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(54) Finned-tube cross-flow heat exchanger

(57) The present invention refers to a finned-tube cross-flow heat exchanger, which comprises a plurality of tubes, through which a first fluid flow is circulated, and a plurality of fins (10) arranged across, i.e. transversally to said tubes. The fins are integrally provided with apertures for said tubes to pass therethrough, as well as with ventilation slits for a second fluid flow to circulate therethrough.

The ventilation slits (211-214) are collected into groups (20) and are provided in a side-by-side arrangement, duly spaced from each other, between the apertures (11, 12) of a same fin, in such a direction as to be capable of intercepting the flow (F) of the second fluid.

Advantages: Improved heat-exchange coefficient deriving from a more marked turbulence being induced in the second fluid flow; reduced scaling of the surfaces of the fins owing to the particular form and arrangement of the slits.

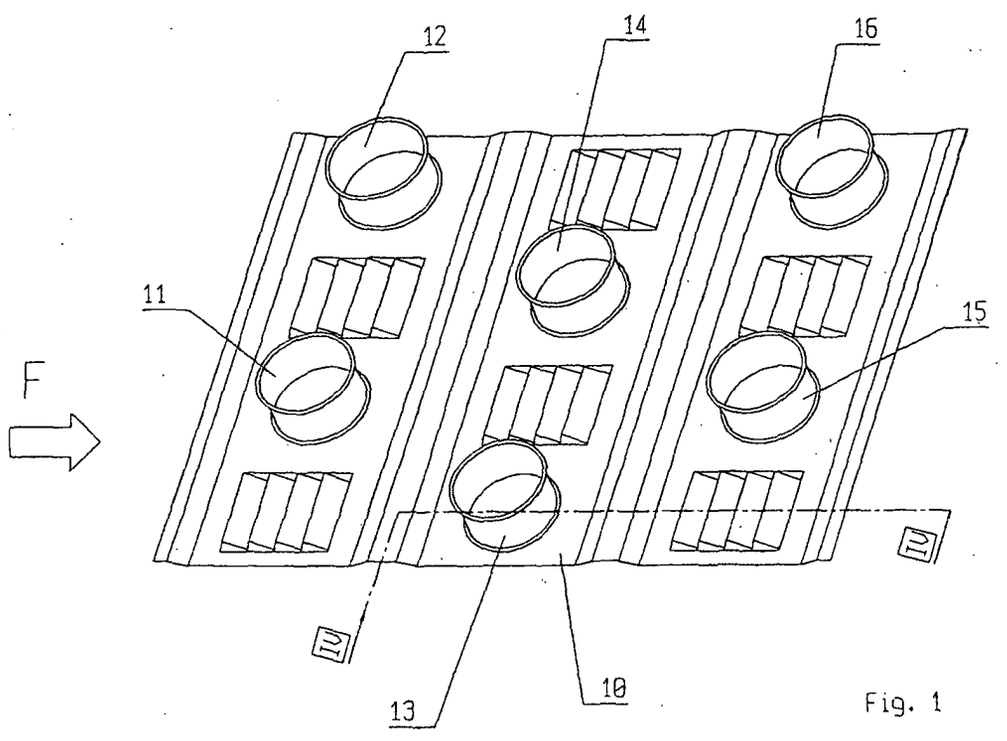

Fig. 1

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Description

[0001] The present invention refers to a finned-tube cross-flow heat exchanger comprised of a plurality of tubes extending parallel to each other, and a plurality of external fins that extend substantially parallel to the tubes transversally thereto. The fins are provided with a plurality of generally collar-shaped apertures, which are passed across by the tubes and are in a heat-conducting contact therewith.

[0002] Heat exchangers of such kind are made through the use of tubes, which may for instance be made of copper, and fins that are usually formed by aluminium foils with a thickness of as low as 0.1 mm. Through the tubes there is circulated a first fluid flow, such as for instance water or water mixtures or a coolant medium, whereas a second fluid flow, which may for instance be a forced air flow, is circulated through the fins in a transverse direction with respect to the tubes themselves.

