(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 June 2014 (05.06.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/083551 A1

(51) International Patent Classification:
F28D 1/047 (2006.01) *F28F 1/02* (2006.01)

(21) International Application Number:
PCT/IB2013/060569

(22) International Filing Date:
2 December 2013 (02.12.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12195010.9 30 November 2012 (30.11.2012) EP
61/731,715 30 November 2012 (30.11.2012) US

(72) Inventor; and
(71) Applicant : **QUESADA, S., Carlos** [CR/CR]; Aptdo.: 488-1007, Av. 1 Calle 32, San José (CR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: HEAT EXCHANGER MEANS

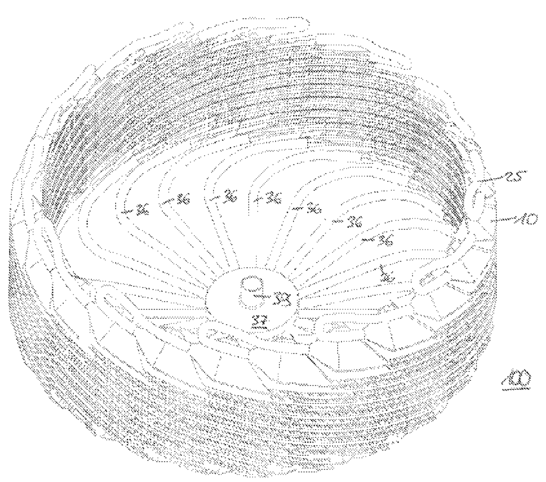

FIG. 10

(57) Abstract: The present invention relates to heat exchanger means (100) comprising several substantially flat and rigid elongated tubing elements (10) having a first side wall (40) and a second side wall (50) being arranged substantially parallel to each other, whereby the tubing elements (10) are forming a substantially overall cylindrical structure having a central longitudinal axis (X) and that the tubing elements (10) are spirally curved around the central longitudinal axis (X) and interleaved in the structure, whereby the tubing elements (10) have a plurality of fins (60) on at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the second side wall (50) and whereby the fins (60) are at least partially covered by a covering wall (70, 80), whereby the tubing elements (10) are at least partially tilted or at least partially tilted and sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure, whereby preferably the helical structure has an overall cylindrical structure and/or that the helical structure is formed in a cylindrical shape.

WO 2014/083551 A1

Heat exchanger means

Description

The present invention relates to a heat exchanger means comprising several substantially flat and rigid elongated tubing elements.

In the technical field of heat exchangers such as evaporators, condensers and radiators and coolers there have been many attempts to provide compact and energy efficient heat exchangers. A heat exchanger is hereby generally known to provide for an exchange of thermal energy between a first medium such as, for example, water and/or a cooling agent, and a second medium such as, for example, air.

For instance, EP 1 840 494 A2 discloses a heat exchanger, whereby the heat exchanger comprises a profile having two flat tubes with several channels and whereby the tubes are connected by means of a bar. The profile is a one-piece profile and may consist of aluminium or an aluminium alloy.

Moreover, DE 20 2008 006 379 U1 discloses an aluminium or aluminium alloy profile, which can be used for tubes for heat exchangers. The profile has a central channel and several further channels arranged around the central channel.

DE 2 209 325 discloses a tube for heat exchangers having a helical structure. Furthermore, DE 2 209 329 discloses heat exchanger tubes having ribs on the inner side and the outer side of the tube.

Additionally GB 1 390 782 discloses a heat-exchange tubing having spaced metal fins projecting inwardly of the tubing from the wall sections of the tubing and extending longitudinally of the tubing.

Further, EP 0 640 803 A1 relates to heat transfer coil, where a second piece of tubing is wound around the first piece of tubing while the first piece is straight and where the first piece of tubing is then formed to define the overall coil shape and then the first and second pieces of tubing internally sized by internal pressurization to also force the two pieces of tubing to intimate contact with each other.

However, it is still desirable to improve the already known technical solutions in the field of heat exchangers.

It is therefore an object for the present invention to improve a heat exchanger means, in particular in that the efficiency of the heat exchanges increases and that the overall structure of the heat exchanger means is improved and simplified and allows a more compact structure of the heat exchanger means.

The above object is solved according to the present invention by heat exchanger means with the features of claim 1. Accordingly, a heat exchanger means comprising several substantially flat and rigid elongated tubing elements is provided, whereby the tubing elements are forming a substantially overall cylindrical structure having a central longitudinal axis and that the tubing elements are spirally curved around the central longitudinal axis and interleaved in the structure, whereby the tubing elements have a plurality of fins in at least one of the outer surfaces of the first side wall and/or of the second side wall and whereby the fins are at least partially covered by covering wall, whereby the tubing elements are at least partially tilted or at least partially tilted and sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure, whereby preferably the helical structure has an overall cylindrical structure and/or that the helical structure is formed in a cylindrical shape.

The tubing element, having a plurality of fins on at least one of the outer surfaces of the first side wall and/or of the second side wall and whereby the fins are at least partially covered by a covering wall, increases the tubing element surface for a better heat exchange between said second medium, such as air, and the heat exchanger means.

The helical structure of the tubing element is determined merely by variables radius r, angle α and angle β. Radius r defines the distance between the center of the tubing element and the central longitudinal axis X of the heat exchanger means. Angle α defines the slope of the tubing element and extends between the central longitudinal axis X of the heat exchanger means and the central axis Z of the tubing element. Angle β defines the tilt of the tubing element and extends between the central longitudinal axis X of the heat exchanger means and the central transversal axis Y of the tubing element.

Therefore, due to the tilted orientation of the tubing element, there are almost no horizontal surfaces on the tubing element within the heat exchanger means. Natural condensate from air moisture disappears very quickly, because of the tilted and at least partially helically wound and/or twisted tubing element. Natural condensate from air moisture disappears to the outside surface of the heat exchanger means, because of the tilted orientation of the tubing element. So, freezing of condensate from air moisture between each of said tubing elements can be minimized.

Compared to the prior art, the tubing element, being at least partially tilted and at least partially helically wound and/or twisted so as to form at least a part of a helical structure, is more efficient with less material. Also the heat exchanger means needs a smaller volume in the whole heat exchanger system, due to the compact set of tubing elements. Making this heat exchanger a high power density solution with minimal volumetric footprint.

Further, this tubing element, being at least partially tilted and at least partially helically wound and/or twisted so as to form at least a part of a helical structure, effects a better interaction between a second medium such as air and the surface of the tubing element, due to the tilted orientation of the tubing element.

