(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 974 759 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.03.2022 Bulletin 2022/13

(21) Application number: **21198836.5**

(22) Date of filing: **24.09.2021**

(51) International Patent Classification (IPC):
F28D 19/04 *(2006.01)* ***F28F 3/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F28D 19/042; F28F 3/027

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **25.09.2020 SE 2051118**

(71) Applicant: **Heatex AB**
215 32 Malmö (SE)

(72) Inventors:
- **Stanezai, Eman**
  211 16 Malmö (SE)
- **Nilsson, Fredrik**
  231 70 Anderslöv (SE)
- **Gidner, Johan**
  227 63 Lund (SE)

(74) Representative: **Nordic Patent Service A/S**
Bredgade 30
1260 Copenhagen K (DK)

(54) WEB, WEB MATRIX, AND ROTOR FOR HEAT EXCHANGER

(57) A web (1) for a rotary heat exchanger (13), said web (1) being configured for transfer of thermal energy and/or moisture to and/or from a fluid. The web (1) comprises a plurality of first profiled sections (2) and a plurality of second profiled sections (3) which are configured to protrude in opposite directions, each protrusion comprising a fluid passage (4). Said first profiled sections (2) and said second profiled sections (3) form a plurality of fluid flow channels (5), each fluid flow channel (5) having a main fluid flow axis (Al) and being configured to allow fluid flow at least partially along said main fluid flow axis (Al). Each fluid flow channel (5) is formed by alternating at least one first profiled section (2) and at least one second profiled section (3) along said main fluid flow axis (Al) and by aligning said fluid passages (4) of said alternatingly arranged first profiled section(s) (2) and second profiled section(s) (3). Each fluid flow channel (5) comprises at least one lateral opening (6) allowing said fluid flow to at least partially travel between adjacent fluid flow channels (5).

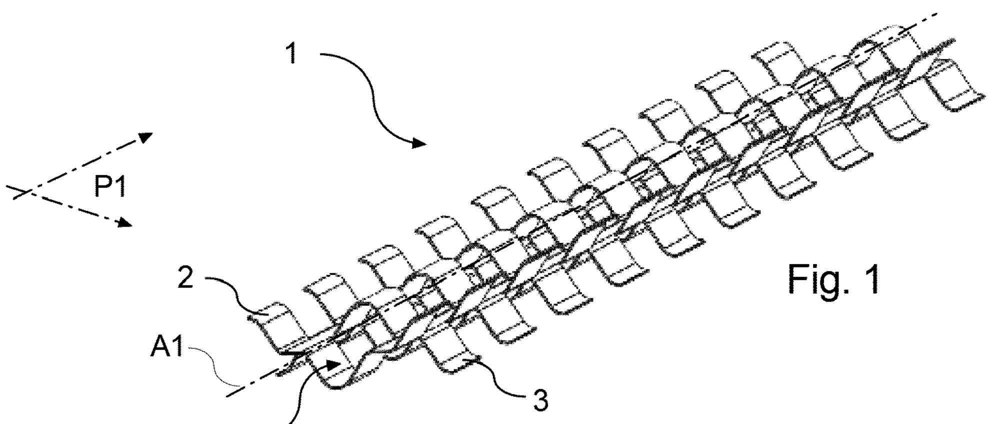

Fig. 1

EP 3 974 759 A1

Description

TECHNICAL FIELD

[0001] The disclosure relates to a web for transfer of thermal energy and/or moisture to and/or from a fluid, the web comprising a plurality of fluid flow channels.

BACKGROUND

[0002] Heat exchangers are used to recycle energy from out-going gas flow to ingoing gas flow in various applications such as ventilation, drying, thermal management of electronic devices, etc. A heat exchanger comprises a plurality of channels configured for fluid flow, which channels may be arranged in a matrix. Oftentimes, the inlet fluid flows in one set of channels in one direction, while the outlet fluid flows in a different set of channels in the opposite direction, as is the case for plate heat exchangers wherein the heat exchanger matrix comprises inlet fluid flows and the outlet fluid flows which are completely separated from each other.

[0003] The fluid flow separation of the plate heat exchanger prevents contamination, i.e. transfer of odor or particles between outlet fluid flow and inlet fluid flow. One important parameter for the performance of the plate heat exchanger is the spacing between adjacent plates. A narrower channel, i.e. a smaller height or distance between adjacent plates, leads to a higher pressure drop as well as to higher efficiency, i.e. more heat is transferred. If a lower pressure drop is required, a larger channel height is preferable, the trade-off being lower efficiency. A plate heat exchanger has an approximate temperature efficiency of 65-80 %, and the allowable pressure drop is usually within the range of between 20 and 100 kPa.

[0004] The matrix of a corresponding rotary heat exchanger instead uses the same channels to accommodate both inlet fluid flow and outlet fluid flow. As the rotor rotates, heat is captured from the outlet fluid in one half of a rotation cycle and released to the inlet fluid during the other half of the rotation cycle. This allows waste energy from the outlet fluid to be transferred to the matrix, and thereafter from the matrix to the inlet fluid. This increases the temperature of the inlet fluid by an amount proportional to the temperature differential between the fluids and depends on the efficiency of the heat exchanger. Since the outlet fluid flow and inlet fluid flow pass through the same rotor channels alternately, the rotor is also, to a large extent, self-cleaning and frost proof.

[0005] The rotor's ability to recover both thermal energy and humidity, i.e. latent energy, makes the rotary heat exchanger very efficient. A rotary heat exchanger usually has a temperature efficiency of 70-90 % with a pressure drop of between 50 and 300 Pa. The rotor may also be used as a desiccant wheel which is provided with a coating applied for the purpose of transferring humidity from one fluid to the other.

[0006] The channels of the matrix of a rotary heat exchanger traditionally have a substantially triangular or sinusoidal shape, facilitating as much matrix surface area as possible which can come into contact with the fluids, improving heat transfer efficiency. However, heat exchange may be made even more efficient if the normally laminar flow of the fluid is interrupted, e.g. by means of heat sinks, and some turbulence within the fluid is created. This is due to laminar flow developing a boundary layer adjacent to the channel wall which restricts heat transfer, and any added turbulence generating significant mixing of the boundary layer and the bulk fluid, allowing highly efficient heat exchange.

SUMMARY

[0007] It is an object to provide an improved web and matrix for a heat exchanger. The foregoing and other objects are achieved by the features of the independent claims. Further implementation forms are apparent from the dependent claims, the description, and the figures.

