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(54) HEAT EXCHANGER UNIT

(57) Heat exchanger unit (1) comprising a casing (2) defining a duct to be flown through by a fluid, a fan (20) disposed in the casing (2) and configured to induce a flow of the fluid through the duct in a flow direction (F), a heat exchanger (5) being V-shaped in side view with an apex (8) at one end and an opening (12) at the opposite end, the heat exchanger (5) being disposed in the duct with the opening (12) directed towards the flow direction (F), wherein a line (CL) passing the apex (8) of the V-shaped heat exchanger (5) in the side view extends horizontally, wherein the fan (20) is disposed downstream of the heat exchanger (5) in the flow direction (F).

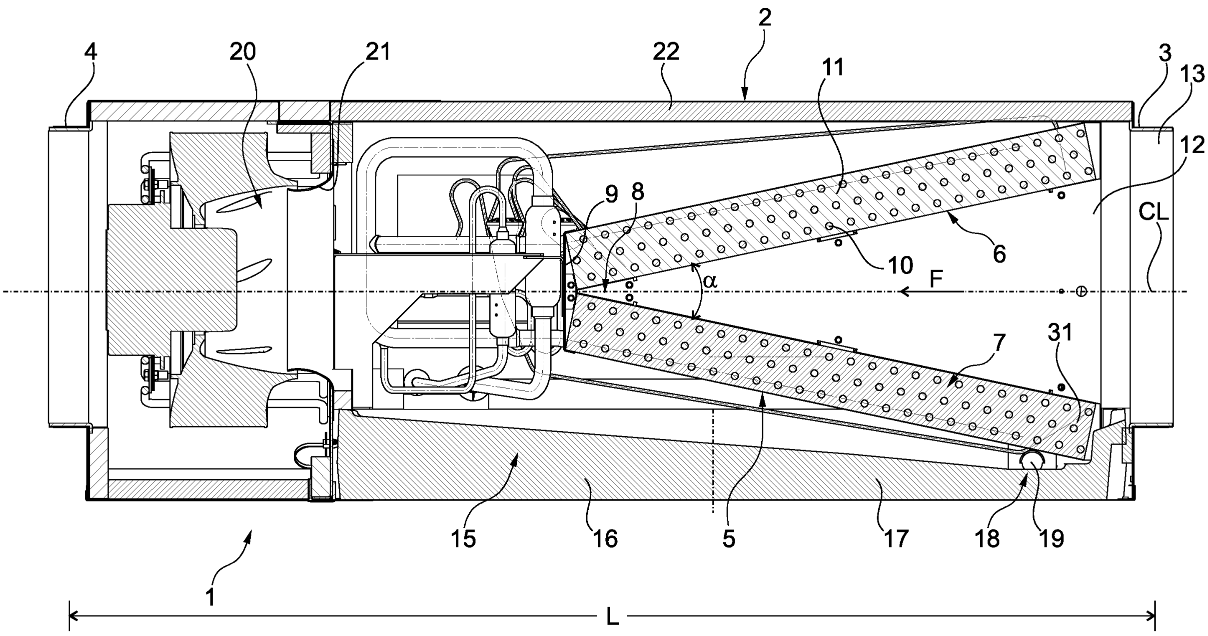

Fig. 3

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Description

Technical Field

[0001] The present invention relates to a heat exchanger unit for an air conditioner. In particular, the heat exchanger unit is of a kind that may be installed at, e.g. hidden behind, a ceiling of a building or any other location providing for a limited installation space, particularly a limited height. Heat exchanger units of this type are often also called duct-type heat exchanger units, which are connected to and form part of an air duct of an air conditioner.

Background

[0002] An example of such heat exchanger unit is known from EP 2 108 897 A1 disclosing a heat exchanger unit having an L-shaped heat exchanger laying on its side, wherein air is flown through both legs of the "L". Such a heat exchanger, however, provides for a relatively small heat exchange surface in combination with a relatively uneven distribution of air flowing through the heat exchanger (uneven air distribution). In addition, the height of the heat exchanger unit is relatively large, because the legs of the "L" shaped heat exchanger are arranged with their width oriented vertically.

[0003] A heat exchanger unit providing for a larger heat exchange surface and a lower height is disclosed in EP 2 402 669 A2. This heat exchanger unit implements a V-shaped heat exchanger with a central axis of the "V" oriented horizontally. Thereby, the height of the heat exchanger can be reduced at the same time increasing the heat exchange surface. Yet, the air distribution of air flowing through the heat exchanger is still relatively uneven, because the air is blown by a fan towards the apex of the "V" leading to reduced heat exchange efficiency.

Brief description of the invention

[0004] In view of the aforesaid, it is the object of the present invention to provide a heat exchanger unit being improved with respect to its heat exchange efficiency.

[0005] This object is solved by a heat exchanger unit as defined in claim 1. Embodiments of the invention are named in the dependent claims, the following description and the accompanying drawings.

[0006] According to one aspect, a heat exchange unit is suggested comprising a casing having a duct to be flown through by a fluid, particularly air (in the following reference is made primarily to air only, but it is to be understood that other fluids may as well be used). The casing is particularly configured to be connected to a fluid path, particularly an air duct, e.g. connecting to a space to be conditioned or a heat source, particularly outside air. As such, the casing will be part of the fluid path.