Such a tubing element for a heat exchanger means may be an elongated heat exchanger microchannel tube. Such an elongated heat exchanger microchannel tube may have a first and a second open end. There may be relatively large parallel opposite side walls of the microchannel tube with generally flat surfaces, which are joined with relatively small opposite edge walls between the side walls. These edge walls may be convexly curved.

Heat transfer vapor or fluid may fill a heat exchanger microchannel tube and may flow from one end of the microchannel tube to the other end. The term microchannel is also known as microport.

A second medium such as air may flow around the outer sides of the tubing element and may transport the heat from the tube away or vice versa.

By providing a plurality of fins on at least one of the outer surfaces of the first side wall and/or of the second side wall the surface for heat exchange is increased. Thus, also the efficiency of the heat exchanger may be significantly improved.

Moreover, it is possible that the width of the first side wall and the second side wall is approximately at least 10 times larger than the distance between the first side wall and the second side wall and/or that the first side wall and second side wall are connected respectively on both sides by a rounded connection wall.

The width of the first side wall and/or the second side wall may be equal and/or chosen within a range of about 10 mm to about 30 mm. Preferably, the width of the first side wall and/or the second side wall may be about 15 mm.

The distance between the first side wall and the second side wall may be chosen respectively, i.e. within a range of about 1 mm to about 3 mm. Preferably the distance may be about 1.5 mm.

Additionally, it is possible that the tubing element is at least partially tilted or at least partially tilted and sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure, whereby preferably the helical structure has an overall cylindrical structure and/or that the helical structure is formed in a cylindrical shape.

In particular, the structure according to the present invention of a heat exchanger means allows a more efficient heat exchange and a more compact structure of a heat exchanger means.

The heat exchanger means may be embodied as a heat exchanger.

It is possible that the fins are arranged between the covering wall and at least one of the outer surfaces of the first side wall and/or of the second side wall and that the covering wall and the outer surface are substantially parallel.

Furthermore, it is possible that the interleaved tubing elements are arranged one upon the other.

The first ends of adjacent tubing elements may be connected by a connecting means, whereby preferably the connecting means is a connector tubing element, which is for instance at least partially U-shaped bended.

Additionally, the second ends of adjacent tubing elements may be connected by a connecting means, whereby preferably the connecting means comprises plurality of connector tubing elements and a central connector portion, whereby for instance the connector tubing elements and the central connector portion are arranged in star-shaped manner.

Moreover, it is possible that the tubing element has a plurality of fins on both of the outer surfaces of the first side wall and of the second side wall.

The fins may be monoblock fins.

Further, the fins may be perpendicularly arranged on the at least one of the outer surfaces of the first side wall and/or of the second side wall.

It is possible that the fins are inclined arranged on the at least one of the outer surfaces of the first side wall and/or of the second side wall, whereby exemplarily the angle between the fins and the outer surface is substantially perpendicular.

Additionally, the fins may merely extend along the whole width of at least one of the outer surfaces of the first side wall and/or of the second side wall and/or are curved.

Furthermore, it is possible that the fins are arranged along a curve extending along the whole width of at least one of the outer surfaces of the first side wall and/or of the second side wall and/or are curved, whereby between the fins being arranged along a curve is a pitch and/or gap.

It is possible that the fins are arranged in a plurality of rows, preferably substantially parallel rows and/or preferably along at least a part of the length of the tubing element.

Further, the tubing elements may comprise at least one microchannel, preferably several microchannels with a round or circular cross-section and/or several microchannels with an angular cross-section, exemplarily several microchannels with a triangular cross-section and/or several microchannels with quadrangular crossection are provided.

Additionally, at least some of the microchannels may be arranged with an off-set to each other, whereby exemplarily all microchannels are arranged with an off-set to each other, whereby preferably the off-set causes chamfers and/or grooves within the first side wall and/or the second side wall.

Moreover, it is possible that the heat exchanger means is a condenser or an evaporator or a radiator or a cooler.

Further, the present invention relates to a tubing element with the features of claim 15. Accordingly, a tubing element for a heat exchanger means is provided comprising the tubing element features as defined in any of claims 1 to 14.

Further details and advantages of the present invention shall be described herein after with respect to the drawings:

Fig. 1: A perspective view of a part of the tubing element according to the present invention in detail;

Fig. 2a, b: A further perspective view of a part of the tubing element according to the present invention in detail in a first and second embodiment;

Fig. 3: A further perspective view of a part of the tubing element according to the present invention in a helical structure;

Fig. 4: A side elevation of the heat exchanger means in a first embodiment according to the present invention;

Fig. 5: A perspective view of a tubing element for a heat exchanger with connecting means;

Fig. 6: A further perspective view of the tubing element according to Fig. 5;

Fig. 7: A perspective view of interconnected tubing elements according to the present invention for a heat exchanger means;

Fig. 8: A further perspective view of interconnected tubing elements for the heat exchanger means according to the present invention according to Fig. 7;

Fig. 9: A side elevation of a heat exchanger according to the present invention; and

Fig. 10: A perspective view of the embodiment of the heat exchanger means according to Fig. 9.

Figure 1 shows a detailed perspective view of an elongated tubing element 10 having a plurality of microchannels 90 with quadrangular cross-section.

The tubing element is a rigid elongated heat exchanger tubing having at least a first end 20 and a second end 30 and having a first side wall 40 and second side wall 50. The first side wall 40 and the second side wall 50 are arranged substantially parallel to each other and the distance d between the first side wall 40 and the second side wall 50 is considerably smaller than the width W of the first side wall 40 and the second side wall 50. Thus, the tubing element has a substantially overall flat tubing structure.

The width W of the first side wall 40 and the second side wall 50 is approximately at least ten times larger than the distance d between the first side wall 40. The second side wall 50 and the first side wall and the second side wall 40, 50 are connected respectively on both sides by a rounded connection wall 45, 55.

The width W of the first side wall 40 and the second side wall 50 is equal and chosen within a range of about 10 mm to 30 mm.

In the embodiment shown in Figure 1, the width W of the first side wall and the second side wall 40, 50 is about 15 mm. The distance d is thus chosen with a value of about 1.5 mm.

Normally, the distance between the first side wall 40 and the second side wall 50 is chosen respectively to the width values of the first side wall 40 and the second side wall 50, i.e. normally within a range of about 1 mm to 3 mm.