[0008] According to a first aspect, there is provided a web for a rotary heat exchanger, the web being configured for transfer of thermal energy and/or moisture to and/or from a fluid, the web comprising a plurality of first profiled sections and a plurality of second profiled sections, the first profiled sections and the second profiled sections being configured to protrude in opposite directions from a main plane of the web, each protrusion comprising a fluid passage, the first profiled sections and the second profiled sections forming a plurality of fluid flow channels, each fluid flow channel having a main fluid flow axis and being configured to allow fluid flow at least partially along the main fluid flow axis, each fluid flow channel being formed by alternating at least one first profiled section and at least one second profiled section along the main fluid flow axis and by aligning the fluid passages of the alternatingly arranged first profiled sections and second profiled sections, each fluid flow channel comprising at least one lateral opening allowing the fluid flow to at least partially travel between adjacent fluid flow channels.

[0009] A web like the one described above comprises as few parts as possible, dispensing of the need for separate distancing components such as spacers. This not only reduces material costs but also facilitates assembly and allows for a more compact heat exchanger, when winding the web into a spiral or stacking several webs on top of each other, forming a heat exchanger comprising multiple layers of webs and hence fluid flow channels. Furthermore, this specific web provides an as large surface area, i.e. energy transfer area, as possible while also allowing the laminar flow of the fluid passing through each fluid flow channel to be interrupted, by a lateral opening in the channel wall, and some turbulence to be created within the fluid. This significantly improves the energy transfer rate of the web, as well as the moisture transfer rate, as the slow-moving boundary layer is broken.

[0010] In a possible implementation form of the first aspect, the first profiled sections protruding in a first direction perpendicular to the main plane, the second profiled sections protruding in a second direction opposite to the first direction, such that the profiled sections together form both spacers as well as a fluid flow channel.

[0011] In a further possible implementation form of the first aspect, the main fluid flow axes extending in parallel with each other and with the main plane. This facilitates having only one common inlet side and one common outlet side in the heat exchanger comprising the web.

[0012] In a further possible implementation form of the first aspect, a fluid outlet end of the first profiled section is arranged adjacent a fluid inlet end of an adjacent second profiled section, and/or wherein a fluid inlet end of the first profiled section is arranged adjacent a fluid outlet end of an adjacent second profiled section, the fluid passage of the first profiled section extending from the fluid inlet end to the fluid outlet end along the main fluid flow axis, and the fluid passage of the second profiled section extending from the fluid inlet end to the fluid outlet end along the main fluid flow axis.

[0013] In a further possible implementation form of the first aspect, the fluid flow can deviate from the main fluid flow axis as it exits the fluid outlet end of the first profiled section of the fluid flow channel, and travel into the fluid passage of the second profiled section of an adjacent fluid flow channel, and/or the fluid flow can deviate from the main fluid flow axis as it exits the fluid outlet end of the second profiled section of the fluid flow channel, and travel into the fluid passage of the first profiled section of an adjacent fluid flow channel. This way, an opening in the channel wall, i.e. an interruption affecting the laminar flow of fluid, is formed at each transition between a first profiled section and a second profiled section, allowing for more efficient heat exchange.

[0014] In a further possible implementation form of the first aspect, the first profiled sections and the second profiled sections of each fluid flow channel have identical shape, an axis of symmetry of the first profiled sections extending coaxially with an axis of symmetry of the second profiled sections, and extending in parallel with the main fluid flow axis of the fluid flow channel. This simplifies the manufacture of the web, since only one shape, though inverted, must be achieved.

[0015] In a further possible implementation form of the first aspect, the first profiled sections and the second profiled sections have different cross-sectional shapes as seen in a plane perpendicular to the main fluid flow axis and to the main plane, increasing the flexibility of the web. For example, the height of each profiled section can be selected to provide greater or lesser spacing between adjacent webs of a matrix, thereby establishing a desired surface area density of the matrix. This implementation form allows the heat exchange matrix to be customized by using two different profiled sections of different surface area densities. Furthermore, the height of the profiled sections determines the extent of separation between adjacent webs and, hence, determines the diameter of the fluid flow channel, the surface area density, and subsequently the airflow versus pressure drop relationship, for the matrix.

[0016] In a further possible implementation form of the first aspect, the first profiled section and the second profiled section each comprises an apex and a base, the apex of the first profiled section and the base of the second profiled section being arranged at one side of the main plane, and the base of the first profiled section and the apex of the second profiled section being arranged at an opposite side of the main plane. The distance between apex and base, i.e. the height of the profiled section can be selected to provide greater or lesser spacing between adjacent webs, thereby providing a desired surface area density.

[0017] In a further possible implementation form of the first aspect, the apex of the first profiled section and the base of the second profiled section are arranged in a first common plane, and the base of the first profiled section and the apex of the second profiled section are arranged in a second common plane. This allows for a symmetrical web that is easy to manufacture and assemble into a matrix.

[0018] In a further possible implementation form of the first aspect, the first profiled section and the second profiled section comprise a strip of web material. By dividing a web material into a plurality of strips, a simple way of manufacturing a web, having aligned fluid flow channels as well as lateral openings between adjacent fluid flow channels, is facilitated.

[0019] In a further possible implementation form of the first aspect, the shape substantially corresponds to one period of a sine wave.

[0020] In a further possible implementation form of the first aspect, the apex corresponds to a crest of the sine wave, and the base corresponds to two troughs of the sine wave.

[0021] In a further possible implementation form of the first aspect, the first profiled section and the second profiled section each comprises at least one stepped part, the stepped part of the first profiled section extending adjacent the stepped part of an adjacent second profiled section. The stepped parts provide stability to the web as well as an increase in surface areas of each fluid flow channel.

[0022] In a further possible implementation form of the first aspect, the stepped parts of the first profiled sections extend coplanar with the stepped parts of the second profiled sections. The stepped parts provide larger coherent surface sub-areas within each fluid flow channel.

[0023] In a further possible implementation form of the first aspect, the stepped part is arranged equidistantly between the apex and the base, facilitating a symmetric web.

[0024] In a further possible implementation form of the first aspect, the web comprises a web material such as polymer, steel, or aluminum foil, and, optionally, a hygroscopic or epoxy coating. This allows the web to be thin, lightweight, and to serve for the transfer of moisture in addition to transfer of energy.

