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(54) **Tubing element for a heat exchanger means**

(57) The present invention relates to a tubing element (10) for a heat exchanger means (100, 100', 100'', 100'''), the tubing element (10, 10', 10'', 10''') being at least partially a rigid elongated heat exchanger tubing having at least a first end (20) and at least a second end (30) and having a first side wall (40) and a second side wall (50), the first side wall (40) and the second side wall (50) being arranged substantially parallel to each other and the distance (d) between the first side wall (40) and the second side wall (50) being considerably smaller than the width of the first side wall (40) and the second side

wall (50) resulting in a substantially overall flat tubing structure, the tubing element (10, 10', 10'', 10''') being at least partially tilted and/or sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure. Furthermore, the present invention relates to a heat exchanger means, the use of a tubing element (10, 10', 10'', 10'''), the use of a heat exchanger means (100, 100', 100'', 100''') and the method of manufacturing of a tubing element (10, 10', 10'', 10''') to manufacture at least partially a heat exchanger means (100, 100', 100'', 100''').

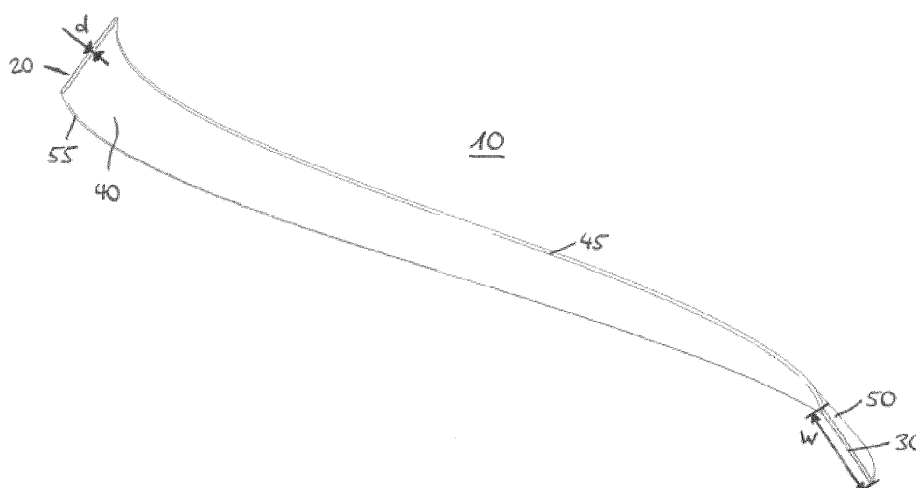


FIG. 1

Description

[0001] The present invention relates to a tubing element for a heat exchanger means, a heat exchanger means, the use of a tubing element to manufacture at least partially a heat exchanger means, the use of a heat exchanger means to exchange heat and the method of manufacturing of a tubing element.

[0002] In the technical field of heat exchangers such as evaporators, condensers, coolers and radiators there have been many attempts to provide compact and energy efficient heat exchangers.

[0003] 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.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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.

[0008] However, it is still desirable to improve the already known technical solutions in the field of heat exchangers.

[0009] It is therefore an object for the present invention to improve a tubing element for a heat exchanger means, a heat exchanger, the use of a tubing element to manufacture at least partially a heat exchanger means, the use of a heat exchanger to exchange heat and a method of manufacturing of a tubing element, in particular in that the efficiency of the heat exchange is increased and that the overall structure of the tubing element and the heat exchanger is improved and simplified and allows a more compact structure of a heat exchanger.

[0010] The above object is solved according to the present invention by a tubing element for a heat exchanger means with the features of claim 1. Accordingly, a tubing element for a heat exchanger means, the tubing element being at least partially a rigid elongated heat exchanger tubing having at least a first end and at least a

second end and having a first side wall and a second side wall, the first side wall and the second side wall being arranged substantially parallel to each other and the distance between the first side wall and the second side wall being considerably smaller than the width of the first side wall and the second side wall resulting in a substantially overall flat tubing structure, the tubing element being at least partially tilted and/or sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] By this, the advantage is achieved that the tubing element has relatively large flat surfaces, which allows a good and improved heat transfer from the medium flowing in the tube through the walls of the tube and to the second medium flowing around the outer sides of the tubing element or vice versa.

[0015] Due to the flat tilted and/or sloped and/or helical overall structure that heat from the first medium flowing within the tube may be drawn and removed or vice versa with higher efficiency, when compared with a structure having a large circular or angular cross-section.

[0016] 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.