[0007] Further, a fan is disposed in the casing. Certainly, more than one fan may be provided. In this instance, it is desirable that the center axes of the fans are aligned and positioned on a horizontal line. The fan or fans are configured to induce a flow of the fluid through the duct in a flow direction.

[0008] Moreover, a heat exchanger is provided within the duct and to be flown through by the fluid flowing through the duct by means of the fan/-s. Preferably, the heat exchanger is disposed in the duct so that no air may bypass the heat exchanger. In other words, the heat exchanger is disposed in the air duct so that the entire amount or at least a major part of air flowing through the duct also passes through the heat exchanger. The heat exchanger is V-shaped in a side or cross-sectional view with an apex at one end and an opening at the opposite end. The angle of the "V" may be adjusted as needed. The larger the angle, the better for achieving even air distribution and good efficiency. The smaller the angle, the better for obtaining a low height. According to one example, the heat exchanger may comprise two planar or plate shaped heat exchange elements which are positioned so as to form the "V". These elements may be fluidly connected by refrigerant piping to be flown through by refrigerant preferably in parallel. Further, these elements may be defined as an upper heat exchange element and a lower heat exchange element. The terms "upper" and "lower" in this context refer to a line passing the apex and extending horizontally in use. In certain embodiments, this line may be a centerline or a line of symmetry of the heat exchanger when seen in the side view. In this particular embodiment, the heat exchanger is disposed in the duct with the opening of the "V" being directed towards the flow direction. In other words, the flow of the fluid through the duct enters the heat exchanger via the opening of the "V".

[0009] Furthermore, the fan or fans is/are disposed downstream of the heat exchanger in the flow direction. To put it differently, the fan is disposed further away from the opening than the apex of the heat exchanger or is disposed on a side of the apex of the "V" of the heat exchanger.

[0010] Because the fan is disposed downstream of the heat exchanger in the flow direction, it can be ensured that fluid is passing the whole or at least a major part of the heat exchanger at a relatively even amount distributed over the heat exchange surface of the heat exchanger (air distribution). In particular, the fan establishes a lower pressure on the side downstream of the heat exchanger. Therefore, air is sucked into the duct from an upstream side of the heat exchanger flowing into an inlet opening of the duct and hence into the opening of the "V" of the heat exchanger more evenly. As a result the amount of air is not as concentrated on a particular portion of the heat exchanger as in the prior art. Hence, a more even air distribution and thus higher efficiency may be achieved.

[0011] According to one embodiment the heat exchanger is symmetric in the side view. In particular, it is desired that a line of symmetry of the heat exchanger in the side view extends horizontally. In this context, the upper and lower heat exchange elements are preferably identical or at least substantially identical. All these measures assist in obtaining an even air distribution.

[0012] In this context it is also desired that the center axis of the fan or fans, particularly their suction opening/-s is located on a line parallel with the line of the V-shaped heat exchanger particularly its centerline or line of symmetry. According to a preferred embodiment, the center axis of the fan or fans, particularly their suction opening/-s is located on a common line with the line of the V-shaped heat exchanger particularly its centerline or line of symmetry in the side view.

[0013] According to an aspect, the fan or fans is/are a backward curved centrifugal fan. As previously described, the heat exchanger unit is disposed in a fluid path (air duct). The heat exchanger unit is further preferably used as part of a heat source unit (also known as outdoor unit even if disposed indoors) and may be combined with a compressor or a separate compressor unit to constitute the "outdoor unit". In these appliances, a relatively large pressure drop has to be overcome because of fences and filters. Therefore a relatively high ESP (external static pressure) is required. In addition a relatively high airflow is required so as to enable the use in an air conditioner supplying a plurality of indoor units disposed in the spaces to be conditioned. In this context, normal outdoor units provide for an air flow of 120 m^3 per minute, whereas common indoor units provide for an air flow of 30 m^3 per minute. The appliance of the heat exchanger unit as described above only requires a lower flow rate as compared to normal outdoor units but a higher flow rate as compared to usual indoor units. The use of a backward curved centrifugal fan is desirable to achieve a relatively high ESP and air flow rate with high-efficiency. An additional requirement for the heat exchanger unit to be placed in the ceiling is that the whole unit and also the fans have to be restricted in regard of weight and size. In addition, the fluid flow rate needs to be adjustable. Also these requirements can be met by the use of a backward curved centrifugal fan.

[0014] In one embodiment, the flow rate to be induced by the fans resides between about 60 m^3 per minute and 100 m^3 per minute and preferably about 60 m^3 per minute and 85 m^3 per minute. This may efficiently be obtained with one or more backward curved centrifugal fans. In addition, the flow rate should also be adjustable in the aforesaid ranges.

[0015] The use of a plurality of backward curved centrifugal fans further provides for a reduced overall fluid speed in the high velocity zones of the fans. Accordingly, the fans may be positioned closer to the heat exchanger without condensation water formed on the outer surface of the heat exchanger being drawn into the fans. By positioning the fans closer to the heat exchanger, a more compact heat exchanger unit as regards its length may be achieved. In particular embodiments, the apex must stay away from the fan between 20 and 30 cm to avoid water from being sucked into the fan at a flow rate of 85 m^3 per minute when two backward curved centrifugal fans are used. In addition, the use of a plurality of fans leads to less noise because each fan may be driven at a lower RPM to reach a certain air flow rate as compared to the use of fewer fans to reach the same air flow rate.