[0025] According to a second aspect, there is provided a web matrix for transfer of thermal energy and/or moisture to and/or from a fluid, the matrix comprising a plurality of webs according to the above, the webs being superimposed onto each other such that the main fluid flow axes of the webs extend in parallel.

[0026] The provision of protruding sections allows the webs of the matrix to be stacked without requiring separate distancing components such as spacers, since each protrusion provides both a fluid channel and vertical separation.

[0027] In a possible implementation form of the second aspect, the web matrix further comprises at least one integral sheet material, each sheet material being arranged between two adjacent webs. The integral sheet material provides separation between adjacent webs.

[0028] In a further possible implementation form of the second aspect, each sheet material is configured to support the apexes of the first profiled sections and the bases of the second profiled sections, or to support the apexes of the second profiled sections and the apexes of the second profiled sections.

[0029] In a further possible implementation form of the second aspect, the apex and/or the base of the first profiled sections and/or the second profiled sections of the webs are fixedly attached to the sheet material.

[0030] According to a third aspect, there is provided a rotor for a heat exchanger comprising the matrix according to the above, a rotation axis of the rotor extending in parallel with the main fluid flow axes of the webs of the matrix. Such a solution facilitates not only a rotor having improved energy transfer rates as well as improved moisture transfer rates, but also enables considerable savings of material in the manufacture of the rotor.

[0031] In a possible implementation form of the third aspect, each fluid flow channel of the webs is configured to accommodate bidirectional fluid flow at least partially along the main fluid flow axis, the fluid flowing in a first direction, along the main fluid flow axis, within a rotor section when the rotor section is in a first angular position, the fluid flowing in a second, opposite direction, along the main fluid flow axis, within the rotor section when the rotor section is in a second angular position.

[0032] In a further possible implementation form of the third aspect, the rotor is configured for air-to-air heat transfer.

[0033] In a further possible implementation form of the third aspect, the rotor is configured for air-to-liquid.

[0034] According to a fourth aspect, there is provided a rotary heat exchanger comprising the rotor according to the above. This solution facilitates not only a heat exchanger having improved energy transfer rates as well as improved moisture transfer rates, but also enables considerable savings of material in the manufacture of the heat exchanger.

[0035] In a possible implementation form of the fourth aspect, the rotary heat exchanger is configured for use in ventilation systems.

[0036] This and other aspects will be apparent from the embodiments described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] In the following detailed portion of the present disclosure, the aspects, embodiments, and implementations will be explained in more detail with reference to the example embodiments shown in the drawings, in which:

Fig. 1 shows a perspective view of a web in accordance with one embodiment of the present invention;

Fig. 2 shows a cross-sectional side view of the embodiment shown in Fig 4;

Fig. 3 shows a partial perspective view of a web in accordance with one embodiment of the present invention;

Figs. 4a to 4c show cross-sectional side views of webs in accordance with one embodiment of the present invention;

Fig 5. shows a cross-sectional side view of a profiled section of the embodiment shown in Fig 4c;

Fig. 6 shows a partial perspective view of a heat exchanger comprising a rotor and a matrix in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0038] Fig. 6 shows a rotary heat exchanger 13 comprising a rotor 12, which rotary heat exchanger 13 may be configured for use in e.g. ventilation systems where there is no need for separating the inlet fluid flows and the outlet fluid flows. The rotor 12 may be configured for air-to-air heat transfer, air-to-liquid heat transfer, or liquid-to-liquid heat transfer. Furthermore, the rotor 12 may be configured for moisture transfer. The rotor 12 may have a temperature efficiency of 70-90 % with a pressure drop of between 50 and 300 Pa.

[0039] The rotor 12 comprises a web matrix 10 comprising a plurality of webs 1, or foils, described in more detail further below. The rotation axis A4 of the rotor 12 extends in parallel with the main fluid flow axes A1 of the webs 1 of the web matrix 10, as indicated in Fig. 6. The web matrix 10 may be either one integral piece or segmented, segmented rotors being divided into sectors, i.e. pie-shaped parts, that are assembled when the rotor is installed.

[0040] The webs 1 comprise a plurality of fluid flow channels 5 which are configured to accommodate bidirectional fluid flow at least partially along the main fluid flow axis A1, which reduces the buildup of laminar flow. By bidirectional is meant that the fluid flows in a first direction D3 along the main fluid flow axis A1 of a fluid flow channel 5 arranged within a specific rotor section, when the rotor section is momentarily in a first angular position R1. Correspondingly, the fluid flows in a second, opposite direction D4 along the same main fluid flow axis A1, when the same rotor section is momentarily in a second angular position R2. The first angular position R1 may for example be any position in the upper 180° of one revolution of the rotor 12 around the rotation axis A4, and the second angular position R2 may be any position in the lower 180° of the revolution.

[0041] Figs. 1 and 2 show an embodiment of the abovementioned web 1, the web 1 being configured for transfer of thermal energy and/or moisture to and/or from the fluid passing therethrough. The fluid may be air, water, or any suitable gas.

[0042] The web 1 comprises a plurality of first profiled sections 2 and a plurality of second profiled sections 3. The first profiled sections 2 and the second profiled sections 3 are configured such that they protrude in opposite directions from the main plane PI of the web 1. Each protrusion forms a fluid passage 4, in other words, the first profiled sections 2 and the second profiled sections 3 are shaped such that they extend in opposite directions, and a fluid passage 4 being created by and within this protrusion. Furthermore, the plurality of first profiled sections 2 and the plurality of second profiled sections 3, since they protrude in opposite directions from the main plane PI, form distances between adjacent, i.e. stacked, webs 1.

[0043] The first profiled sections 2 and the second profiled sections 3 together form a plurality of fluid flow channels 5. Each fluid flow channel 5 has a main fluid flow axis A1 and is configured to allow fluid flow at least partially along the main fluid flow axis A1, in first direction D3 and second direction D4. The plurality of fluid flow channels 5 within one web 1 is arranged such that they extend substantially in parallel, i.e. the main fluid flow axes A1 of the fluid flow channels 5 are parallel with each other, within the main plane PI. The main plane PI may be is curved, e.g. when the web 1 is used in the matrix of a rotary heat exchanger 13. This curvature or arching requires the plurality of webs 1 of the web matrix 10 to be stacked or wound such that each layer of web 1 is correctly arched as well as distanced from each other.