[0017] The first side wall and second side wall may be connected respectively on both sides by a rounded connection wall.

[0018] Furthermore, it is possible that the helical structure has an overall cylindrical structure and/or that the helical structure is formed in a cylindrical shape.

[0019] Additionally, the tubing element may comprise at least one microchannel.

[0020] Moreover, several microchannels with a round or circular cross-section and/or several microchannels with an angular cross-section may be provided. Exemplarily, several microchannels with a triangular cross-section and/or several microchannels with quadrangular cross-section can be provided.

[0021] It is possible that at least some of the microchannels are arranged with an off-set to each other. Ex-

emplarily, all microchannels may be arranged with an off-set to each other.

[0022] For instance, the off-set may cause chamfers and/or grooves within the first side wall and/or the second side wall.

[0023] Particularly, it is possible that the tubing element comprises at its first end and at its second end a collecting portion, which is reducing the width of the first side wall and the second side wall to a smaller width.

[0024] Furthermore, the present invention relates to a heat exchanger means with the features of claim 10. Accordingly, a heat exchanger means has at least one tubing element according to any of claims 1 to 9.

[0025] Said heat exchanger may comprise several tubing elements. Moreover, it is possible that the tubing elements are substantially forming an 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.

[0026] The heat exchanger means may be a radiator or a cooler or a condenser or an evaporator.

[0027] Additionally, the present invention relates to the use of a tubing element to manufacture at least partially a heat exchanger means with the features of claim 13. Accordingly, a tubing element is used to manufacture at least partially a heat exchanger means according to claim 10 or 11 exemplarily by tilting and/or sloping and at least partially helically winding and/or twisting the tubing element so at least to form a part of a helical structure.

[0028] Moreover, the present invention relates to the use of a heat exchanger means to exchange heat with the features of claim 14. Accordingly, a heat exchanger means is used, whereby the heat exchanger means is a heat exchanger means according to claim 10 or 11, to exchange heat, exemplarily to use a heat exchanger means as a radiator or as a cooler or as a condenser or as an evaporator.

[0029] Furthermore, the present invention relates to a method of manufacturing of a tubing element with the features of claim 15. Accordingly, a tubing element according to any of claims 1 to 9 is manufactured, whereby exemplarily the tubing element is received by using an extrusion process of a heat transfer material, whereby preferably the extrusion process is a single extrusion process and/or whereby preferably the heat exchanger material is at least partially aluminium or copper or an alloy thereof.

[0030] Further details and advantages of the present invention shall be described herein after with respect to the drawings:

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

Fig. 2: A further perspective view of tubing element shown in Figure 1 showing the angles for the slope and the twist of the tubing element;

Fig. 3: A perspective view of tubing element according to the present invention in a second embodiment;

5 Fig. 4: A further perspective view of tubing element shown in Figure 3 showing the angles for the slope and the twist of the tubing element;

Fig. 5: A perspective view of a tubing element with several alternatives for the internal structure of the tubing element;

Fig. 6: A side elevation of a tubing element in a helical structure;

Fig. 7: A perspective view of the helical structure shown in Figure 6;

Fig. 8: A side elevation of interlaced sloped helical tubing elements according to the present invention with adjacent sloped and twisted similarly helically formed tubing elements;

Fig. 9: A perspective view of the interlaced tubing elements helixes as shown in Figure 8;

Fig. 10: A further embodiment of a tubing element, which is helically formed;

Fig. 11: A side elevation of interlaced sloped helical tubing elements with adjacent sloped and twisted similarly helically formed tubing elements as shown in Figure 10;

Fig. 12: A perspective view of the interlaced tubing element helixes shown in Figure 11;

Fig. 13: A further embodiment of the tubing element;

Fig. 14: A side elevation of interlaced sloped helical microchannel tubing elements according to Figure 13;

Fig. 15: A further perspective of tubing element according to Figure 13; and

Fig. 16: A further perspective view of the interlaced tubing element helixes as shown Figure 14.

50 **[0031]** Figure 1 shows the perspective view of a first embodiment of the tubing element 10. The tubing element 10 is a rigid elongated heat exchanger tube 10 having a first end 20 and a second end 30.

55 **[0032]** There are relatively large parallel opposite side walls 40 and 50 with generally flat surfaces. The opposite parallel arranged side walls 40, 50 of the tubing element are joined with relatively small opposite edge walls 45, 55, which are rounded connection walls 45, 55. The tub-

ing element 10 is partially tilted and sloped and also helically wound and twisted so as to form at least a part of a helical structure.