[0016] According to an even further aspect, the heat exchanger comprises an air impermeable connecting element connecting an upper and a lower heat exchanger portion, for example the upper and lower heat exchanger element described above. The connecting element is disposed at the apex and configured to block the flow of fluid through the heat exchanger at the apex, particular the tip of the apex. An area is created at the apex of the heat exchanger, particularly if planar shaped heat exchanger elements are used, which is not capable of effectively exchanging heat. By blocking the flow of fluid through this portion by means of the connecting element, the flow rate at the apex is decreased. Thereby the fluid distribution of fluid flowing through the remaining portions of the heat exchanger is improved. More particular, the connecting element forms a barrier creating a higher pressure drop at the apex causing the reduction in air flow through the apex. Without the connecting element, the air flow flowing through the apex may become too high. In addition, the connecting element may preferably be used to physically connect the upper and lower heat exchanger elements at the apex and thus, improve rigidity of the heat exchanger.

[0017] It is preferred that the connecting element extends beyond the apex of the heat exchanger covering a part of a lower surface of the lower portion of the heat exchanger, particularly the lower heat exchanger element. In use, condensation water is formed at the outer surface of the heat exchanger which tends to flow along the surfaces of the heat exchanger downwards. By extending the connecting element beyond the apex so that it covers a part of a lower surface of the lower portion of the heat exchanger, this condensation water is guided away from the apex or front portion of the heat exchanger by the extended portion of the connecting element. Thereby, it can be prevented that water drops fall down from the heat exchanger at the apex. This is particularly in case of the arrangement of the fan downstream of the heat exchanger close to the apex. If water drops down from the apex or other portions near the fan, water may be drawn into the fan and, therefore, into the fluid path (air duct). In the best case, the above configuration guides the water along the lower surface of the lower heat exchanger portion to the very end of the lower heat exchanger portion at the opening of the heat exchanger. As a drain pan will be positioned below the heat exchanger (see below) and because of the "V", the distance between the very end of the lower heat exchanger portion and the drain pan will be minimal over the length of the heat exchanger and the drain pan. Therefore, any risk of water being drawn into the fans and, hence, the air duct can be surely prevented.

[0018] The use of a V-shaped heat exchanger with the direction of fluid flow toward the opening of the V-shaped heat exchanger may result in a relatively low air flow rate at the entry portion of the heat exchanger near the opening. In order to improve the fluid distribution through the legs of the heat exchanger, particularly the upper and lower heat exchanger element, particularly near the opening, a guide blade may be provided and positioned between the opposite ends in the horizontal direction, i. e. between the apex and the opening, of the heat exchanger. According to one aspect, the guide blade is oriented lengthwise between the opposite ends particularly closer to the apex than to the opening. In one embodiment, the guide blade may be fixed at its ends in the width direction to the casing. According to an embodiment, the guide plate has no physical contact with the heat exchanger particularly the fins of the heat exchanger. Such a guide blade has been proven particularly advantageous at higher flow rates which are particularly necessary if the heat exchanger unit of the present invention is used as an outdoor unit (see above), however being positioned indoors. Yet, the guide plate may also be used for indoor units of air-conditioners. Thus, the guide plate contributes to an increased efficiency of the heat exchanger. Such a guide blade is particularly preferred when the heat exchanger unit is used in cooling only applications of the air conditioner or as an indoor heat exchanger (of an indoor unit) in heat pump applications. Otherwise a risk may exist that ice formed on the surface of the upper heat exchanger element facing the guide plate falls down onto the guide plate during defrosting operation and blocks the flow path through the heat exchanger.

[0019] To provide for an even air distribution through the upper and lower heat exchanger portion or element it is beneficial that the guide blade has an airfoil with a line of symmetry being aligned with the line, particularly the centerline or line of symmetry of the heat exchanger.

[0020] Further the guide blade has been proven to be most effective if the guide blade has a leading edge directed towards the flow direction and being pointed (sharp). One particularly advantageous shape of the guide plate is an airfoil in the shape of a dolphin flipper fin.

[0021] Further, the effect of the guide blade is most effective if the blade is positioned as close as possible to the heat exchanger. However the effect again diminishes when the guide blade is positioned closer than 15 mm to the heat exchanger.

[0022] In order to collect condensation water formed on of the outer surfaces of the heat exchanger, the heat exchanger unit according to an aspect further comprises a drain pan. The drain pan may be a drain pan which needs to be manually removed and emptied or drain pan that is connected to drainage.

[0023] It is preferred that the drain pan has a lowest position. If the drain pan is connected to drainage, a drain opening is disposed at the lowest position. According to an aspect it is preferred that the lowest position and if present the drain opening is disposed in that half of the drain pan away from the fan seen in the flow direction. In particular, the drain pan extends in a direction away from the fan. If the drain pan in this extension direction is separated into halves, the lowest position is positioned in that half that is further away from the fan than the other half. Furthermore, the drain pan is particularly designed so as to guide water accumulated in the drain pan away from the fan to its lowest position and if present the drain opening. According to a further aspect the lowest position of the drain pan is matched with the lowest corner (very end) of the heat exchanger, particularly the lower corner (very end) of the lower heat exchanger element. Thus, the drain pan may even be used to support the heat exchanger and it can be ensured that water is guided by the lower heat exchanger element directly to the lowest position of the drain pan (see above).