[0044] Each fluid flow channel 5 is formed by alternating at least one first profiled section 2 and at least one second profiled section 3 along the main fluid flow axis A1, such that every second section is a first profiled section 2 and every second profile is a second profiled section 3. The first profiled sections 2 protrude in a first direction D1 which is perpendicular to the main plane PI, and the second profiled sections 3, correspondingly, protrudes in a second direction D2 opposite to the first direction D1, as illustrated in Fig. 2. The fluid passages 4 of the alternatingly arranged first profiled sections 2 and second profiled sections 3 are aligned such that a fluid flow channel 5 is formed by this plurality of aligned fluid passages 4. The size of the fluid passages 4 and, hence, fluid flow channels 5 in the first direction D1 and the second direction D2 is usually called well height. Different well heights and rotor diameters give different efficiencies, pressure drops, and airflow rates.

[0045] By alternating first profiled sections 2 and second profiled sections 3, a fluid outlet end 2b of a first profiled section 2 may be arranged adjacent a fluid inlet end 3a of an adjacent second profiled section 3, and/or a fluid inlet end 2a of a first profiled section 2 may be arranged adjacent a fluid outlet end 3b of an adjacent second profiled section 3. The fluid passage 4 of the first profiled section 2 extends from the fluid inlet end 2a to the fluid outlet end 2b, of the first profiled section 2, along main fluid flow axis A1. The fluid passage 4 of the second profiled section 3 extends from the fluid inlet end 3a to the fluid outlet end 3b, of the second profiled section 3, along main fluid flow axis A1.

[0046] The use of two alternating first profiled sections 2 and second profiled sections 3 not only provides fluid flow channels but also distancing between directly adjacent webs 1, as well as facilitates arching of the webs and a stable yet efficient web matrix 10. An increased number of profiled sections would complicate manufacture as well as arching.

[0047] Each fluid flow channel 5 comprises at least one lateral opening 6 allowing the fluid flow to at least partially travel between adjacent fluid flow channels 5, and not only along the main fluid flow axis A1. A lateral opening 6 may be formed at each transition between a first profiled section 2 and a second profiled section 3, as shown in Figs. 1 and 3, i.e. the lateral opening 6 may be air gaps formed between adjacent profiled sections 2, 3.

[0048] The fluid flow may deviate from the main fluid flow axis A1, i.e. travel through a lateral opening 6, as it exits the fluid outlet end 2b of a first profiled section 2 of a fluid flow channel 5a, and travel into the fluid passage 4 of a second profiled section 3 of an adjacent fluid flow channel 5b. Correspondingly, the fluid flow may deviate from the main fluid flow axis A1, i.e. travel through a lateral opening 6, as it exits a fluid outlet end 3b of a second profiled section 3 of a fluid flow channel 5a, and travel into the fluid passage 4 of a first profiled section 2 of an adjacent fluid flow channel 5b.

[0049] The first profiled sections 2 and the second profiled sections 3 of each fluid flow channel 5 may have identical shapes, as illustrated in Fig. 2 and Figs. 4a and 4c. In this case, the axis of symmetry A2 of the first profiled sections 2 may extend coaxially with the axis of symmetry A3 of the second profiled sections 3. The axes of symmetry A2, A3 extend in parallel with the main fluid flow axis A1 of the fluid flow channel 5. Nevertheless, the first profiled sections 2 and the second profiled sections 3 may also be offset relative to each other, in the first or second directions D1, D2 (vertically or radially) or in a direction within the main plane PI (horizontally or circumferentially).

[0050] Furthermore, the first profiled sections 2 and the second profiled sections 3 may have different cross-sectional shapes as seen in a plane P2 perpendicular to the main fluid flow axis A1 and to the main plane PI. The axes of symmetry A2, A3 may, in this case, extend either coaxially or in parallel.

[0051] As illustrated in Fig. 2, the first profiled section 2 and the second profiled section 3 may each comprise an apex 7 and a base 8. The apex 7 of the first profiled section 2 and the base 8 of the second profiled section 3 are arranged at one side of the main plane PI, and the base 8 of the first profiled section 2 and the apex 7 of the second profiled section 3 are arranged at the opposite side of the main plane PI. The apex 7 of the first profiled section 2 and the base 8 of the second profiled section 3 may be arranged in a first common plane P3, and the base 8 of the first profiled section 2 and the apex 7 of the second profiled section 3 may be arranged in a second common plane P4. One or several of the apexes 7 and the bases 8 may also be arranged with some vertical offset, such that they do not extend in a common plane.

[0052] The cross-sectional shapes of the first profiled section 2 and the second profiled section 3 may substantially correspond to a period of a sine wave. The apex 7 may correspond to a crest of the sine wave, and the base 8 may correspond to two troughs of the sine wave. The cross-sectional shapes of the first profiled section 2 and the second profiled section 3 may also substantially correspond to a period of a square wave, a triangular wave, a sawtooth wave or any other suitable periodic wave.

[0053] The first profiled section 2 and the second profiled section 3 may be shaped such that they have substantially identical apexes 7 and bases 8. This is illustrated in Figs. 4a to 4c, which show different embodiments of the first profiled section 2 and the second profiled section 3. The cross-sectional shapes of the first profiled section 2 and the second profiled section 3 may correspond to a period of a sine wave, wherein every second apex 7 of each profile 2, 3 corresponds to a crest of the sine wave, and every second apex 7 corresponds to the trough of the sine wave, as shown in Figs. 4a and 4bc.

[0054] As shown in Figs. 2 and 4a to 4c, the apexes 7 and bases 8 may be shaped such that they have an as small surface as possible in contact with any adjacent element such as a sheet material 11, described in more detail below, or an adjacent web 1.

[0055] The first profiled section 2 and the second profiled section 3 may also have complex periods as shown in Figs. 4c and 5. For example, the first profiled section 2 and the second profiled section 3 may be shaped such that they have a wave-shape which is not purely sinusoidal, but which e.g. may comprise flat areas such as flat apexes 7 and flat bases 8.

[0056] The first profiled section 2 and the second profiled section 3 may each comprise at least one stepped part 9. As shown in Fig. 2, each first profiled section 2 and each second profiled section 3 may comprise two preferably coplanar stepped parts 9. As shown in Fig. 5, each first profiled section 2 and each second profiled section 3 may comprise one stepped part 9. The stepped part 9 of the first profiled section 2 may extend adjacent the stepped part 9 of an adjacent second profiled section 3. The stepped parts 9 may be arranged coplanar with, or at an angle to, the main plane PI. The stepped parts 9 of the first profiled section 2 may extend coplanar with the stepped parts 9 of the second profiled section 3. Furthermore, the stepped part 9 may be arranged equidistantly between the apex 7 and the base 8 of a section, i.e. at a vertical center point of the fluid flow channel 5.