[0033] The distance d between the first side wall 40 and the second side wall 50 is considerably smaller than the width W of the side walls 40, 50.

[0034] The opposite side walls 40 and 50 of the heat exchanger microchannel tube 10 are oppositely disposed in general parallel planes in the helix within the tube 10 there may be one or more media flow channels, which are formed between the oppositely disposed side walls 40, 50. The media flow channels are angularly disposed with respect to the axis. A heat transfer vapor or fluid such as water or oil or any refrigerant (liquid or vapor refrigerant) fills the heat exchanger microchannel tube 10 and flows from one end 20 of the microchannel tube 10 to the other end 30. Preferably, the resulting helix of the microchannel tube 10 is formed in a cylindrical shape (see e.g. Figures 6 and 7 (continuously) and also Figures 10 and 11 (partial loop)).

[0035] Figure 2 shows the defining angles, i.e. angle $\alpha 1$ defining the slope and angle $\beta 1$ defining the tilt. The twist of the tube 10 is determined merely by variables radius r , angle $\alpha 1$ defining the slope and angle $\beta 1$ defining the tilt.

[0036] The tubing element 10 is an elongated heat exchanger microchannel tube 10. The heat exchanger microchannel tube 10 may be longitudinally curved around an central axis X into a helix. This axis X is shown in Figure 2 and is the central axis X of the overall and imaginary cylindrical shape of the helix.

[0037] Figure 3 shows another embodiment of the tubing element 10' according to the present invention. As can be seen from Figure 4 and when compared with Figure 2, the tubing element 10' as shown in Figure 3 and 4 has a different slope and tilt as the tubing element 10 as shown in Figure 1 and 2. Particularly, the angle $\alpha 2$ is larger and also the angle $\beta 2$, resulting in a lower slope and a smaller tilt of the tubing element 10' when compared with tubing element 10 according to Figure 1 and 2. The radius r is in both examples the same.

[0038] Figure 5 shows tubing element 10 of Figure 1. As can be seen in the upper part of Figure 5, several alternatives are possible for the internal structure of the tubing element 10.

[0039] As can be seen in alternative A, maybe only one channel may be provided which is defined by the side walls 40, 50 and the connecting walls 45, 55. As can be further derived from this detail A, 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 resulting in a substantially overall flat tubing structure of the tubing element 10. Exemplarily, 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 and the second side wall 50.

[0040] Furthermore, as shown in detail B, there may

be also several microchannels 60 with a circular cross-section.

[0041] Alternatively, as shown in detail C, there may be also several microchannels 70 with an angular cross-section, i.e. quadrangular cross-section.

[0042] As shown in detail D, there may be also several microchannels 80 to a triangular cross-section.

[0043] As shown in detail E, there may be several microchannels 90 with a quadrangular cross-section, which are arranged with an off-set O to each other. In particular, all microchannels 90 are arranged with an off-set to each other forming a plurality of grooves 95 on the outer sides of the tubing element 10.

[0044] The cross-sections of the microchannels shown in Figure 5 according to alternatives A to E may have a diameter of about 0.5 - 1.0 mm, for example. However, it is possible that the diameter is smaller, e.g. for microstructures or that the diameter is larger, e.g. for large applications.

[0045] Figure 6 is a side elevation of the flat tubing element, i.e. a flat microchannel tube sloped and tilted twisted into a helix. The single extruded microchannel tube 10 is made of a heat transfer material, usually aluminum. This heat transfer material is rolled and formed into a sloped and tilted continuous helix H .

[0046] Tube 10 has, as already discussed above, parallel side walls 40, 50 and the connecting walls 45, 55 which appear as curved edges. The tubing element is twisted to a desirable tilt S and formed into the continuous helix H . The tube may have a plurality of adjacent small parallel internal channels with circular, angular, rectangular, square or more preferably circular cross sections (see e.g. Figure 5).

[0047] The heat transfer vapor or fluid flows through the channels and transfers heat through the tube bodies to the tube walls 40,50 and edges 45, 55, from where heat is transferred between the walls and the surrounding medium or vice versa, such as e.g. already shown in Figure 5, the walls 40, 50 may be scored, grooved or dimpled to increase the heat transfer surfaces.

[0048] Figure 7 is a perspective view of the tube helix H as shown in Figure 6. Figure 7 shows the spaces between the microchannel tube spirals in which either microchannel tube helices or fins or both may be added.