[0003] Considerable efforts are largely known to be currently made by heat-exchanger manufacturers in view of reducing the number and the diameter of the tubes in order to make heat exchangers to as compact as possible a size, i.e. to minimize both space requirements and the overall weight of such heat exchangers, as well as in view of limiting air-pressure drops across the fins so as to be able to reduce the power rating of the related fan and, therefore, the overall energy usage. To this purpose, it has proved advantageous to also provide the fins with a plurality of ventilation slits. Such ventilation slits are obtained by cutting out the fins in the spaces comprised between the apertures for the tubes, and are bent at definite angles relative to the lying plane of the fins themselves.

[0004] These slits are effective in creating a number of continuous and repeated interruptions in the boundary layer of the air flow, thereby converting it into a turbulent flow, in order to boost the heat-exchange effect between the two fluids inside the heat exchanger.

[0005] A significant review of the later developments in this particular field of the related art can be derived from the volume "Recent Developments in Finned-Tube Heat Exchangers - Theoretical and Practical Aspects" by A. Auracher et al., pp. 126-133, and the publication "The effect of Lances on Finned-Tube Heat Exchanger Performance" by V. Kadambi, ASHRAE Transactions no. 2741.

[0006] Following characteristics emerge from the above-cited literature as far as ventilation slits are concerned:

- ventilation slits, substantially equal in length, are collected into groups;
- the same slits are bent into both a V-shape and a W-shape, when viewed from the front;
- V-shaped ventilation slits are alternated "symmetrically" with W-shaped ventilation slits in the overall arrangement, so that the number of ventilation slits is in all cases even and equal in each group.

[0007] It is the main object of the present invention to provide a finned-tube cross-flow heat exchanger, in which the construction of the ventilation slits in the fins is such as to enable the heat-exchange effect between the fluids to be further improved over the one ensured by the heat exchangers cited in the above-indicated literature. This aim is reached in a heat exchanger as defined in the appended claims.

[0008] Features and advantages of the heat exchanger according to the present invention will anyway be more readily understood from the description of a preferred embodiment thereof that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a perspective view of a portion of a heat exchanger according to the present invention;
- Figure 2 is a partial top view of the heat exchanger shown in Figure 1, illustrating the various groups into which the ventilation slits are collected;
- Figure 3 is a cross-sectional view of a heat-exchanger portion along the line IV-IV of Figure.

[0009] As a preliminary remark, it should be noticed that, in the above-noted drawings, a representation of the heat-exchanger tubes, through which a first fluid flow is circulated and which are an integral part of the same heat-exchanger, has been intentionally omitted on the ground that they are by no means involved or even affected by the innovatory features of the present invention.

[0010] The heat exchanger, a portion of which is illustrated in Figure 1, comprises a surface formed by fins 10, which may for instance be constituted by a thin aluminium plate, or aluminium foil, having a thickness of approximately 0.1 mm. This surface is provided with a plurality of circular apertures provided with a collar for the heat-exchanger tubes to pass therethrough in a state of heat conduction. Only six of such apertures, as indicated by the reference numerals 11, 12, 13, 14, 15 and 16, are represented in Figure 1. The arrangement of these apertures further indicates that, in a fully conventional manner, the tubes within the heat exchanger are arranged in rows and ranks. The rows are arranged in the flow direction F of the second fluid in the heat exchanger, whereas the ranks are arranged perpendicularly to said flow direction F.

[0011] In the spaces that are comprised between the above-noted apertures, each fin 10 is provided with a plurality of ventilation slits, which are obtained by cutting out the plate forming the fin 10 and bending the cutout

portion with respect to the plane of the same plate, as this has already been noted hereinbefore, with the use of such techniques and tools as largely known to those skilled in the art.

[0012] According to an essential feature of the present invention, the ventilation slits of each group situated between two adjacent tubes are subdivided into an even or odd number of sub-groups, each such sub-group being formed by an again even or odd number of ventilation slits. For reasons of greater simplicity, reference numerals have only been used in the Figures to indicate those ventilation slits that are shown to be comprised between the two adjacent apertures 11 and 12, relating to the same rank of tubes.

[0013] More specifically, the reference numeral 20 is used to generally indicate the group of ventilation slits that are situated between the two adjacent apertures for the tubes 11 and 12, whereas the reference numerals 211, 212, 213 and 214 are used to indicate the four slits that form said group (see Figure 2). The various sub-groups 20 of ventilation slits turn therefore out as lying spaced from each other in a side-by-side arrangement in the direction in which said second fluid is caused to flow.