[0057] The first profiled section 2 and the second profiled section 3 may each comprise a strip of web material. The web material may be one integral piece of sheet material, into which parallel, throughgoing slits are cut and strips are formed by the material located between two such adjacent slits. A number of profiled sections may be formed by one such integral piece of material, as suggested in Figs. 4a to 5. A profiled section is formed by allowing the strip to protrude in direction D1 or direction D2. The slits preferably extend in parallel with each other and perpendicular to the main fluid flow axis A1.

[0058] The web 1 may comprise a web material such as polymer, steel, or aluminum foil, and, optionally, be covered by a hygroscopic or epoxy coating.

[0059] The present invention also relates to a web matrix 10 for transfer of thermal energy and/or moisture to and/or from a fluid. The web matrix 10 comprises a plurality of webs 1 which are superimposed onto each other such that the main fluid flow axes A1 of the webs 1 extend in parallel. This is illustrated schematically in Fig. 6. The plurality of webs 1 may be superimposed onto each other by stacking and curving individual webs or rolling one or several webs onto each other, forming a spiral. The web(s) is/are configured such that curing of the web(s) is possible without affecting the configuration of the first profiled section 2 and the second profiled section 3, and hence, without affecting the efficiency of the web matrix 10.

[0060] As shown in Fig. 3, the web matrix 10 may further comprise at least one integral sheet material 11, each sheet material 11 being arranged between two adjacent webs 1 such that they together create fluid flow channels 5 for the fluid to pass through. Each sheet material 11 may be configured to support the apexes 7 of the first profiled sections 2 and the bases 8 of the second profiled sections 3, or alternately, support the apexes 7 of the second profiled sections 3 and the apexes 7 of the second profiled sections 3.

[0061] The apex 7 and/or the base 8 of the first profiled sections 2 and/or the second profiled sections 3 of the webs 1 may be fixedly attached to the sheet material 11, e.g. by means of adhesive such as glue, or may be non-fixed in relation to the sheet material 11. The apex 7 and/or the base 8 of the first profiled sections 2 may also be in fixed, or non-fixed, contact with adjacent and a corresponding apex 7 and/or base 8 of the second profiled sections 3.

[0062] The various aspects and implementations have been described in conjunction with various embodiments herein. However, other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed subject-matter, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage.

[0063] The reference signs used in the claims shall not be construed as limiting the scope. Unless otherwise indicated, the drawings are intended to be read (e.g., cross-hatching, arrangement of parts, proportion, degree, etc.) together with the specification, and are to be considered a portion of the entire written description of this disclosure. As used in the description, the terms "horizontal", "vertical", "left", "right", "up" and "down", as well as adjectival and adverbial derivatives thereof (e.g., "horizontally", "rightwardly", "upwardly", etc.), simply refer to the orientation of the illustrated structure as the particular drawing figure faces the reader. Similarly, the terms "inwardly" and "outwardly" generally refer to the orientation of a surface relative to its axis of elongation, or axis of rotation, as appropriate.

Claims

1. A web (1) for a rotary heat exchanger (13), said web (1) being configured for transfer of thermal energy and/or moisture to and/or from a fluid,

said web (1) comprising a plurality of first profiled sections (2) and a plurality of second profiled sections (3),
said first profiled sections (2) and said second profiled sections (3) being configured to protrude in opposite directions from a main plane (Pl) of said web (1), each protrusion comprising a fluid passage (4),
said first profiled sections (2) and said second profiled sections (3) forming a plurality of fluid flow channels (5), each fluid flow channel (5) having a main fluid flow axis (A1) and being configured to allow fluid flow at least partially along said main fluid flow axis (A1),
each fluid flow channel (5) being formed by alternating at least one first profiled section (2) and at least one second profiled section (3) along said main fluid flow axis (A1) and by aligning said fluid passages (4) of said alternatingly arranged first profiled section(s) (2) and second profiled section(s) (3),
each fluid flow channel (5) comprising at least one lateral opening (6) allowing said fluid flow to at least partially travel between adjacent fluid flow channels (5).

2. The web (1) according to claim 1, wherein a fluid outlet end (2b) of said first profiled section (2) is arranged adjacent a fluid inlet end (3a) of an adjacent second profiled section (3), and/or wherein

a fluid inlet end (2a) of said first profiled section (2) is arranged adjacent a fluid outlet end (3b) of an adjacent second profiled section (3),
said fluid passage (4) of said first profiled section (2) extending from said fluid inlet end (2a) to said fluid outlet end (2b) along said main fluid flow axis (A1), and
said fluid passage (4) of said second profiled section (3) extending from said fluid inlet end (3a) to said fluid outlet end (3b) along said main fluid flow axis (A1).

3. The web (1) according to claim 2, wherein

said fluid flow can deviate from said main fluid flow axis (A1) as it exits said fluid outlet end (2b) of said first profiled section (2) of said fluid flow channel (5a), and
travel into said fluid passage (4) of said second profiled section (3) of an adjacent fluid flow channel (5b), and/or
said fluid flow can deviate from said main fluid flow axis (A1) as it exits said fluid outlet end (3b) of said second profiled section (3) of said fluid flow channel (5a), and
travel into said fluid passage (4) of said first profiled section (2) of an adjacent fluid flow channel (5b).

4. The web (1) according to any one of the previous claims, wherein

said first profiled section(s) (2) and said second profiled section(s) (3) of each fluid flow channel (5) have identical shape,
an axis of symmetry (A2) of said first profiled section(s) (2) extending coaxially with an axis of symmetry (A3) of said second profiled section(s) (3), and
extending in parallel with said main fluid flow axis (A1) of said fluid flow channel (5).

5. The web (1) according to claim 3, wherein said first profiled section (2) and said second profiled section (3) each comprise an apex (7) and a base (8), said apex (7) of said first profiled section (2) and said base (8) of said second profiled section (3) being arranged at one side of said main plane (Pl), and said base (8) of said first profiled section (2) and said apex (7) of said second profiled section (3) being arranged at an opposite side of said main plane (Pl).

6. The web (1) according to claim 5, wherein said apex (7) of said first profiled section (2) and said base (8) of said second profiled section (3) are arranged in a first common plane (P3), and
said base (8) of said first profiled section (2) and said apex (7) of said second profiled section (3) are arranged in a second common plane (P4).

