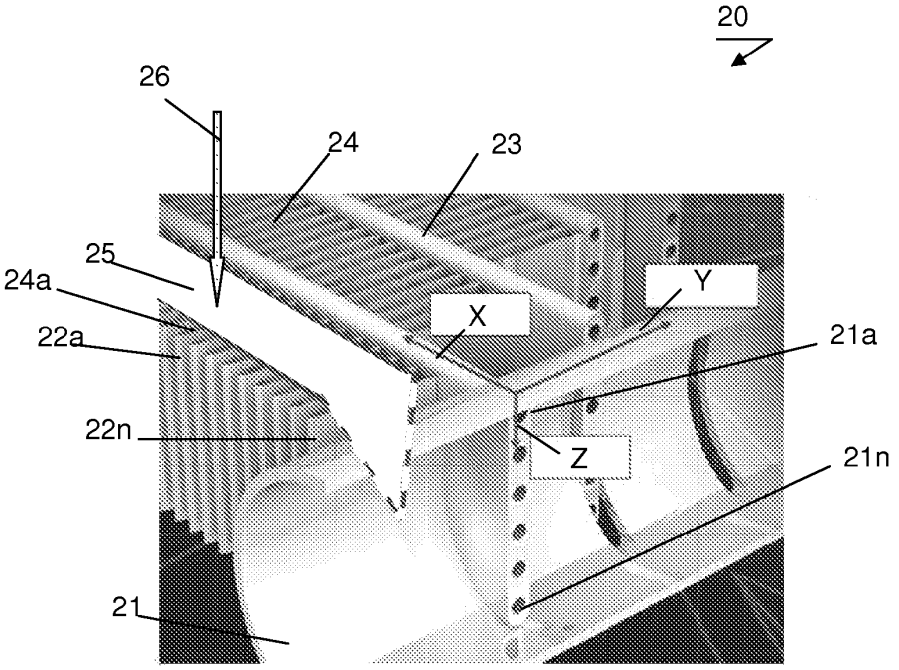

Fig. 2

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a heat exchanger, notably a micro-channel heat exchanger.

[0002] The invention further relates to an air conditioning system.

BACKGROUND OF THE INVENTION

[0003] An embodiment of a heat exchanger is known from US 7, 281, 387. The known heat exchanger comprises a plurality of parallel fins arranged between the adjacent tubes. The known fins have a substantially uniform depth and may be arranged in a suitable profile, like a zigzag between the adjacent tubes. An inflowing air stream impinging on the fins of the known heat exchanger is intercepted by the whole cross-section of the fin structure arranged between the tubes.

[0004] It is a disadvantage of the known heat exchanger that the relatively fine structure of the fin sequence is relatively sensitive for particle contamination present in the inflowing air stream. When such particle contamination is deposited on the fins or between the fins local efficiency of the known heat exchanger may be substantially reduced.

[0005] It is a still further disadvantage of the known heat exchanger that air cooling applications may be impeded by water condensing on the surfaces of the individual fins. The known fins structure is not able to drain this water, so it accumulates in the fine fin structure, thereby blocking the stream of the inflowing air.

[0006] It is a still further disadvantage of the known heat exchanger that for air cooling applications aiming at the target evaporator temperatures below zero degrees centigrade undesirable frost may be accumulated on the surfaces of the individual fins substantially reducing the overall efficiency of the heat exchanger. The fact that the known fin structure is not able to drain water well, defrost cycles are not effective. The melt water during the defrost cycle accumulates in the fine fin structure. Subsequently this water is transformed into substantially solid ice formations and blocking the air flow.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide a heat exchanger, notably a micro-channel heat exchanger with improved operational characteristics. In particular, it is an object of the invention to provide an improved heat exchanger, in particular it is an object of the invention to provide a heat exchanger having improved fin structure.

[0008] To this end the heat exchanger according to an aspect of the invention comprises a first set of tubes enclosing a second set of fins, the first set of tubes cooperating with a manifold, characterized in that the fins of the second set are substantially meander or canted -shaped having a number of substantially mutually parallel surfaces in a direction transverse to the meander propagation direction, wherein a depth profile is provided in the said mutually parallel surfaces.

[0009] An additional advantage is that the fin structure has a reduced resistance for the inflowing stream of air. It particular, it is found advantageous that the substantially parallel surfaces of the meander structure are shaped as respective openings diverging towards the external face of the heat exchanger conceived to intercept the inflowing stream of air.