The tubing element 10 is at least partially tilted and sloped and also at least partially helically wound and twisted as shown in Figure 2a so as to form at least a part of a helical structure (see Figure 3), whereby the helical structure has an overall cylindrical structure and the helical structure is formed in a cylindrical shape.

As best seen in Figure 3, the tubing element 10 is forming an overall cylindrical structure having a central longitudinal axis X, said tubing element 10 being spatially curved around the central longitudinal axis X and interleaved in the structure (see Figure 4) of several equal tubing elements 10. The tubing elements 10 have a plurality of fins 60 on both outer surfaces 42, 52 of the first side wall 40 and the second side wall 50, as can be seen in Figures 1, 2a and 3. The helical structure of the tubing element 10 is determined merely by variables radius r, angle α and angle β. Radius r defines the distance between the center of the tubing element 10 at the intersection of the central axis Z and the central transversal axis Y, both of the tubing element 10 and the central longitudinal axis X of the heat exchanger means 100. Angle α defines the slope of the tubing element 10 and extends between the central longitudinal axis X of the heat exchanger means 100 and the central axis Z of the tubing element 10. Angle β defines the tilt of the tubing element 10 and extends between the central longitudinal axis X of the heat exchanger means 100 and the central transversal axis Y of the tubing element 10.

The fins 60 are arranged between the covering walls 70, 80 and the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50. Moreover, the covering wall 70, 80 and the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50 are substantially parallel. However, the covering wall 70, 80 and the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50 are not directly connected to each other so that e.g. a cooling medium may flow through the fins 60 arranged within the space provided by the covering wall 70, 80 and the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50.

In particular, the cooling medium may enter the space also from the sides of the rounded connection walls 45, 55. In the embodiment shown in Figs. 1 to 4, the fins 60 are arranged on angles between 22.5 and 45 degrees on the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50.

Alternatively, it is possible that the fins 60 are inclined arranged on the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50, whereby exemplarily the angle between the fin 60 and the outer surface 42, 52 is substantially perpendicular.

The fins 60 merely extend along the whole width of the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50 and are curved. Furthermore, the fins 60 are arranged along a curve extending along the whole width of the outer surfaces 42, 52 of the first side wall 40 and the second side wall 50. Moreover, between the fins 60 several gaps 62 are provided. Through the gaps 62 the medium, e.g. a cooling or heating medium may pass.

The fins 60 and the curve of fin 60 and the connection walls 45, 55 are arranged such to each other that they enclose an angle γ. The angle γ is chosen in the embodiment shown in Figs. 1 to 4 within a range about 22.5° to about 45°, here in an angle of about 45° in Fig. 1 and 22.5 degrees in Figs. 2 to 4.

An angle of about 45° between the fins 60 and the curve of fins 60 and at least one of the connection walls 45, 55 is considered to be substantially neutral, in particular as a neutral arrangement with respect to the interference with e.g. fans or the like, which may be connected or used together with the heat exchanger means 100 comprising such tubing elements 10, as e.g. shown in Figures 4, 9 and 10.

Figure 2b shows an alternative embodiment of a tubing element 10', which is almost identical with the embodiment shown in Figure 2a. The only difference is that the tubing element 10' comprises fins 60' which merely extend along the whole width W of the outer surfaces 42, 52 of the first side wall 40 and the second sidewall 50.

As can be seen in Figure 3, the tubing elements 10 are tilted and sloped and helical wound and twisted so as to form a part of a helical structure, whereby this helical structure has an overall cylindrical structure.

These tubing elements are interleaved and arranged one upon the other to a heat exchanger means 100, as shown in Figure 4. Also, the central longitudinal axis is shown.

Figure 5 shows a non-tilted and unwound rigid elongated tubing element 10 for heat exchanger 100 according to the present invention. The tubing element 10 has the same structural and functional features as described with respect to the tubing element 10 shown in Figure 1 to 4.

Moreover, the tubing element 10 comprises at its first end 20 and at its second end 30 a collecting portion 21, 31, which is reducing the width W of the first side wall 40 and the second side wall 50 to a smaller width.

The collecting portions 21, 31 are equipped with tubular elements 22, 32, i.e. tubular connectors with a circular cross-section by means of which the tubing element 10 may be connected with another tubing element or any connecting means, e.g. the first and second connecting means 25 and 35 as shown in Figure 7, 8, 9 and 10.

Figure 6 shows a tubing element 10 according to Figure 5, whereby the tubing element 10 shown in Fig. 6 has been partially tilted and sloped and partially helically wound and twisted so as to form at least a part of a helical structure.

After the at least partially tilting and sloping and the at least partially helically winding and twisting as described in connection with Figure 6, the so formed rigid elongated tubing elements 10 for the heat exchanging means 100 may be attached to another, equally formed further tubing element 10. Both tubing elements 10 are connected by a first connecting means 25. This connecting means 25 is a connector tubing element 25, which is U-shaped bended, see Figure 7.

Figure 8 is another perspective view of the arrangement of tubing elements as shown in Figure 7.

The so connected tubing elements 10 may be further combined to an overall cylindrical structure of a heat exchanger means 100, as shown in Figure 9 and 10. As can be seen in Figure 9 and 10, the second end 30 of adjacent tubing elements 10 are connected by a second connecting means 35. Also, the central longitudinal axis is shown in Figure 9.

The second connecting means 35 comprises a plurality of connected tubing elements 36 and a central connector portion 37, whereby the connector tubing elements 36 and the central connector portion 37 are arranged in a star-shaped manner.

The connector tubing element 36 form alternatingly an inlet or an outlet. The inlet connector tubing elements 36 are connected with the inlet portion 38 of the central connector portion 37 and the outlet connector tubing elements 36 are connected with the outlet portion 39 of the central connector portion 38. In any case, inlet and outlet function may be interchanged, i.e. the inlet may be the outlet or vice versa.

Claims

1. Heat exchanger means (100) comprising several substantially flat and rigid elongated tubing elements (10) having a first side wall (40) and a second side wall (50) being arranged substantially parallel to each other, whereby the tubing elements (10) are forming a substantially overall cylindrical structure having a central longitudinal axis (X) and that the tubing elements (10) are spirally curved around the central longitudinal axis (X) and interleaved in the structure, whereby the tubing elements (10) have a plurality of fins (60) on at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the second side wall (50) and whereby the fins (60) are at least partially covered by a covering wall (70, 80), whereby the tubing elements (10) are at least partially tilted or at least partially tilted and sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure, whereby preferably the helical structure has an overall cylindrical structure and/or that the helical structure is formed in a cylindrical shape.