[0049] Figure 8 is a side elevation of interlaced sloped helical microchannel tubes 10 for adjacent sloped and tilted and twisted similarly helically formed tubes 10. Several microchannel tube helices H' are interspersed in the heat transfer coil C as shown in Figure 8. Opposite substantially rectangular ends 20, 30 of the microchannel tubes 10 are evenly spaced to be received in end fittings and/or headers and subsequently to be fixed in the end fittings and/or headers, such as by bracing. The tubes 10 are evenly spaced in helices H' . The flat surfaces 40, 50 are inclined/tilted at an angle to an axis of the heat transfer coil arrangement C to facilitate maximizing heat transfer surface area of the tubes 10. As shown in Figure 2, a preferred angle $\beta 1$ defining the tilt may be about 45°.

[0050] Figure 9 is a perspective view of the interlaced tube helices H' as shown in Figure 8.

[0051] A similar embodiment as shown in Figures 8 and 9 is shown in Figure 10 and 11. A sloped and tilted and twisted tubing element 10" is forming a helical structure H". Several tubing elements 10" are used to form a heat exchanger means 100" having an overall cylindrical structure.

[0052] Figure 12 is a perspective view of heat exchanger means 100" as shown in Figure 10 and 11.

[0053] As can be seen in Figure 13, which is showing a further alternative embodiment of the present invention, the tubing element 10"" may be equipped with a plurality of grooves 95 on the outer sides of the tubing element 10"".

[0054] Moreover, the tubing element 10"" comprises at its first end 20 and at its second end 30 a collecting portion 25, 35, which is reducing the width of the first side wall 40 and the second side wall 50 to a smaller width. The collecting portions 25, 35 are equipped with tubular connectors 27, 37 having a circular cross-section.

[0055] Figure 15 is a further perspective view of embodiment shown in Figure 13 of the tubing element 10"".

[0056] As can be seen in Figures 14 and 16, several tubing elements 10"" form a heat exchanger means 100"". The heat exchanger means 100"" is formed of interlaced sloped and tilted helically wound microchannel tubes 10"" with adjacent sloped and tilted and twisted similarly helically formed further tubes 10"". Figure 14 is side elevation of this embodiment of the heat exchanger means 100"" and Figure 16 a perspective view thereof.

Claims

1. Tubing element (10, 10', 10", 10'") for a heat exchanger means (100, 100', 100", 100'"), the tubing element (10, 10', 10", 10'") being at least partially a rigid elongated heat exchanger tubing having at least a first end (20) and at least a second end (30) and having a first side wall (40) and a second side wall (50), the first side wall (40) and the second side wall (50) being arranged substantially parallel to each other and the distance (d) between the first side wall (40) and the second side wall (50) being considerably smaller than the width (W) of the first side wall (40) and the second side wall (50) resulting in a substantially overall flat tubing structure, the tubing element (10, 10', 10", 10'") being at least partially tilted and/or sloped and at least partially helically wound and/or twisted so as to form at least a part of a helical structure.
2. Tubing element (10, 10', 10", 10'") according to claim 1,
characterized in that
the width (W) of the first side wall (40) and the second side wall (50) is approximately at least ten times larg-

er than the distance (d) between the first side wall (40) and the second side wall (50).

3. Tubing element (10, 10', 10", 10'") according to claim 1 or 2,
characterized in that
the first side wall (40) and second side wall (50) are connected respectively on both sides by a rounded connection wall (45, 55).
4. Tubing element (10, 10', 10", 10'") according to any of the preceding claims,
characterized in that
the helical structure has an overall cylindrical structure and/or that the helical structure is formed in a cylindrical shape.
5. Tubing element (10, 10', 10", 10'") according to any of the preceding claims,
characterized in that
the tubing element (10, 10', 10", 10'") comprises at least one microchannel (60, 70, 80, 90).
6. Tubing element (10, 10', 10", 10'") according to claim 5,
characterized in that
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 cross-section, are provided.
7. Tubing element (10, 10', 10", 10'") according to claim 6,
characterized 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.
8. Tubing element (10, 10', 10", 10'") according to claim 7,
characterized in that
the off-set causes chamfers and/or grooves (95) within the first side wall (40) and/or the second side wall (50).
9. Tubing element (10'") according to any of the preceding claims,
characterized in that
the tubing element (10'") comprises at its a first end (20) and at its second end (30) a collecting portion (25, 35), which is reducing the width of the first side wall (40) and the second side wall (50) to a smaller width.
10. Heat exchanger means (100, 100', 100", 100'") hav-

ing at least one tubing element (10, 10', 10", 10''') according to any of the preceding claims.