[0010] In a particular embodiment of the heat exchanger the depth profile provided in the substantially parallel surfaces of the fins is V-shaped, having the wider portion of the V-shape at an external face of the heat exchanger conceived to receive an inflowing stream of air.

[0011] It is found that in this particular embodiment the heat exchanger is less sensitive to particle contamination present in the inflowing stream of air, which contributed to the improved operational characteristics of the heat exchanger according to the invention.

[0012] It is further found that the heat exchanger having the V-shaped depth profiles in the substantially parallel surfaces of the fins has an increased cooling capacity in condensing or frost accumulating conditions.. This may be explained by the fact that in the heat exchanger according to the invention an improved water draining capacity is achieved.

[0013] In a still further embodiment of the heat exchanger according to the invention the depth profile is provided for a portion of the said meander of canted shape.

[0014] It is found that for some circumstances it may be sufficient to provide the depth profile in the substantially parallel surfaces of the fins only for a portion of the fins forming the meander structure.

[0015] The invention further relates to an air conditioning device comprising the heat exchanger as is discussed with reference to the foregoing.

[0016] These and other aspects of the invention will be discussed with reference to drawings wherein like reference signs correspond to like elements. It will be appreciated that the drawings are presented for illustrative purposes only and may not be used for limiting the scope of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Figure 1 presents in a schematic way an embodiment of a known heat exchanger.

Figure 2 presents in a schematic way an embodiment of the heat exchanger according to an aspect of the invention.

Figure 3 presents in a schematic way an embodiment of the heat exchanger according to a further aspect of the invention.

Figure 4 presents in a schematic way a further embodiment of the heat exchanger according to a still further aspect of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0018] Figure 1 presents in a schematic way an embodiment of a known heat exchanger. The known heat exchanger 10 comprises a set of tubes 2 enclosing a set of fins 4, which may propagate according to a meander shape in a meander propagation direction M. The fins 4 in the meander structure form mutually substantially parallel surface 3a, ..., 3n, which are transversely arranged to the tubes 2. Preferably, the surfaces 3a, ...3n are substantially perpendicular to the tubes 2. The known heat exchanger 10 further comprises a manifold 8 comprising a set of channels 6.

[0019] It is found that the known heat exchanger has a limitation that the spaces between the substantially parallel surfaces 3a, ..., 3n may be polluted with particles present in the inflowing air thereby reducing cooling capacity of the known heat exchanger.

[0020] Figure 2 presents in a schematic way an embodiment, based on standard heat exchanger 10, of the heat exchanger 20 according to an aspect of the invention having a cross-sectional dimension X, Y and a depth dimension Z. The heat exchanger 20 comprises a set of tubes 23 enclosing the set of fins having the substantially parallel surface 22a, ..., 22n. The fins and the tubes are connected with the manifold 21 provided with channels 21a, ...21n.

[0021] In accordance with the invention the substantially parallel surfaces 22a, ..., 22n are provided with a depth profile 25, which has a wider portion at a face surface 24 of the fins conceived to intercept the stream of the inflowing air 26. It will be appreciated that the depth profile may have different shapes.

[0022] In accordance with the invention, the depth profile 25 provided in the parallel fins 22a, ..., 22n decrease the resistance for the inflowing air 26. In addition, the depth profile 25 ensures that the particles possible present in the inflowing air have a lower probability to deposit on the external face portion 24a and thereby to block the pathway of the inflowing air 26 towards the inner volume of the heat exchanger.

[0023] In accordance with the invention, the depth and slant profile 25 provided in the parallel fins 22a, ..., 22n increase the water drain capacity. In addition, with horizontal application of the heat exchanger, with het profiled air intake surface facing the ground, the gravity helps to drains the water so it drips of the point of the canted profile.

[0024] Accordingly, the heat exchanger of the invention has in practice an increased cooling capacity and an increased robustness with respect to operational malfunction.

[0025] Figure 3 presents in a schematic way an embodiment in a still different shape of the heat exchanger 30 according to an aspect of the invention. In the cross-sectional view shows the staggered tubes 37 with the parallelogram shaped fins having surfaces 32. Air can enter the heat exchanger with reduced flow resistance due to the V-shaped profile 36 and water drains itself easy from the projecting edge of the tube 37.

[0026] Figure 4 presents in a schematic way a further embodiment of the heat exchanger 40 according to a still further aspect of the invention. In this embodiment the tubes 42 and the fins 41 are affixed to the manifold 43. The fins 41 are provided with the depth profile (i.e. groove) as is discussed with the reference to the foregoing along the complete length of the meander structure having a suitable plurality of substantially parallel surfaces (not shown for clarity).