2. Heat exchanger means (100) according to claim 1,
c h a r a c t e r i z e d in that
the fins (60) are arranged between the covering wall (70, 80) and at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the

second side wall (50) and that the covering wall and the outer surface are substantially parallel.

3. Heat exchanger means (100) according to claim 1 or 2,
c h a r a c t e r i z e d in that
the interleaved tubing elements (10) arranged one upon the other.

4. Heat exchanger means (100) according to any of the preceding claims,
c h a r a c t e r i z e d in that
the first ends (20) of adjacent tubing elements (10) are connected by a first connecting means (25), whereby preferably the first connecting means (25) is a first connector tubing element (25), which is for instance at least partially U-shaped bended.

5. Heat exchanger means (100) according to any of the preceding claims,
c h a r a c t e r i z e d in that
the second ends (30) of adjacent tubing elements (10) are connected by a second connecting means (35), whereby preferably the second connecting means (35) comprises plurality of connector tubing elements (36) and a central connector portion, whereby for instance the connector tubing elements (36) and the central connector portion (37) are arranged in star-shaped manner.

6. Heat exchanger means (100) according to any of the preceding claims,
c h a r a c t e r i z e d in that
the tubing element (10) has a plurality of fins (60) on both of the outer surfaces (42, 52) of the first side wall (40) and of the second side wall (50).

7. Heat exchanger means (100) according to any of the preceding claims,
c h a r a c t e r i z e d in that
the fins are monoblock fins (60).

8. Heat exchanger means (100) according to any of the preceding claims, c h a r a c t e r i z e d in that
the fins (60) are perpendicularly arranged on the at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the second side wall (50).

9. Heat exchanger means (100) according to any of claims 1 to 8, c h a r a c t e r i z e d in that
the fins (60) are inclined arranged on at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the second side wall (50), whereby exemplarily the angle between the fins (60) and the outer surface (42, 52) is substantially perpendicular.

10. Heat exchanger means (100) according to any of the preceding claims, c h a r a c t e r i z e d in that
the fins (60) merely extend along the whole width of at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the second side wall (50) and/or are curved and/or that the fins (60) are arranged along a curve extending merely along the whole width of at least one of the outer surfaces (42, 52) of the first side wall (40) and/or of the second side wall (50) and/or are curved, whereby between the fins (60) being arranged along a curve is a pitch and/or gap.

11. Heat exchanger means (100) according to any of the preceding claims, c h a r a c t e r i z e d in that
the fins (60) are arranged in a plurality of rows, preferably substantially parallel rows and/or preferably along at least a part of the length of the tubing element (10).

12. Heat exchanger means (100) according to any of the preceding claims, c h a r a c t e r i z e d in that
the tubing elements (10) comprise at least one microchannel (60, 70, 80, 90), preferably several microchannels (60) with a round or circular cross-section and/or several microchannels (70, 80, 90) with an angular cross-section, exemplarily several microchannels with a triangular cross-section (80) and/or several microchannels (70, 90) with quadrangular crossection are provided.

13. Heat exchanger means (100) according to claim 12,
c h a r a c t e r i z e d in that
at least some of the microchannels (90) are arranged with an off-set (O) to each other, whereby exemplarily all microchannels (90) are arranged with an off-set (O) to each other, whereby preferably the off-set causes chamfers and/or grooves within the first side wall (40) and/or the second side wall (50).

14. Heat exchanger means (100) according to any of the preceding claims,
c h a r a c t e r i z e d in that
the heat exchanger means (100) is a condenser or an evaporator or a radiator or a cooler.

15. Tubing element (10) for a heat exchanger means (100) comprising the tubing element features according to any of the preceding claims.