11. Heat exchanger means (100, 100', 100", 100''') according to claim 10, 5
characterized in that
several tubing elements (10, 10', 10", 10''') are provided and that the tubing elements (10, 10', 10", 10''') are substantially forming an overall cylindrical structure having a central longitudinal axis (X) and that the tubing elements (10, 10', 10", 10''') are spirally curved around the central longitudinal axis (X) and interleaved in the structure. 10

12. Heat exchanger means (100, 100', 100", 100''') according to claim 10 or 11, 15
characterized in that
the heat exchanger means (100, 100', 100", 100''') is a radiator or a cooler or a condenser or an evaporator. 20

13. The use of a tubing element (10, 10', 10", 10''') to manufacture at least partially a heat exchanger means (100, 100', 100", 100''') according to claim 10, exemplarily by tilting and/or sloping and at least partially helically winding and/or twisting the tubing element (10, 10', 10", 10''') so as to form at least a part of a helical structure. 25

14. The use of a heat exchanger means (100, 100', 100", 100''') according to claim 10 or 11 to exchange heat, exemplarily to use the heat exchanger means (100, 100', 100", 100''') as a radiator or as a cooler or as a condenser or as an evaporator. 30
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15. Method of manufacturing of a tubing element (10, 10', 10", 10''') according to any of claims 1 to 9, whereby exemplarily the tubing element (10, 10', 10", 10''') is received by using an extrusion process of a heat transfer material, whereby preferably the extrusion process is a single extrusion process and/or whereby preferably the heat transfer material is at least partially aluminium or copper or an alloy thereof. 40
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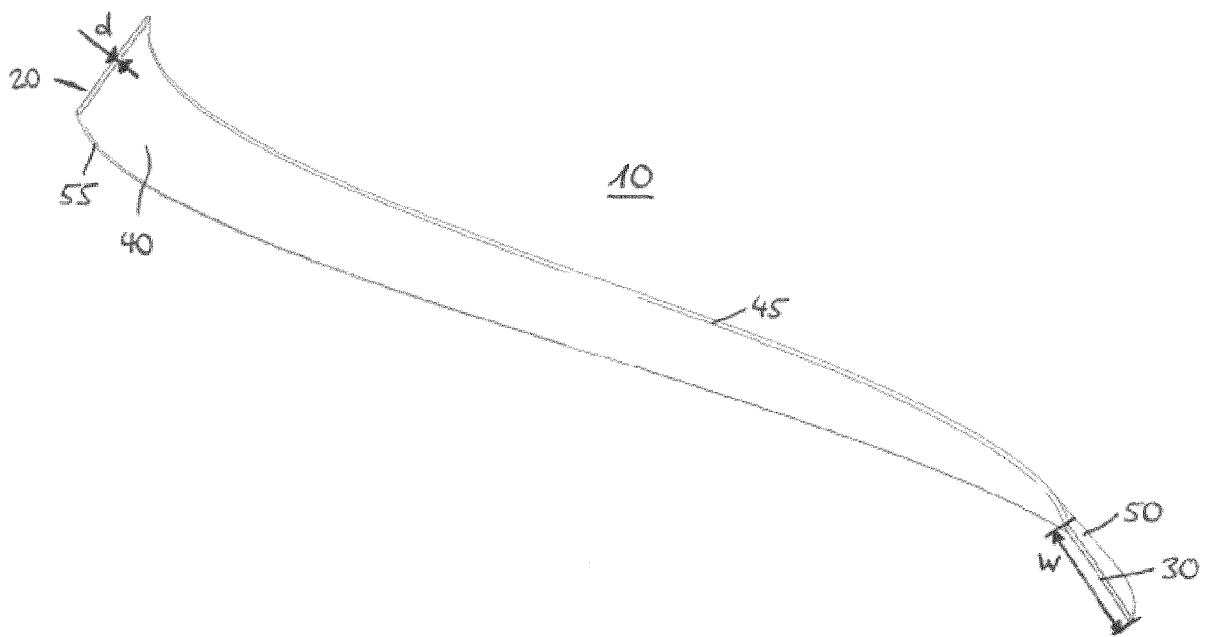