7. The web (1) according to any one of the previous claims, wherein said first profiled section (2) and said second profiled section (3) each comprise at least one stepped part, said stepped part (9) of said first profiled section (2) extending adjacent said stepped part (9) of an adjacent second profiled section (3).

8. The web (1) according to claim 7, wherein said stepped part(s) (9) of said first profiled section(s) (2) extend coplanarly with said stepped part(s) (9) of said second profiled section(s) (3).

9. The web (1) according to any one of the previous claims, wherein said web (1) comprises a web material such as polymer, steel, or aluminum foil, and, optionally, a hygroscopic or epoxy coating.

10. A web matrix (10) for transfer of thermal energy and/or moisture to and/or from a fluid, said web matrix (10) comprising a plurality of webs (1) according to any one of claims 1 to 9,
said webs (1) being superimposed onto each other such that the main fluid flow axes (A1) of said webs (1) extend in parallel.

11. The web matrix (10) according to claim 10, further comprising at least one integral sheet material (11), each sheet material (11) being arranged between two adjacent webs (1).

12. The web matrix (10) according to claim 10 or 11, wherein the apex (7) and/or the base (8) of the first profiled sections (2) and/or the second profiled sections (3) of said webs (1) are fixedly attached to said sheet material (11).

13. A rotor (12) for a heat exchanger comprising the web matrix (10) according to any one of claims 10 to 12, a rotation axis (A4) of said rotor (12) extending in parallel with the main fluid flow axes (A1) of the webs (1) of said web matrix (10).

14. The rotor (12) according to claim 13, wherein each fluid flow channel (5) of said webs (1) is configured to accommodate bidirectional fluid flow at least partially along said main fluid flow axis (A1),
said fluid flowing in a first direction (D3), along said main fluid flow axis (A1), within a rotor section when said rotor section is in a first angular position (R1),
said fluid flowing in a second, opposite direction (D4), along said main fluid flow axis (A1), within said rotor section when said rotor section is in a second angular position (R2).