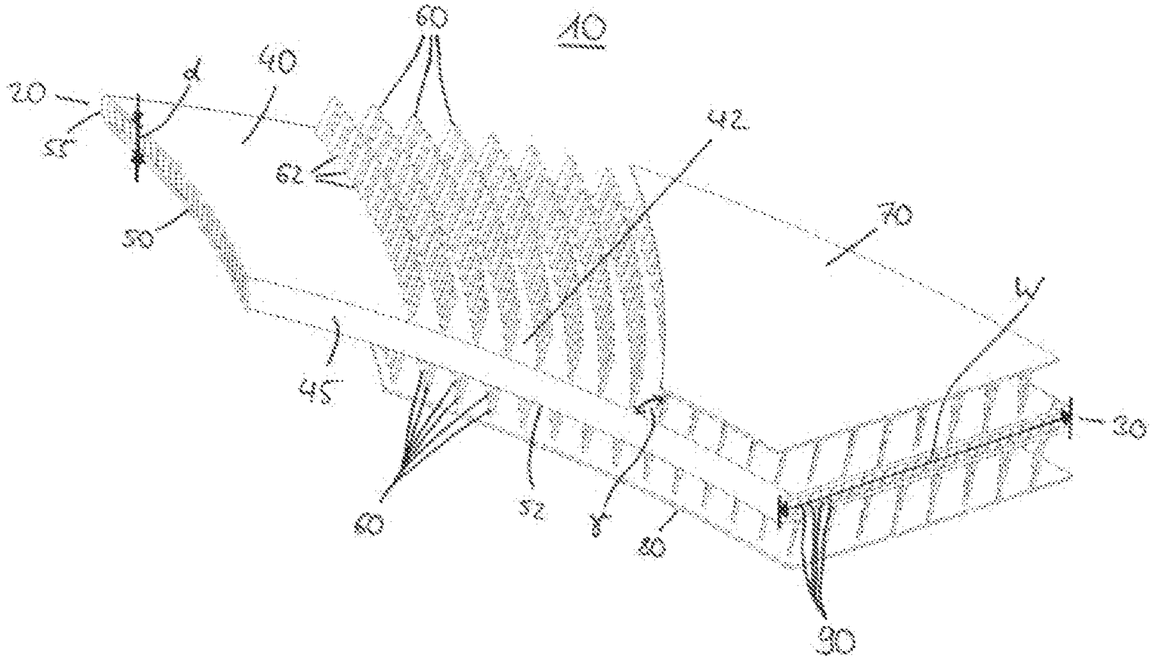

FIG. 1

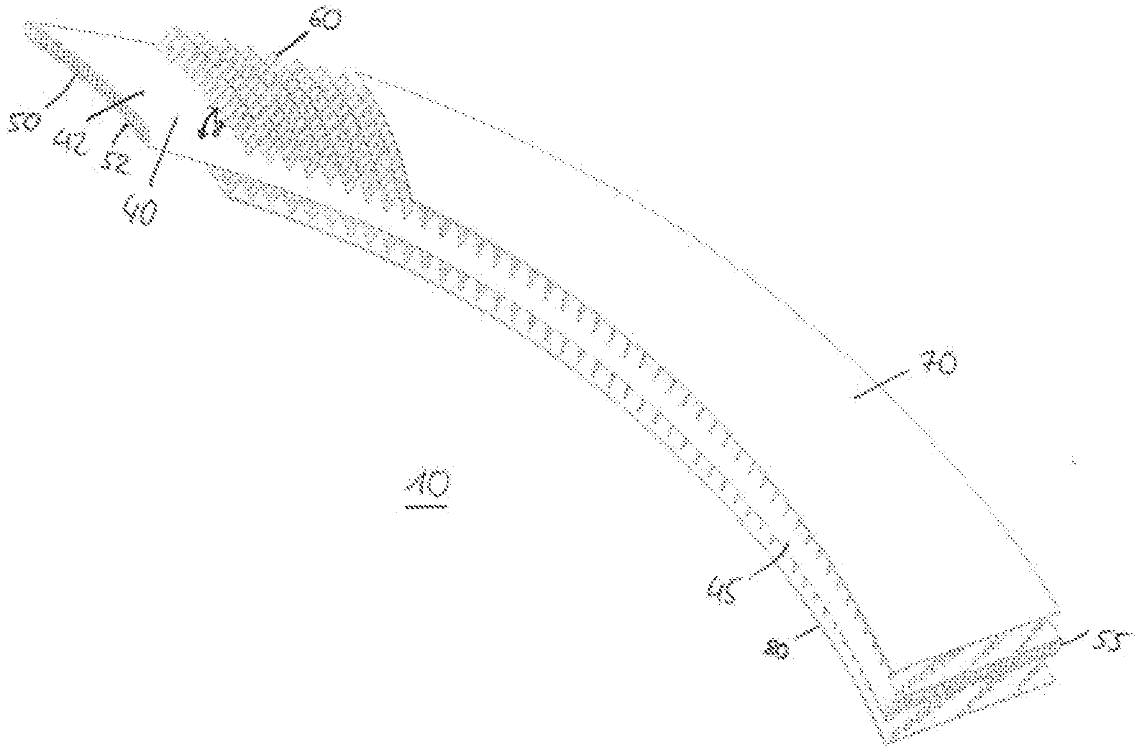

FIG. 2a

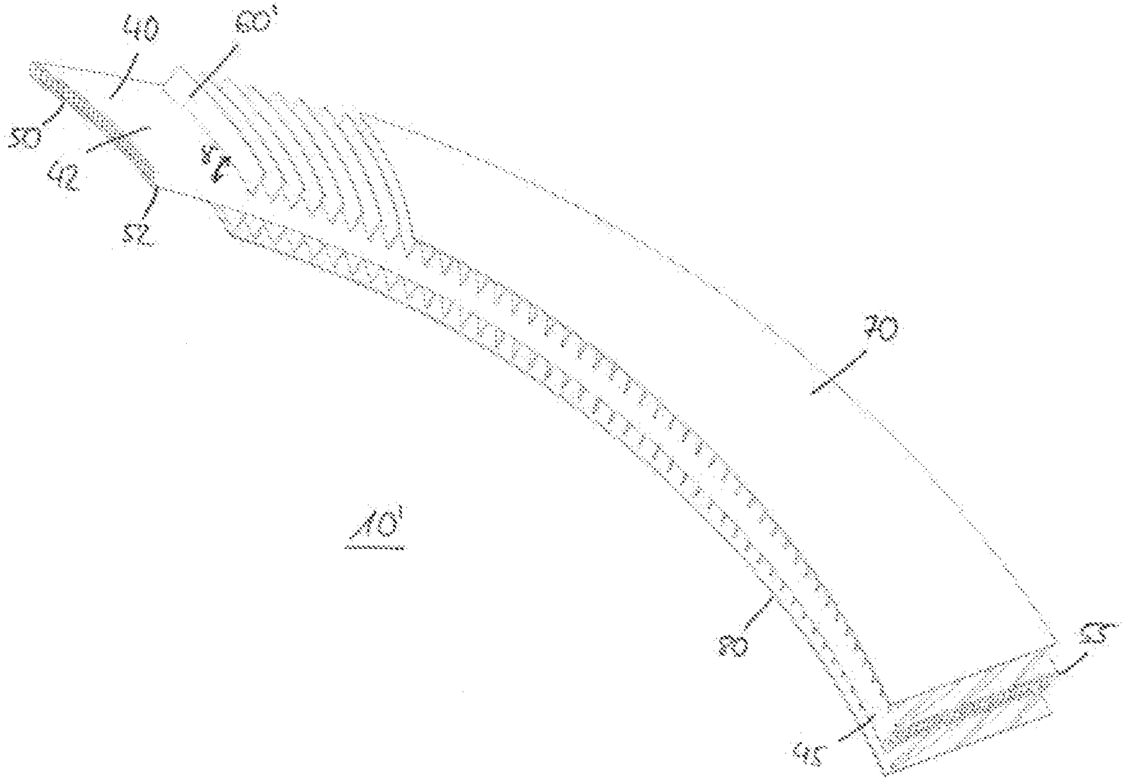

FIG. 2b

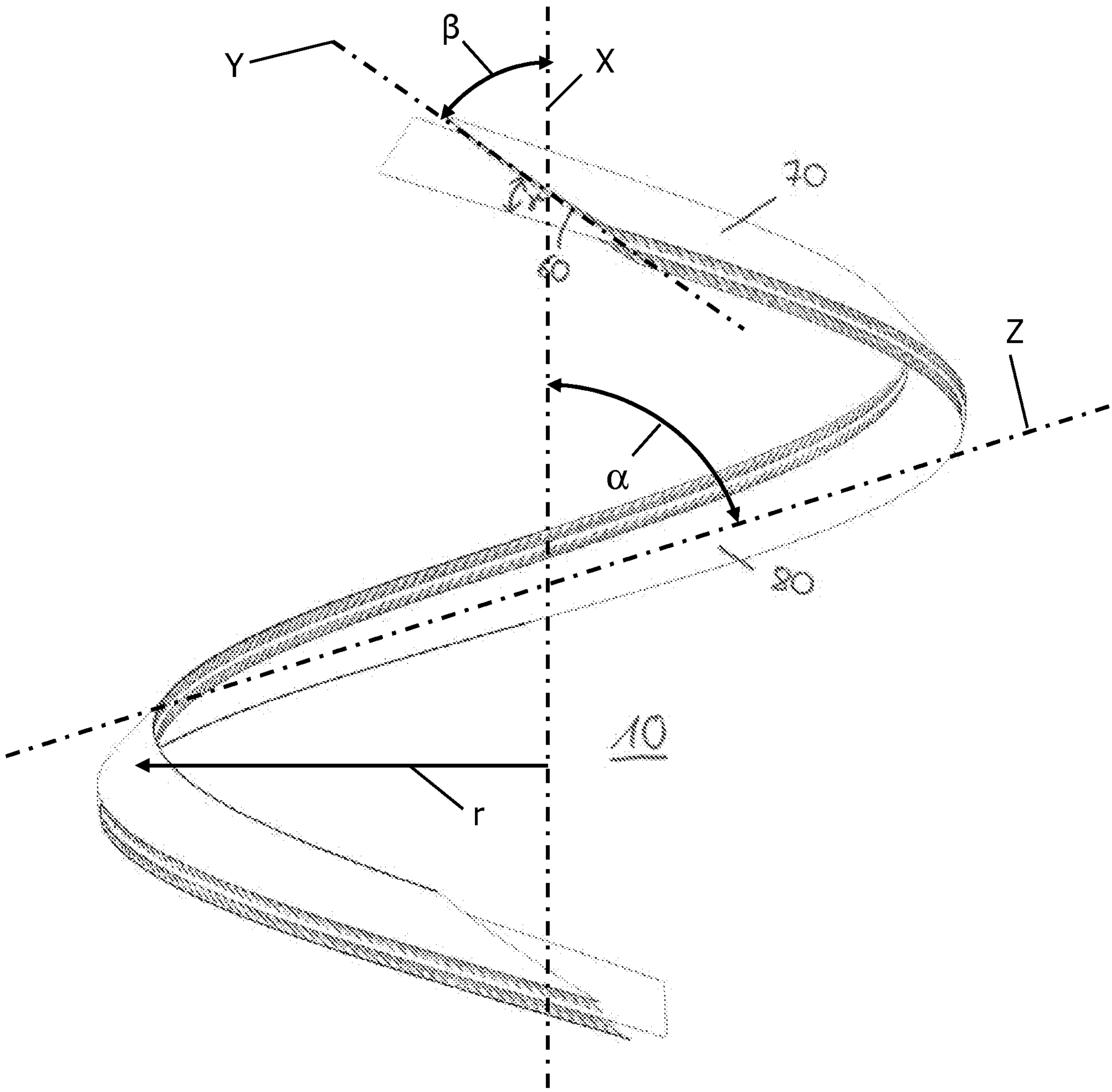

FIG. 3

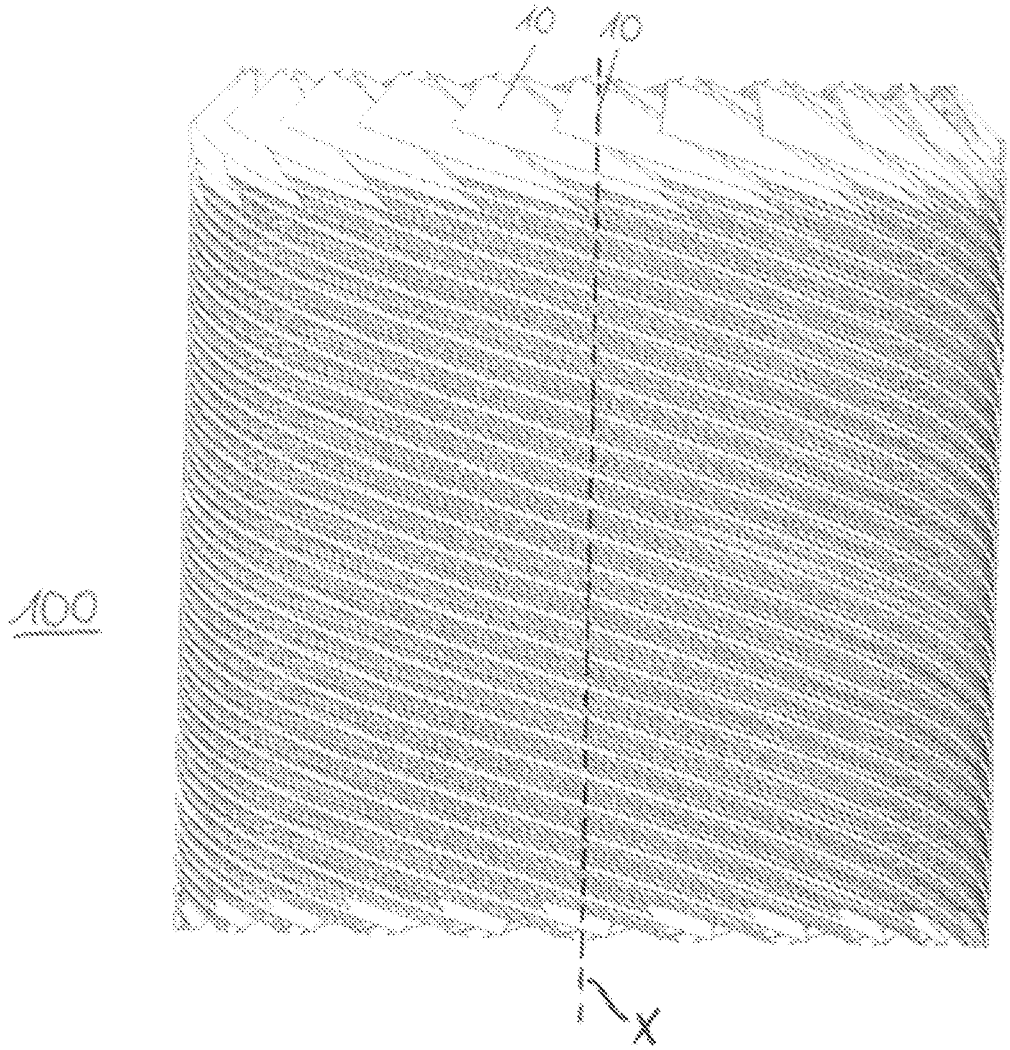

FIG. 4

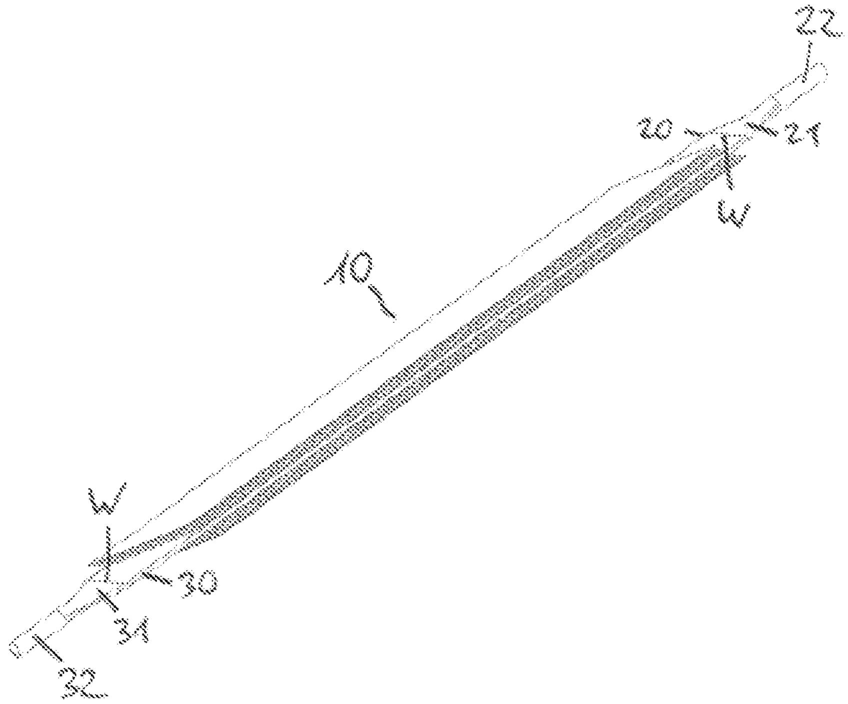

FIG. 5

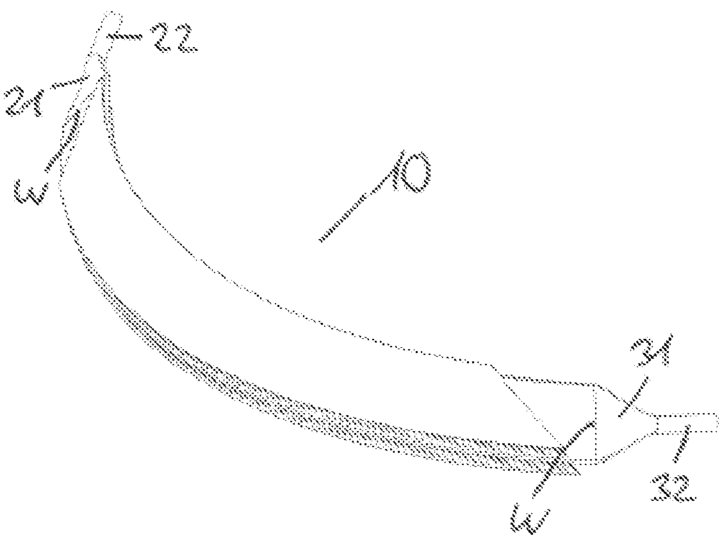

FIG. 6