[0024] According to a further aspect, the heat exchanger unit further comprises an insulation (thermal and/or sound) disposed on an opposite side of the heat exchanger relative to the drain pan. In order to obtain a duct which is as symmetric as possible in order to obtain an as even as possible air distribution through the heat exchanger, it is preferred that the surfaces of the insulation and the drain pan directed toward the heat exchanger have approximated, preferably identical shapes. Particularly in combination with the connecting plate, the pressure within the "V" may be balanced with the result of a more even fluid flow distribution.

[0025] Furthermore and in order to further prevent water from dropping from the heat exchanger close to the fan it is preferred to use waffled fins for the heat exchanger or at least one of the upper and lower portion (element) of the heat exchanger. In this context, the heat exchanger or heat exchanger elements each comprise loops of tubing with fins being interposed between the tubing. These fins are preferably waffled fins without any openings formed in the fins itself.

[0026] Further features and effects of the heat exchanger unit may be obtained from the following description of embodiments. In the description of these embodiments reference is made to the accompanying drawings.

Brief description of drawings

[0027]

Figure 1 shows a perspective view of a heat exchanger unit from one side;

Figure 2 shows a perspective view of the heat exchanger unit of figure 1 from the opposite side;

Figure 3 shows a longitudinal section through the heat exchanger unit along a line cutting a center of one of the fans; and

Figure 4 shows a simulation of air distribution over the heat exchanger in a) a heat exchanger without a guide blade, b) a heat exchanger with a pointed guide blade and c) a heat exchanger with a dolphin flipper fin shaped guide blade.

Description of embodiments

[0028] Figures 1 and 2 show a heat exchanger unit 1 in accordance with one embodiment.

[0029] The heat exchanger unit 1 comprises a casing 2 being configured for connection to an air duct of an air conditioner. In particular, the heat exchanger unit is configured as an "outdoor" unit of an air conditioner which is however disposed inside particularly within ceiling of a building. Hence a first connection 3 is provided at the casing 2 for connection to an air duct communicating the heat exchanger unit 1 with the outside of the building and so as to enable sucking of outdoor air into the casing 2. A connection 4 provided for the connection of the heat exchanger unit 1 to the air duct again leading to the outside of the building and to enable blowing out of air having parsed the heat exchanger 5 to the outside is disposed at the opposite end of the casing 2.

[0030] The casing is substantially rectangular and flat, meaning that the height H is a smaller than the width W and the length L. In one embodiment the height H is not more than 500 mm, preferably not more than 450 mm, more preferably not more than 400 mm and most preferred not more than 350 mm.

[0031] The heat exchanger unit 1 further comprises a heat exchanger 5 which is also visible in figure 1. However, the configuration of heat exchanger 5 can be best seen from figure 3. Figure 3 also represent a side view of the heat exchanger 5.

[0032] The heat exchanger 5 comprises an upper heat exchanger element 6 and a lower heat exchanger element 7. Both, the upper and lower heat exchanger elements 6, 7 are flat or planar shaped and are positioned with an angle α enclosed between them. Hence the heat exchanger 5 has a V-shape wherein the "V" is oriented horizontally. A line CL passing the apex 8 of the "V" is oriented horizontally, that is along the length L extension of the heat exchanger unit 1. The line CL is also the centerline of the heat exchanger 5 or to put it differently a line of symmetry of their off as regards the heat exchanger elements 6, 7.

[0033] Heat exchanger 5 is arranged within the air duct formed by the casing 2 so that all air sucked in through the opening at the connection 3 has to flow through the heat exchanger 5 without any air bypassing the heat exchanger 5 at the top or the bottom or the sides of the heat exchanger 5 in the width direction W.

[0034] The upper and lower heat exchanger elements 6, 7 are connected to each other at the apex 8 by a connecting element 9. The connecting element is impermeable to air and also used to mechanically or physically connect the upper and lower heat exchanger elements 6, 7. Each of the heat exchanger elements 6, 7 comprises heat exchanger coils 10 (loops of tubing) and fins 11 disposed there between. The heat exchanger of the present embodiment is particularly applied for outdoor applications, i.e. as part of the heat source unit of an air conditioner. In this case, the fins of the upper and lower heat exchanger element 6, 7 are preferably waffled fins. In case the heat exchanger is, however, used for indoor applications (when indoor air passes the heat exchanger), that is as indoor unit of an air conditioner, louvered fins may be used. Louvered fins are preferably for a good air flow through the heat exchanger as several holes are provided to allow the air to flow through the fins. However, condensation water may accumulate in these holes and may lead to problems regarding the formation of frost during heating operation if used as outdoor application (i.e. when outdoor passes the heat exchanger), when the ambient temperature is lower than about 7°C. To prevent these problems it is in these cases preferred to use waffled fins.