[0027] While specific embodiments have been described above, it will be appreciated that the invention may be practiced otherwise than as described. Moreover, specific items discussed with reference to any of the isolated drawings may freely be inter-changed supplementing each outer in any particular way. The descriptions above are intended to be illustrative, not limiting. Thus, it will be apparent to one skilled in the art that modifications may be made to the invention as described in the foregoing without departing from the scope of the claims set out below.

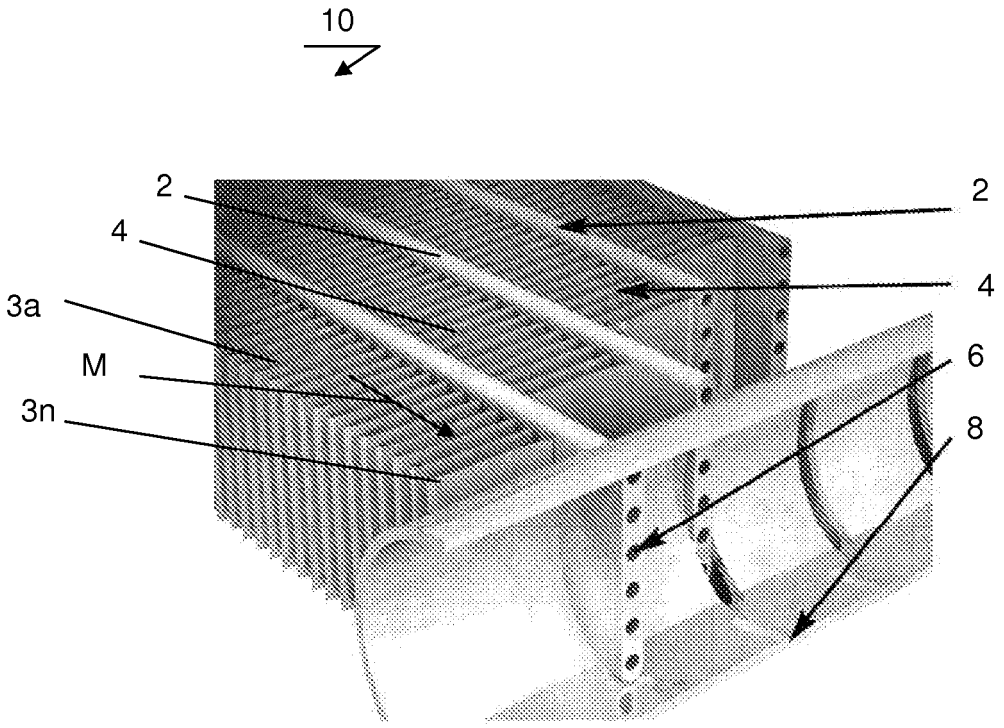
Claims

1. A heat exchanger comprising a first set of tubes enclosing a second set of fins, the first set of tubes cooperating with a manifold, **characterized in that** the fins of the second set are substantially meander or canted-shaped having a number of substantially mutually parallel surfaces in a direction transverse to the meander propagation direction, wherein a depth profile is provided in the said mutually parallel surfaces.

2. The heat exchanger according to claim 1, wherein the depth profile is V-shaped, having the wider portion of the V-shape at an external face of the heat exchanger conceived to receive an inflowing stream of air.

3. The heat exchanger according to claim 1 or 2, wherein the depth profile is provided for a portion of the said meander or canted shape.