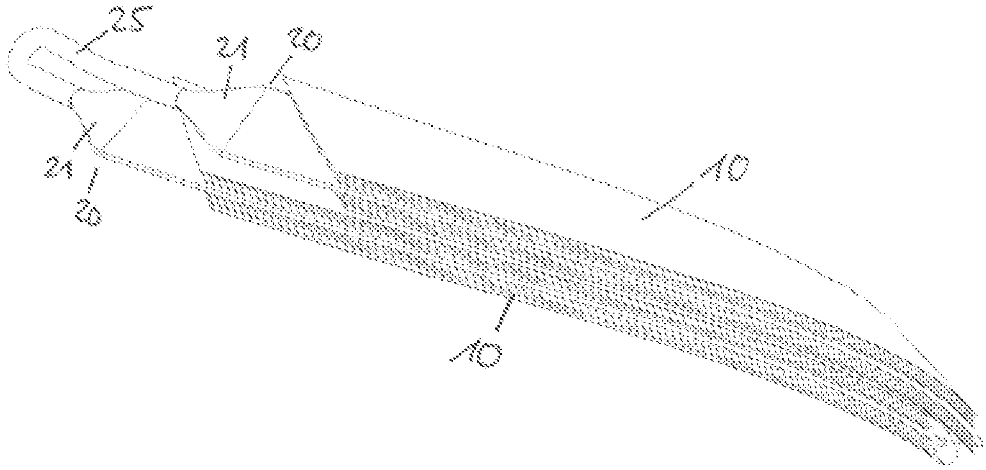

FIG. 7

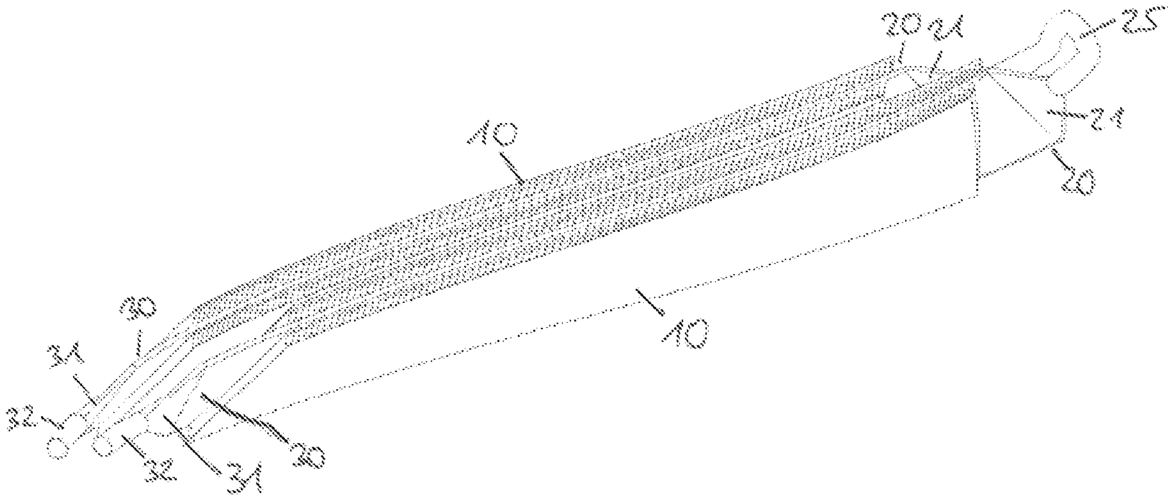

FIG. 8

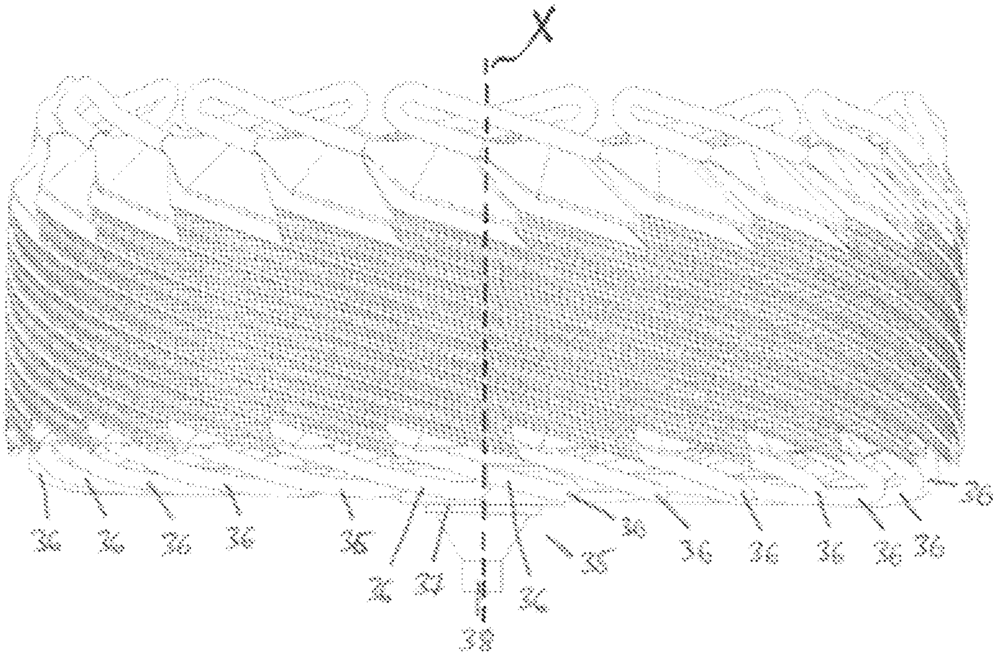

FIG. 9

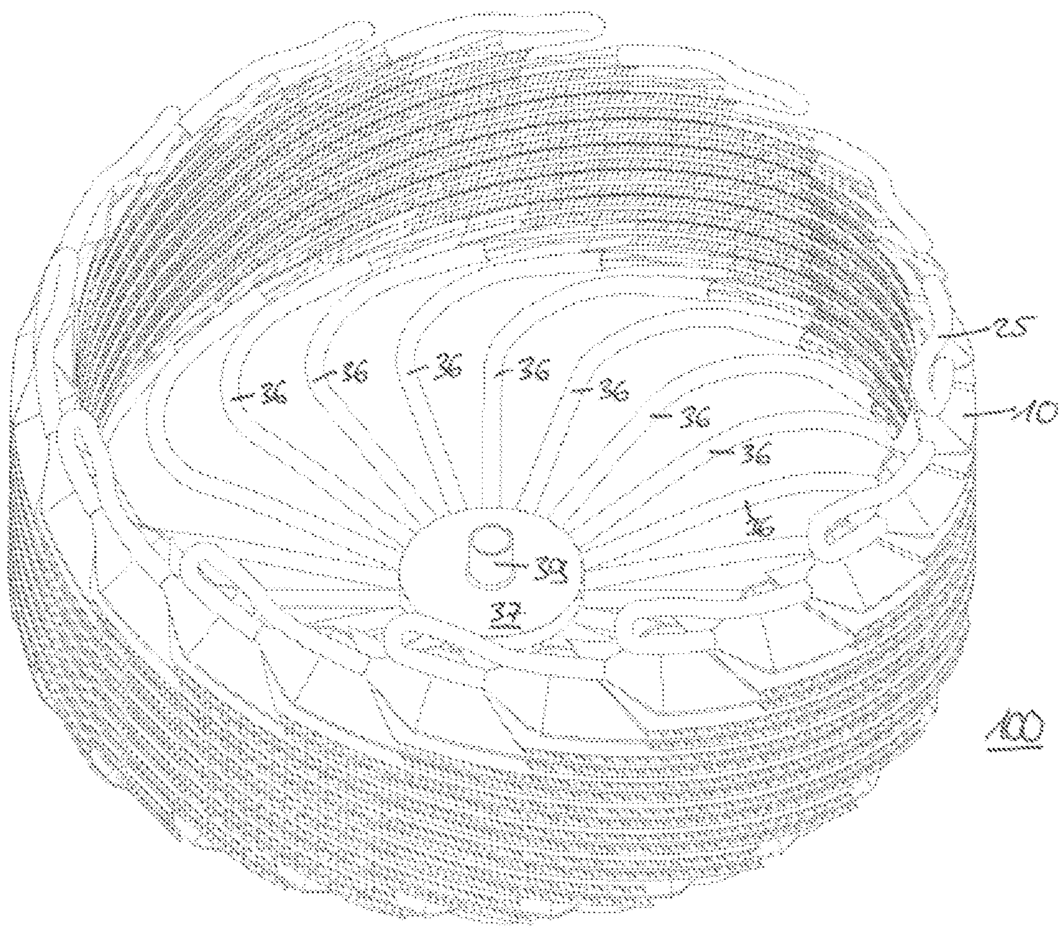

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/060569

A. CLASSIFICATION OF SUBJECT MATTER
INV. F28D1/047 F28F1/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F28F F24H F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004 218954 A (TOYO RADIATOR CO LTD) 5 August 2004 (2004-08-05) figures 3, 6 abstract paragraph [0004] paragraph [0013] paragraph [0014] -----	1-15
A	DE 38 15 647 A1 (SUEDDEUTSCHE KUEHLER BEHR [DE]) 22 December 1988 (1988-12-22) figures -----	1-15
A	US 2007/125528 A1 (FAKHERI AHMAD [US]) 7 June 2007 (2007-06-07) figures 5a-5c -----	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 February 2014	18/02/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fernandez Ambres, A

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2013/060569

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2004218954 A	05-08-2004	NONE	
DE 3815647 A1	22-12-1988	NONE	
US 2007125528 A1	07-06-2007	NONE	