15. The rotor (12) according to claim 13 or 14, wherein said rotor (12) is configured for air-to-air heat transfer.

16. A rotary heat exchanger (13) comprising the rotor (12) according to any one of claims 13 to 15.

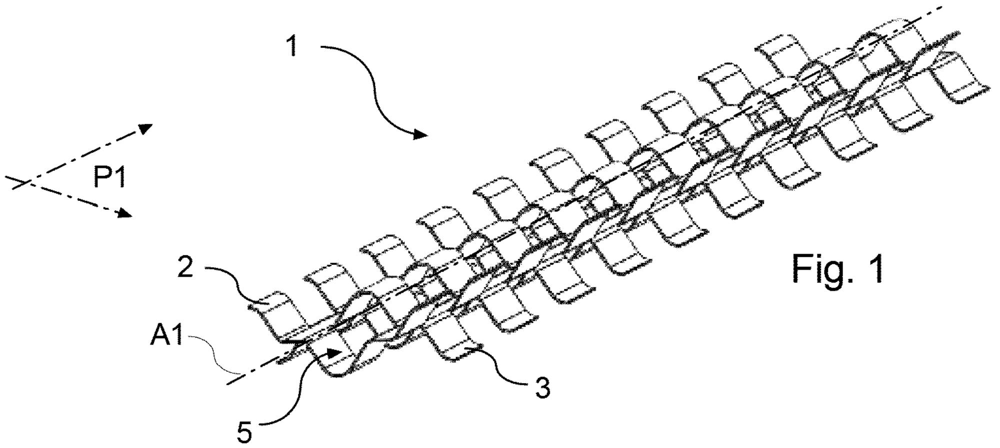

Fig. 1

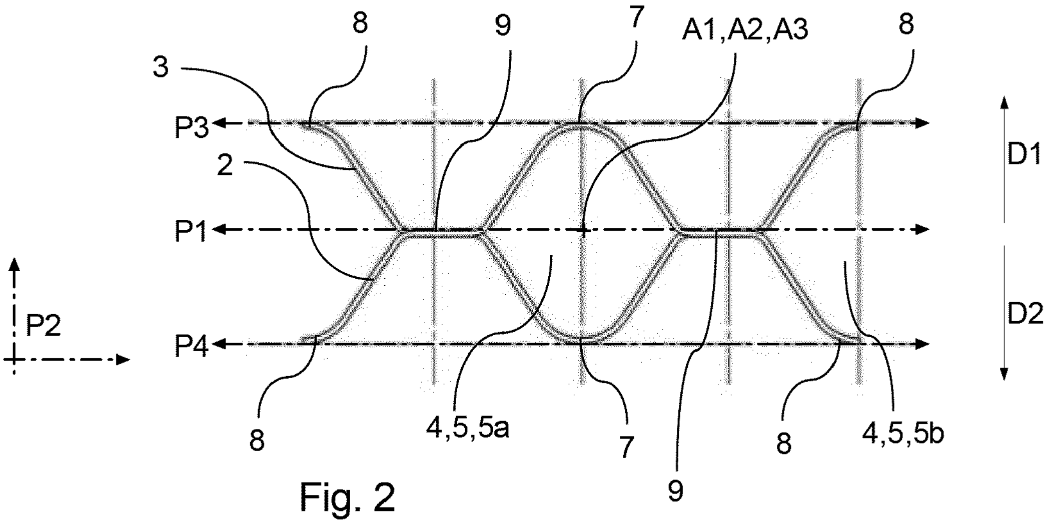

Fig. 2

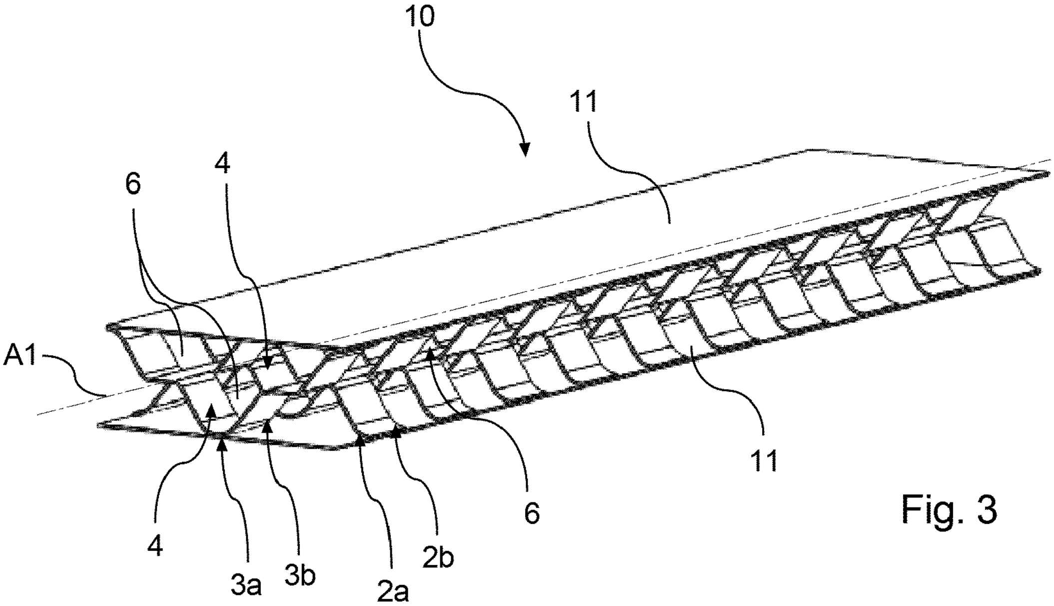

Fig. 3

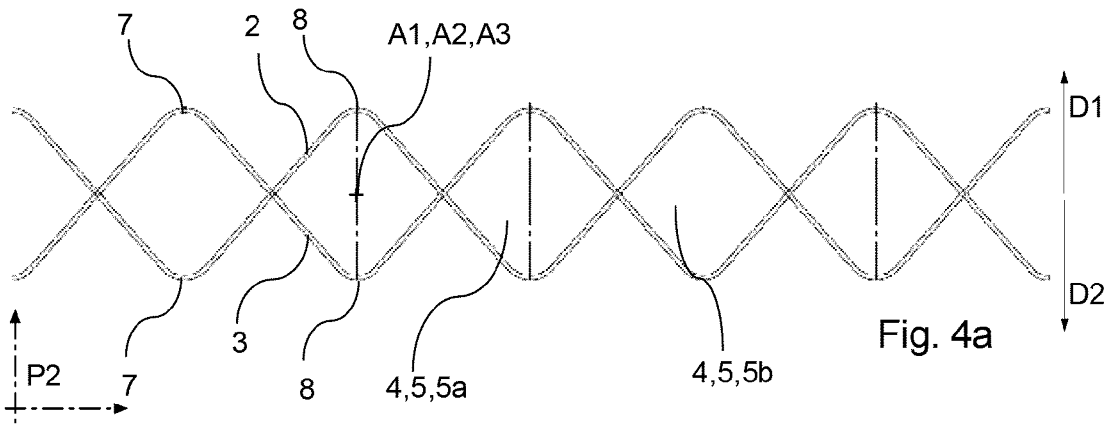

Fig. 4a

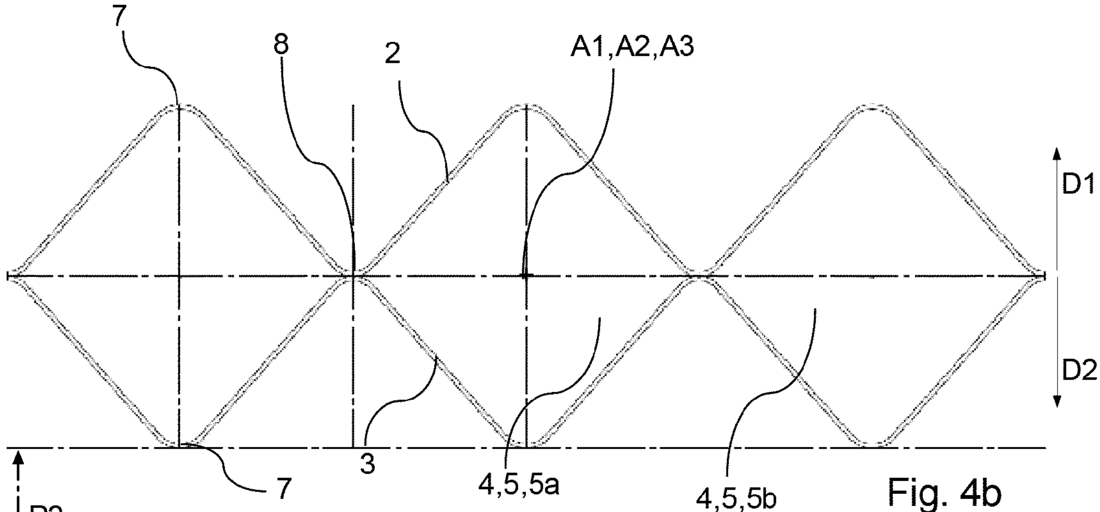

Fig. 4b

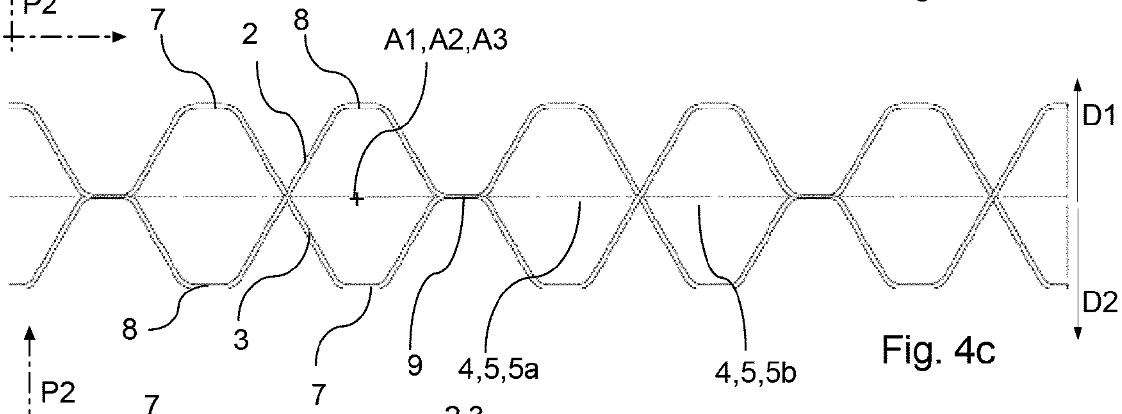

Fig. 4c

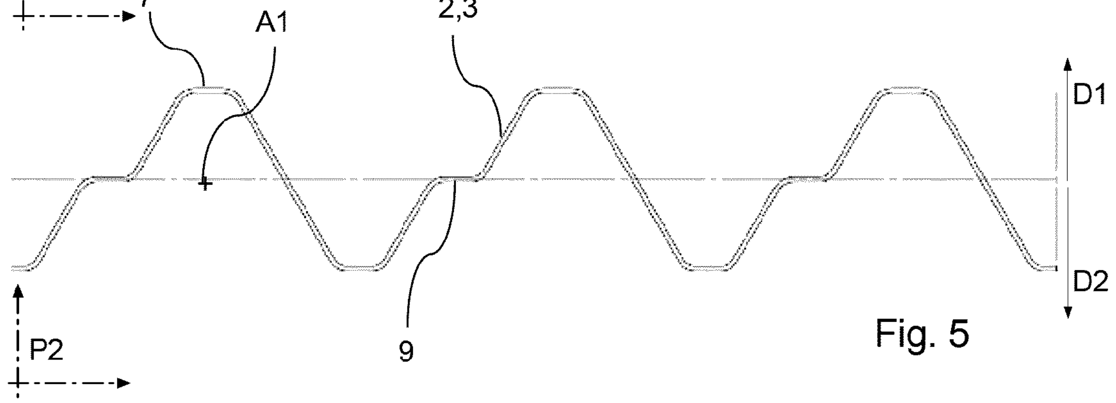

Fig. 5

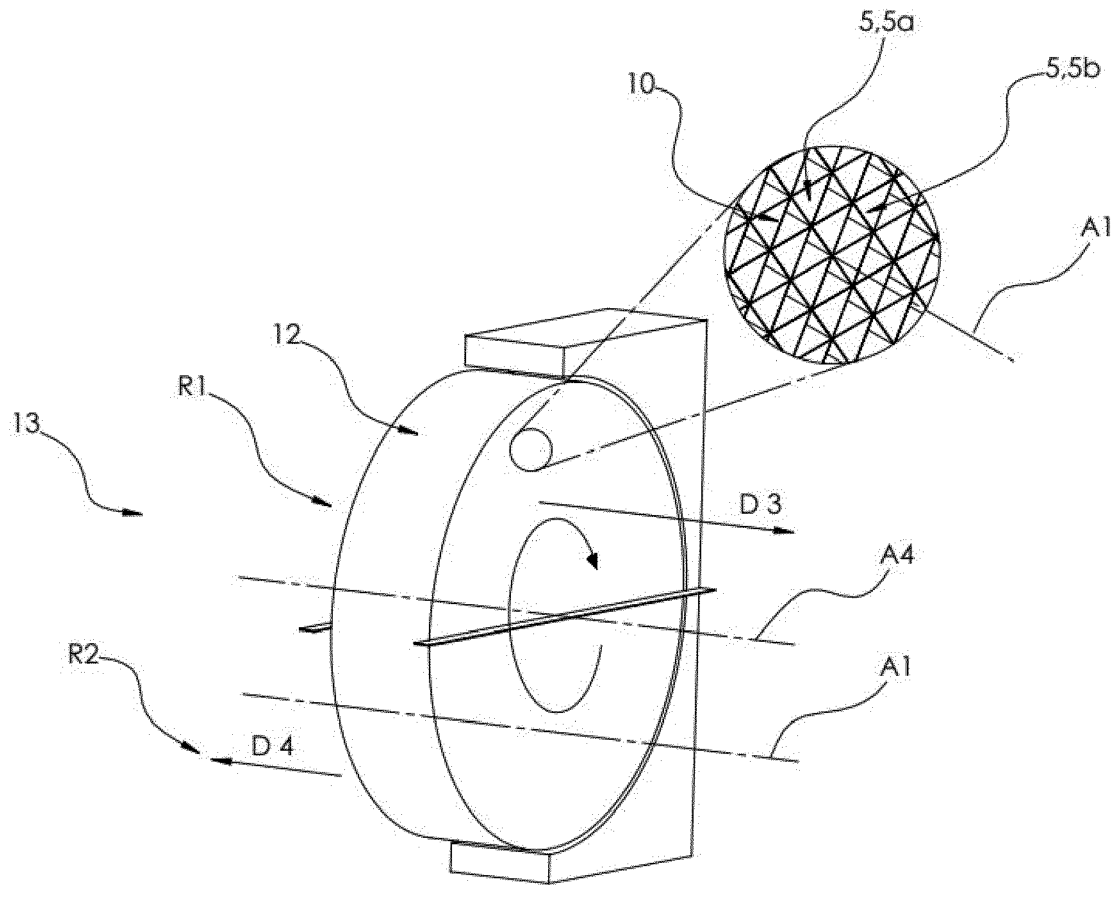

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 19 8836

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 2 752 128 A (JOSEPH DEDO LEWIS) 26 June 1956 (1956-06-26)	1-12	INV. F28D19/04 F28F3/02
Y	* figure 3 *	13-16	
X	US 4 804 041 A (HASEGAWA KAORU [JP] ET AL) 14 February 1989 (1989-02-14) * figure 2 *	1	
X	DE 10 74 063 B (GEA-LUFTKÜHLER GMBH) 25 May 1965 (1965-05-25) * figure 1 *	1	
X	US 2014/352345 A1 (HAKBIJL MARK [NL] ET AL) 4 December 2014 (2014-12-04)	1-16	
Y	* figures 4,4a,5,5a *	13-16	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F
F24F

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 January 2022	Martínez Rico, Celia

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 19 8836

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-01-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2752128 A	26-06-1956	NONE	
US 4804041 A	14-02-1989	JP H035516 B2	25-01-1991
		JP S61262593 A	20-11-1986
		US 4804041 A	14-02-1989
DE 1074063 B	25-05-1965	NONE	
US 2014352345 A1	04-12-2014	AU 2012354313 A1	17-07-2014
		BR 112014012144 A2	13-06-2017
		CN 104081148 A	01-10-2014
		EP 2791608 A1	22-10-2014
		ES 2604712 T3	08-03-2017
		JP 6211526 B2	11-10-2017
		JP 2014533821 A	15-12-2014
		KR 20160033573 A	28-03-2016
		MX 363494 B	26-03-2019
		NL 2007827 C2	23-05-2013
		US 2014352345 A1	04-12-2014
		WO 2013095105 A1	27-06-2013
		ZA 201404570 B	30-09-2015

EPO FORM P0459

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