4. An air conditioning system comprising a heat exchanger according to any one of the preceding claims.



PRIOR ART

Fig. 1

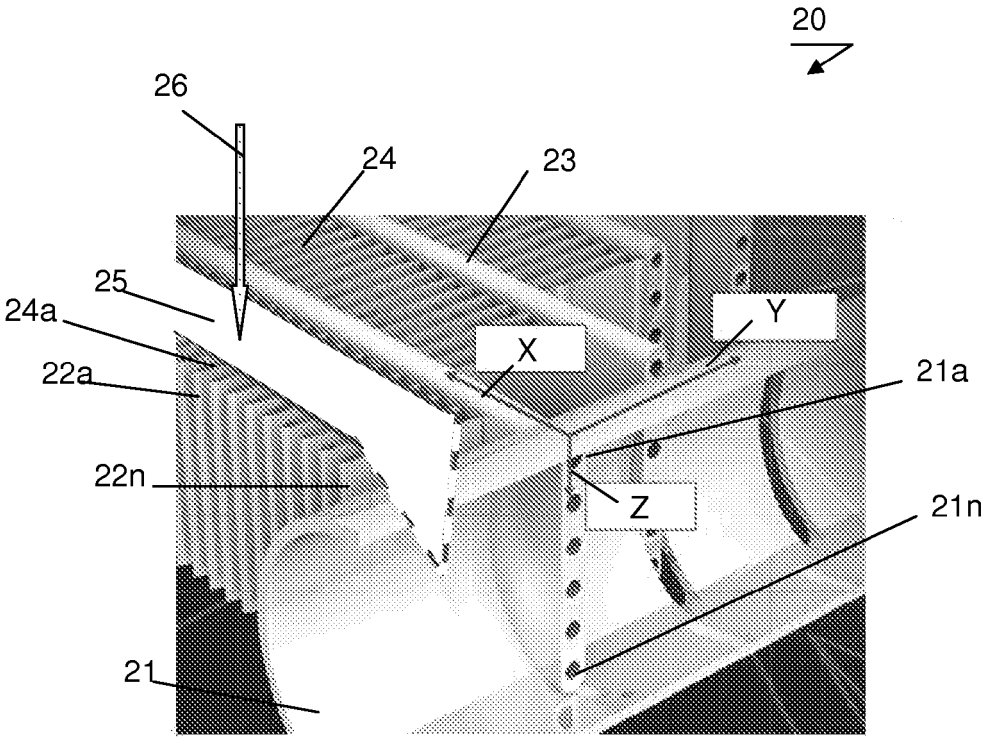


Fig. 2

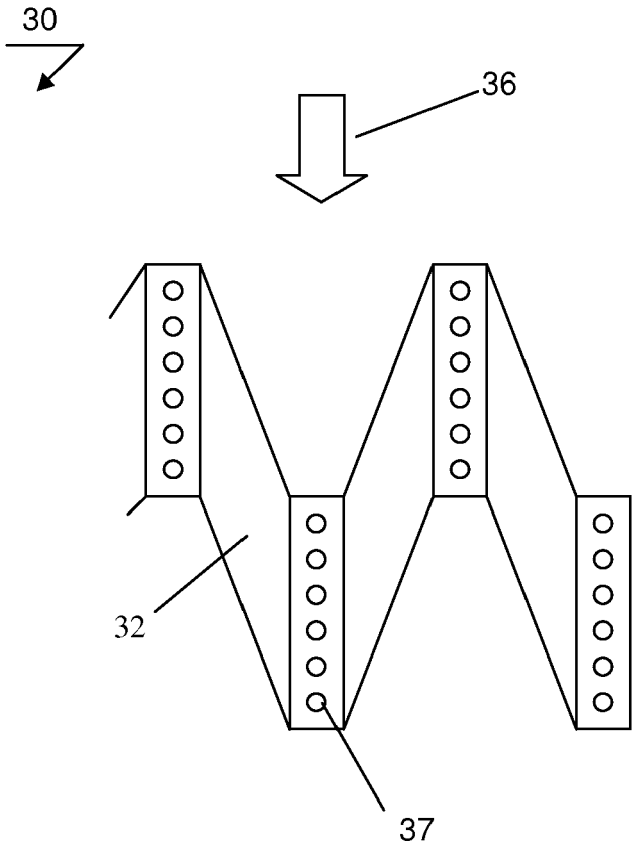


Fig. 3

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 3491

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	US 2010/006276 A1 (CREMASCHI LORENZO [US] ET AL) 14 January 2010 (2010-01-14) * abstract; figure 19 * * paragraph [0075] *	1,3,4	INV. F28F1/12 F28F17/00
X	WO 2011/034633 A1 (CARRIER CORP [US]; TARAS MICHAEL F [US]; ESFORMES JACK LEON [US]; MEHE) 24 March 2011 (2011-03-24) * abstract * * figure 4 *	1,3,4	
X	JP 58 160797 A (NIPPON LIGHT METAL CO) 24 September 1983 (1983-09-24) * abstract; figure 6 *	1-4	

TECHNICAL FIELDS SEARCHED (IPC)

F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 August 2011	Bain, David

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 16 3491

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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17-08-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010006276 A1	14-01-2010	NONE	
WO 2011034633 A1	24-03-2011	NONE	
JP 58160797 A	24-09-1983	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 7281387 B **[0003]**