[0035] Two backward curved centrifugal fans 20 are provided inside the casing. These backward curved centrifugal fans 20 each have a suction opening 21. In the side view (figure 3), the center axis of the suction opening 21 and hence the fans 20 is substantially congruent or aligned with the center line CL of the heat exchanger 5. In some appliances, it may however be sufficient as in the depicted embodiment that the center axis of the suction opening 21 and the centerline CL of the heat exchanger 5 are parallel but displaced relative to each other in a horizontal direction.

[0036] In use, the fans 20 create a suction force at the suction opening 21 so as to induce a fluid flow (airflow) in the direction F. Thus air, particularly outside air is drawn in through the connection 3 toward the open end 12 of the heat exchanger 5, passes through the upper and lower heat exchanger elements 6, 7 and is sucked through the suction opening 21 to be flown out through the connection 4. As such the casing 2 defines a duct from the connection 3 via the heat exchanger 5 and the fan 20 to the connection 4. In this context, the connection 3 and the connection 4 define an inlet opening 13 and an outlet opening 14.

[0037] Furthermore, a drain pan 15 is provided within the casing. The drain pan 15 is separated into two halves 16, 17 along the length L of the casing 2 in the side view. In figure 3, the two halves 16, 17 are identified by the dotted line with one half being located on the left side and one half being located on the right side of the dotted line. The drain pan 15 has a lowest position 18 at which a drain opening 19 is provided. The bottom of the drain pan 15 slants toward the drain opening 19 and hence the lowest position 18. Thus water dropping from any component into the drain pan is directly guided to the drain opening 19 and the lowest position 18 which is furthest away from the fan 20. Thereby it is prevented that water accumulated within the drain pan may be sucked into the fan 20 and hence through the opening 14 into the duct. The drain opening 19 is directly connected to drainage so that water is directly drained.

[0038] Moreover, a sound and/or thermal insulation 22 are provided within the casing 2 at the side opposite to the drain pan 15 with respect to the line CL. In the cross section and hence a side view (figure 3), the inner surfaces of the drain pan 15 and the insulation 22 respectively directed to the heat exchanger 15 should be approximated so that the duct created within the casing 2 is as symmetric as possible.

[0039] Further, the distance between the apex 8 and the entry of the suction opening 21 should be as short as possible to reduce the length. In particular, the high velocity so as of the fans should in the side view not overlap with the heat exchanger 5 and/or the drain pan 15.

[0040] Figure 4 shows simulations of the air distribution through the heat exchanger 5. Figure 4a) shows that the pressure drop may be increased at the apex 8 by the connecting plate 9 as compared to the pressure drop at the opening 12 thereby providing for more even air distribution of air (amount of air) flowing through the heat exchanger 5.

[0041] Even though the air distribution flowing through the upper and lower heat exchanger element 6, 7 is already a relatively even in figure 4 a), because of the disposal of the fan 20 downstream of the heat exchanger 5 and the provision of the connecting element 9 it becomes apparent that the air passing through the top corner and bottom corner portion 30 and 31 at the very end of the upper and lower heat exchanger element 6, 7 of the heat exchanger 5 is relatively low as compared to other portions.

[0042] In order to even out the air distribution one may hence provide a guide blade 32 which is preferably symmetric to the centerline the CL and having an airfoil directed toward the opening 12 of the heat exchanger 5. In other words, the leading end 33 is directed toward the opening 12. The leading end 33 of the guide blade 32 may be pointed as shown in figure 4b) or the airfoil may have the shape of a dolphin flipper fin as shown in figure 4 c).

[0043] The pressure drop at the apex is increased by the connecting element 9 and therefore, a better air distribution can be achieved. In particular, the flow of fluid through the portions 30 and 31 is increased relative to the portions close to the apex 8. Thus, the air distribution of air flowing through the heat exchanger 5 is improved with a guide blade 32.

Claims

1. Heat exchanger unit (1) comprising:

a casing (2) defining a duct to be flown through by a fluid,
a fan (20) disposed in the casing (2) and configured to induce a flow of the fluid through the duct in a flow direction (F),
a heat exchanger (5) being V-shaped in side view with an apex (8) at one end and an opening (12) at the opposite end, the heat exchanger (5) being disposed in the duct with the opening (12) directed towards the flow direction (F), wherein a line (CL) passing the apex (8) of the V-shaped heat exchanger (5) in the side view extends horizontally,
characterized in that
the fan (20) is disposed downstream of the heat exchanger (5) in the flow direction (F).

2. Heat exchanger unit (1) according to claim 1, wherein the center axis of the fan (20) and the line (CL) of the V-shaped heat exchanger (5) are parallel in the side view, preferably at the same height in the side view.

3. Heat exchanger unit (1) according to claim 1 or 2, wherein the fan (20) is a backward curved centrifugal fan.

4. Heat exchanger unit (1) according to any one of the preceding claims, wherein the heat exchanger (5) further comprises a connecting element (9) connecting an upper (6) and a lower (7) heat exchanger portion, the connecting element (9) being disposed at the apex (8) and being configured to block the flow of fluid through the heat exchanger (5) at the apex (8).

5. Heat exchanger unit (1) according to claim 4, wherein the connecting element (9) extends beyond the apex (8) of the heat exchanger (5) covering a part of a lower surface of the lower heat exchanger portion (7).