[0014] It should be noticed that, in an advantageous manner, all above-mentioned ventilation slits are equally sized in both their width and length, i.e. have the same width and length, as measured on the drawing plane of Figure 2. These geometrical characteristics contribute to facilitating production of the fins and, as a result, of the entire heat exchanger.

[0015] Furthermore, all ventilation slits have advantageously the same shape, when viewed from the front, i. e. on a plane that is perpendicular to the direction of the arrow F (Figure 1), which indicates the flow direction of the second fluid in the heat exchanger. It therefore ensues that, according to the present invention, the flow-path followed by the second fluid in the heat exchanger, i.e. the fluid that flows over and along the fins of the heat exchanger, is subjected to a sequence of impingements and localized diversions or deviations by the ventilation slits themselves, which, by rupturing the boundary layer of said flow, increase the turbulence thereof and, as a result, enhance the overall heat-exchange efficiency. Figure 3, which is a partial cross-sectional view of the heat exchanger illustrated in Figure 1, is quite explanatory in this connection.

[0016] Experimental work carried out by the Applicant has demonstrated that, in a heat exchanger using a halogen as a first medium, i.e. inside the tubes, and forced air as a second fluid flowing over and along the fins 10, improvements ranging from approximately 20 to 20 percent can be obtained in the heat-exchange efficiency, i. e. the "air-side" heat-exchange coefficient (depending on the number of tube ranks, the spacing of the fins from each other, and the front air velocity in the direction F - see Figure 1).

[0017] This result can be ascribed to the main features of the present invention, i.e. the fact of having (in each one of the groups comprised between the apertures of two adjacent tubes) the ventilation slits in the form of air-intake provisions subdivided into an even or odd number of sub-groups, in the flow direction of the second fluid in the heat exchanger. The efficiency of the "air side" heat exchange is preserved for a long time thanks to the shape that has been specially worked out for the slits so that they will not retain dust, particles or any other kind of dirt that may be carried by the air threads flowing through the same slits.

[0018] In other words, the particularly advantageous results of the present invention practically derive from the particular arrangement of the ventilation slits that are so provided in the fins 10 of the heat exchanger.

[0019] It will be readily appreciated that other embodiments may of course be implemented, based on the same features and characteristics as mentioned above, by those skilled in the art without departing from the scope of the present invention. In particular, the tubes forming a heat exchanger according to the present invention may be arranged according to any spatial configuration, and may be further be made of copper or any other similar or suitable material. Similarly, the fins arranged transversally with respect to the tubes may be of aluminium or any other similar or suitable material.

Claims

1. Finned-tube cross-flow heat exchanger comprising a plurality of parallel tubes arranged in rows and ranks for a first fluid flow to be circulated therethrough, and a plurality of fins (10) extending parallel to each other and arranged transversally with respect to said tubes, said fins being integrally provided with apertures (11, 12, 13, 14, 15, 16), for said tubes to pass therethrough, and ventilations slits provided in the spaces comprised between said apertures for a second fluid to flow therethrough, **characterized in that** the ventilation slits (211, 212, 213, 214) in the fins (10) are collected into groups (20) and are arranged in a direction so as to be able to intercept the flow (F) of the second fluid.

2. Finned-tube cross-flow heat exchanger according to claim 1, **characterized in that** in the space comprised between two consecutive ranks (11, 12) of tubes, the fins (10) are provided with an even or an odd number of sub-groups (20) of ventilation fins, each sub-group comprising an even or an odd number of slits.

3. Finned-tube cross-flow heat exchanger according to claim 1 or 2, **characterized in that** all ventilation slits (211-214) are substantially equal in both their width and their length, as measured on the lying plane of the fin (10).

4. Finned-tube cross-flow heat exchanger according to any of the preceding claims, **characterized in that** the tubes for the circulation of the first fluid are made of copper, or a similar metal, and are spatially arranged in any suitable geometrical configuration, whereas the fins (10) are constituted by thin plates of aluminium or similar material.