6. Heat exchanger unit (1) according to any one of the preceding claims, further comprising a guide blade (32), the guide blade (32) being disposed between the opposite ends of the heat exchanger (5).

7. Heat exchanger unit (1) according to claim 6, wherein the guide blade (32) has an airfoil with a line of symmetry being aligned with the line (CL) of the heat exchanger (5).

8. Heat exchanger unit (1) according to claim 6 or 7, wherein the guide blade (32) has a leading edge (33) directed towards the flow direction (F), the leading edge (33) being pointed.

9. Heat exchanger unit (1) according to anyone of claims 6 to 8, wherein the guide blade (32) has an airfoil in the shape of a dolphin flipper fin.

10. Heat exchanger unit (1) according to any one of claims 6 to 9, wherein a shortest distance between

the guide blade (32) and the heat exchanger (5) is not less than 15 mm.

11. Heat exchanger unit (1) according to any one of the preceding claims, further comprising a drain pan (15), wherein the drain pan (15) has a drain opening (19) disposed in that half (17) of the drain pan (15) in the flow direction (F) away from the fan (20), wherein the drain pan (15) is configured to guide water accumulated in the drain pan (15) away from the fan (20) to the drain opening (19).

12. Heat exchanger unit (1) according to any one of the preceding claims, further comprising a drain pan (15), and an insulation (22) disposed on an opposite side of the drain pan (15) relative to the heat exchanger (5), wherein surfaces of the insulation (22) and the drain pan (15) directed toward the heat exchanger (5) have approximated shapes in side view.

13. Heat exchanger unit (1) according to one of the preceding claims, wherein the heat exchanger (5) comprises coils (10) and waffled fins (11) disposed between the coils (10).

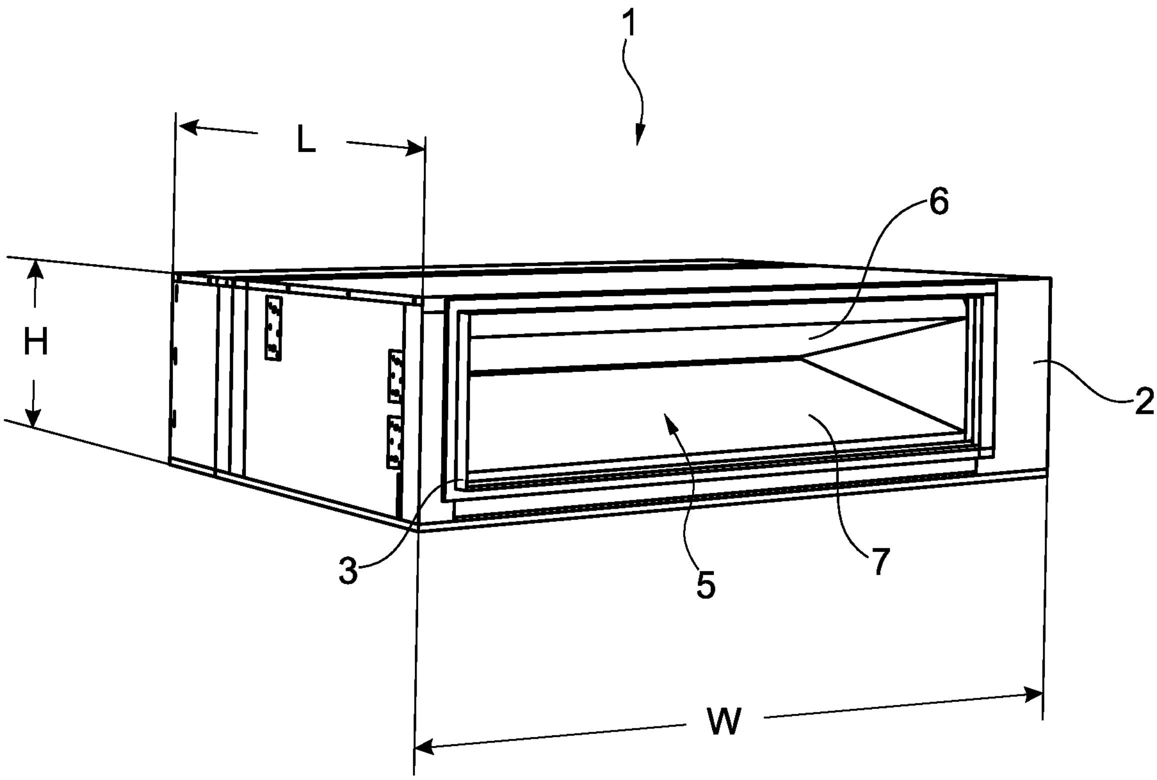

Fig. 1

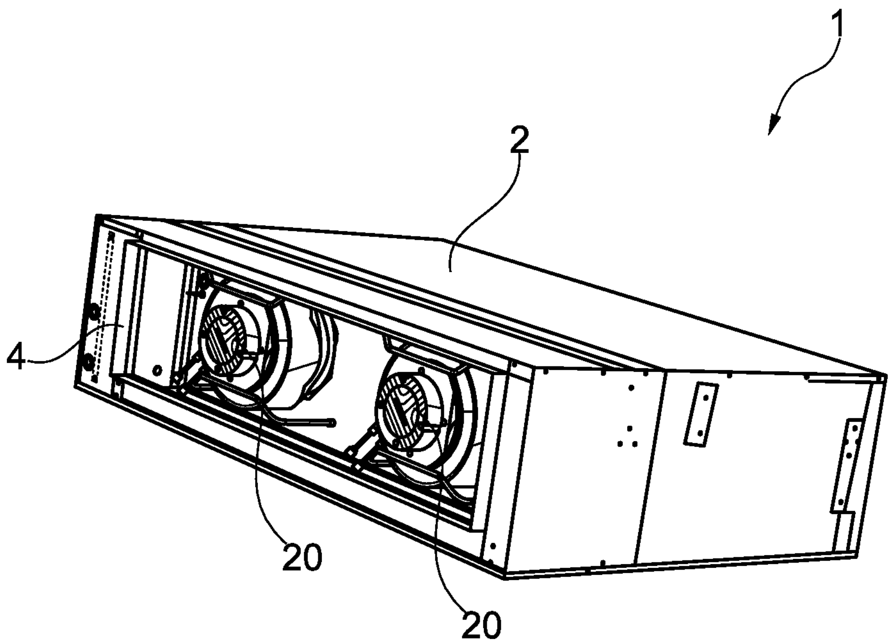

Fig. 2

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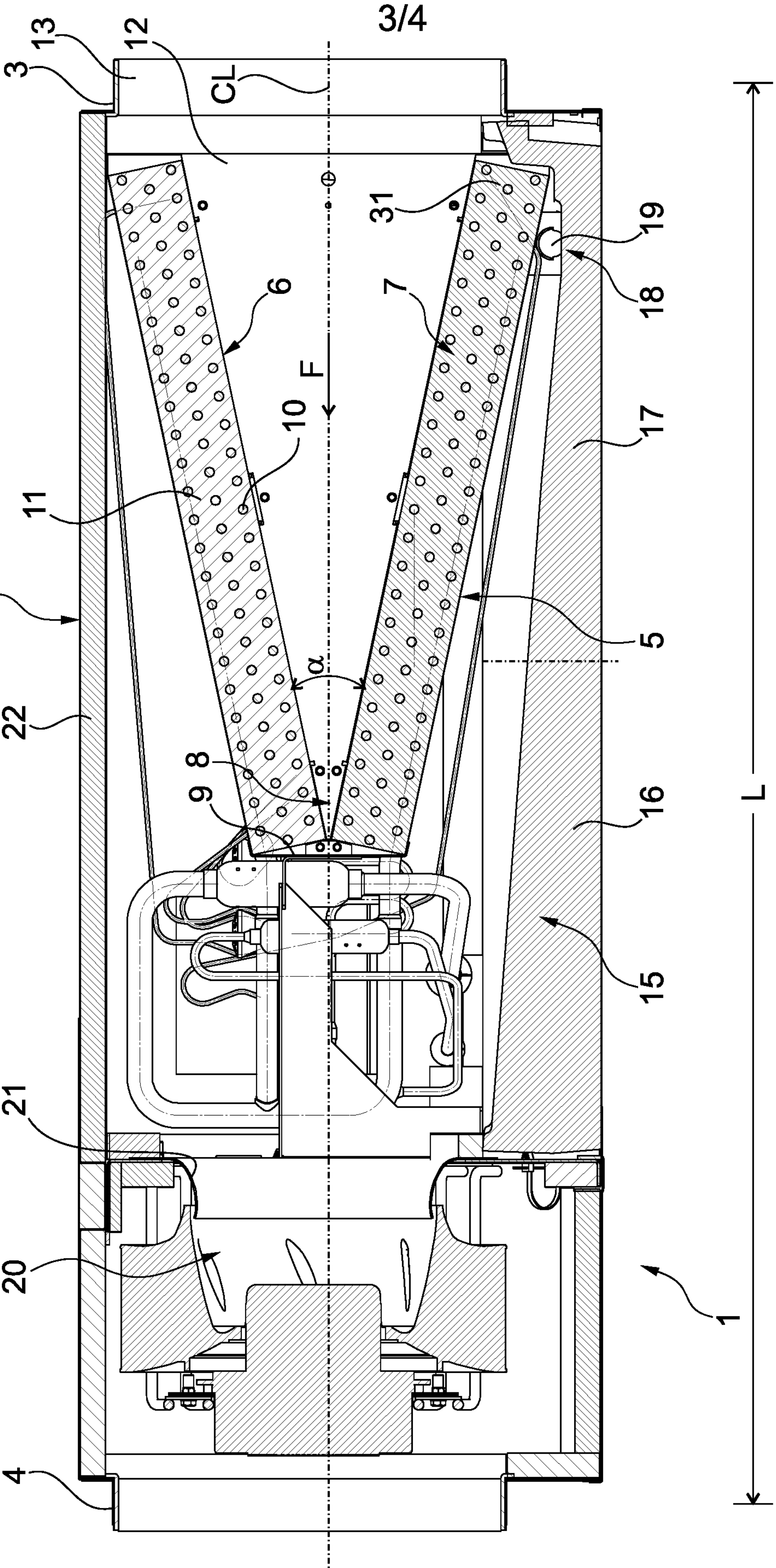