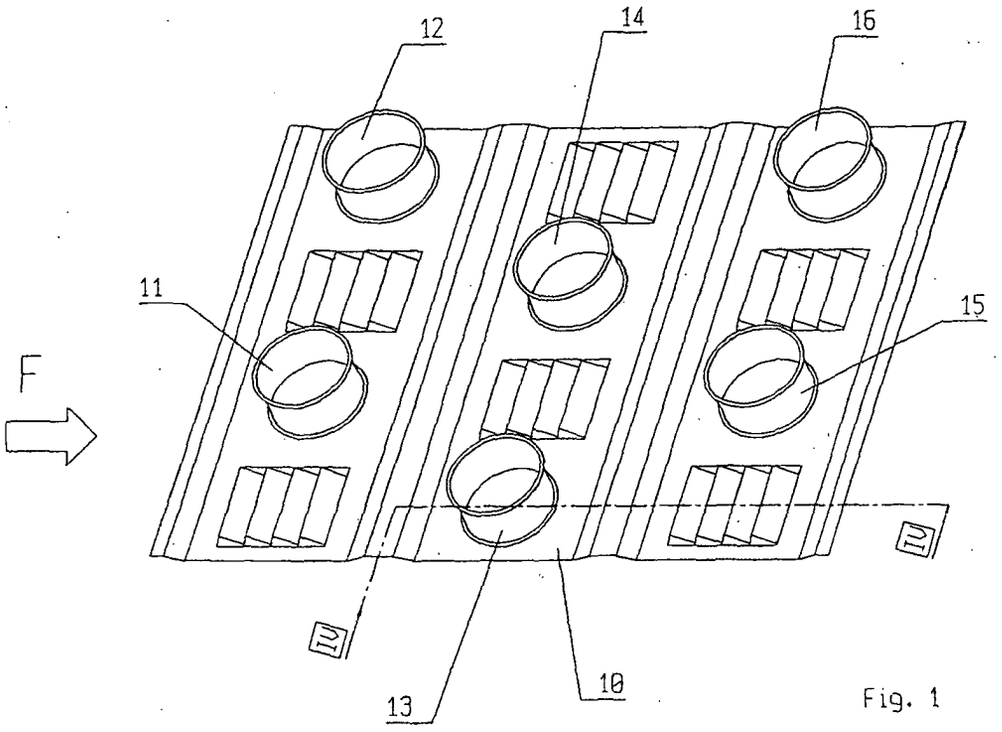

Fig. 1

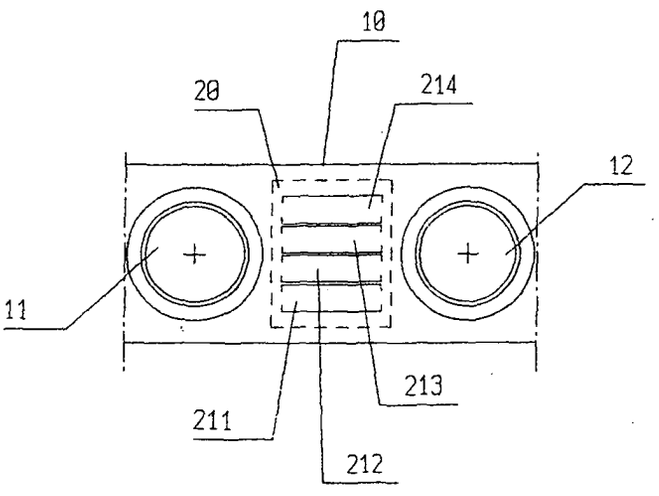

Fig. 2

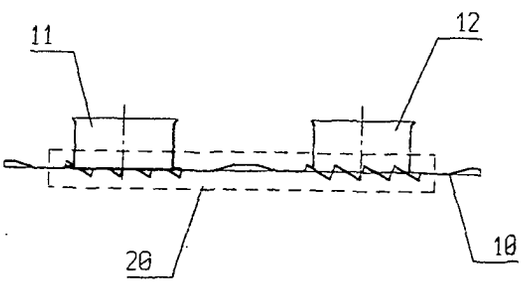

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 04 00 2280

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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X	JP 62 147290 A (FUJITSU GENERAL LTD) 1 July 1987 (1987-07-01) * abstract *	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7) F28F F28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	7 June 2004	Mellado Ramirez, J

CATEGORY OF CITED DOCUMENTS

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