Fig. 3

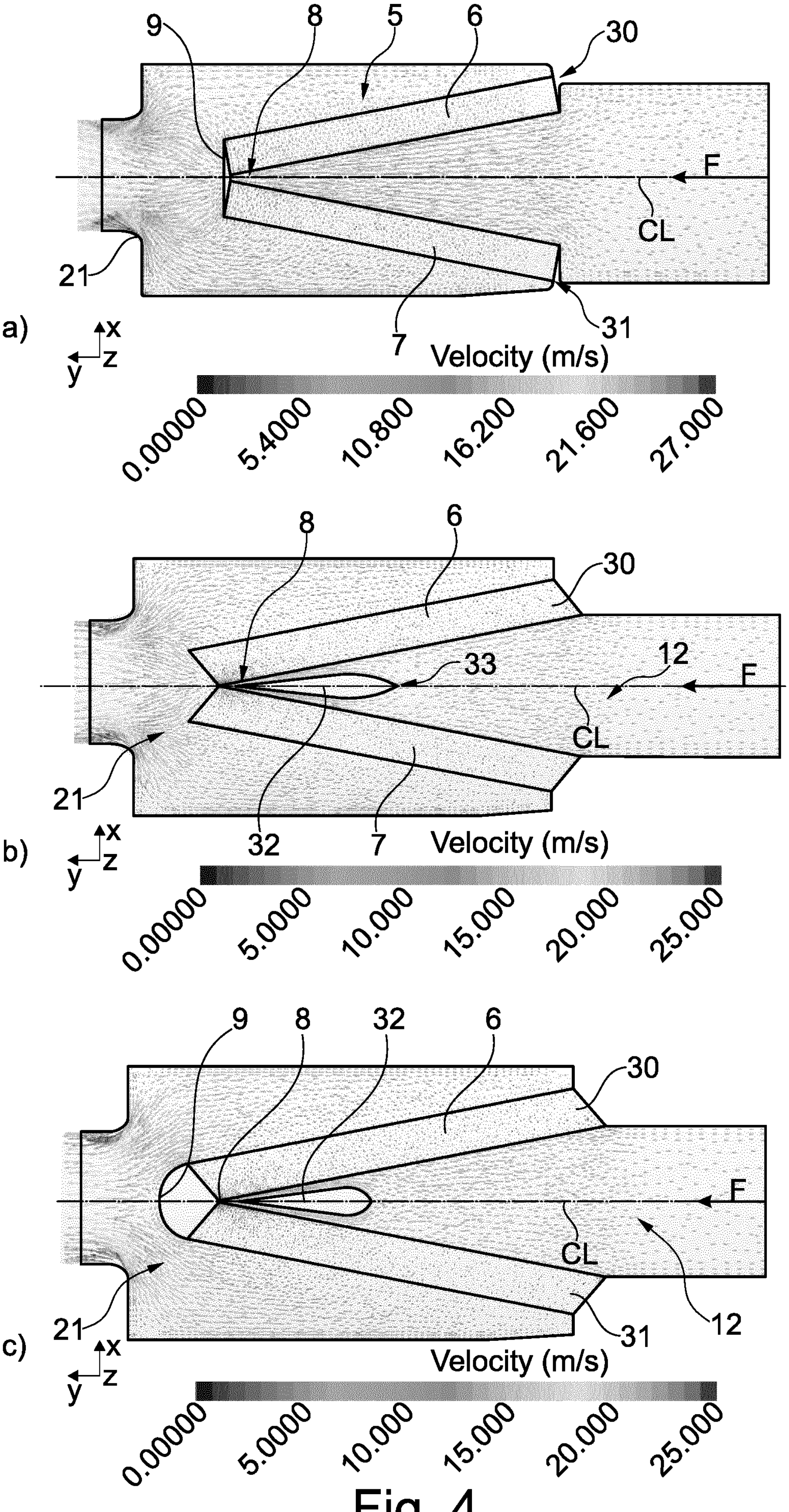
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Fig. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 15 16 4039

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 Y	US 5 964 370 A (RUST JR RAYMOND A [US] ET AL) 12 October 1999 (1999-10-12) * column 3, line 10 - column 5, line 48; figures 1,2,8 *	1-5, 11-13 6-10	INV. F24F1/00 F24F13/30 F28D1/04 F28F13/06 F28F17/00 ADD. F28F9/22
X	CN 1 782 601 A (LG ELECTRONICS TIANJIN [CN]) 7 June 2006 (2006-06-07) * the whole document *	1-3, 6-10,13	
Y	EP 2 520 893 A1 (DANFOSS SANHUA HANGZHOU MICRO [CN]) 7 November 2012 (2012-11-07) * paragraph [0004] - paragraph [0009] * * paragraph [0029] - paragraph [0036] * * paragraph [0048] - paragraph [0057] * * figures 1-15 *	6-10	
A	US 2007/169499 A1 (RIOS ARTURO [US] ET AL) 26 July 2007 (2007-07-26) * paragraph [0022] - paragraph [0024]; figures 1a,1b,6a *	1,4,5, 11,12	

TECHNICAL FIELDS SEARCHED (IPC)

F24F
F28D
F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	5 October 2015	Arndt, Markus

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