FIG. 1

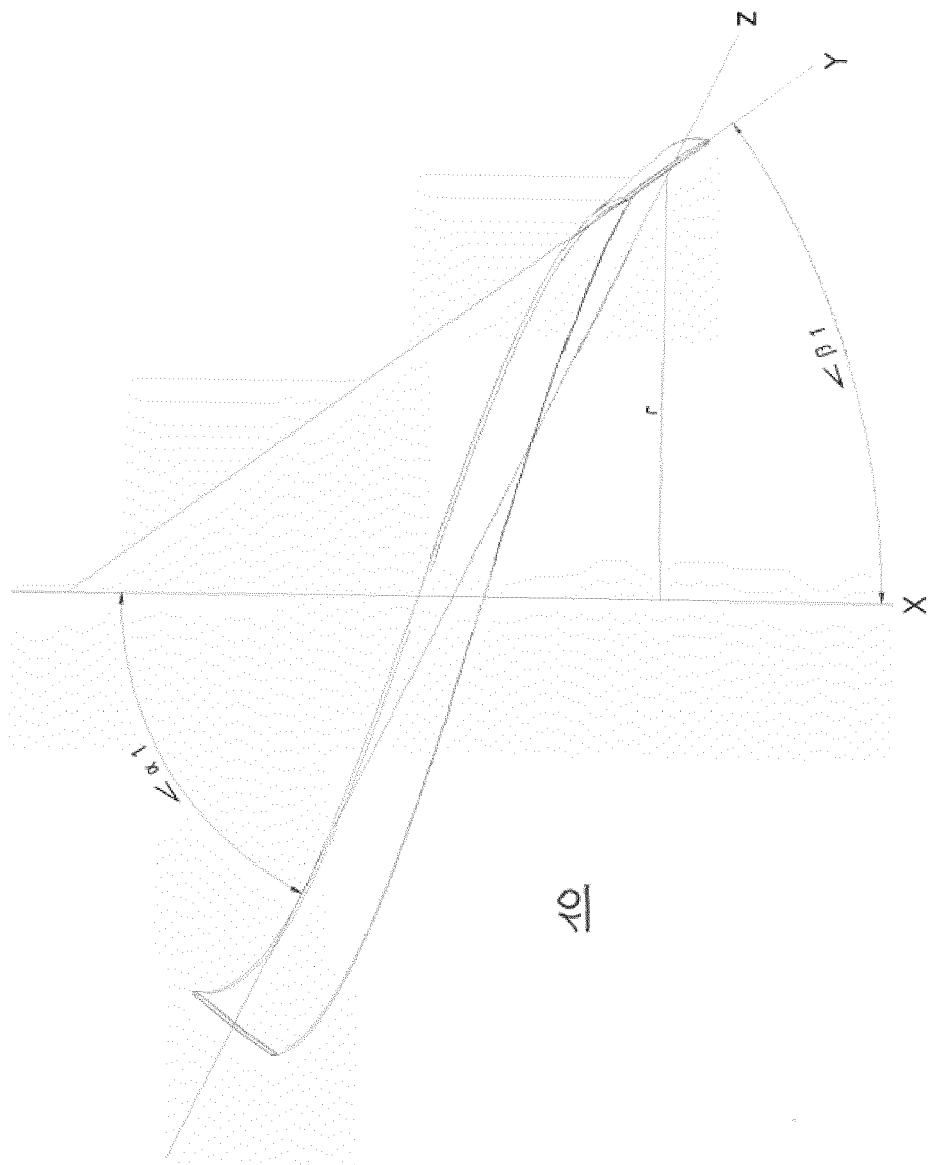


FIG. 2

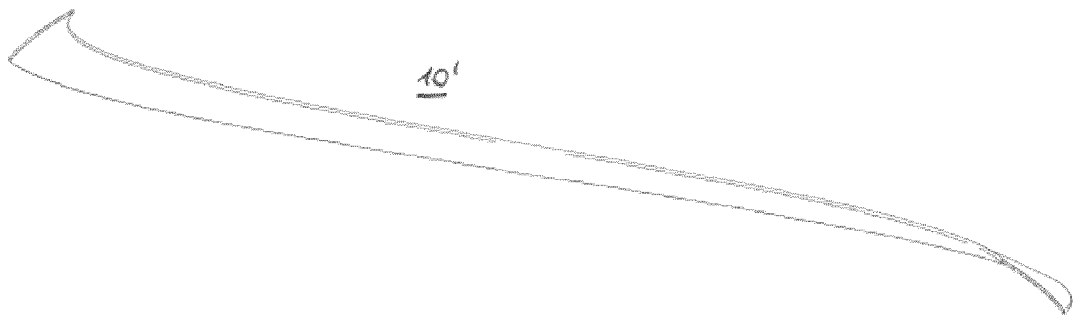


FIG. 3

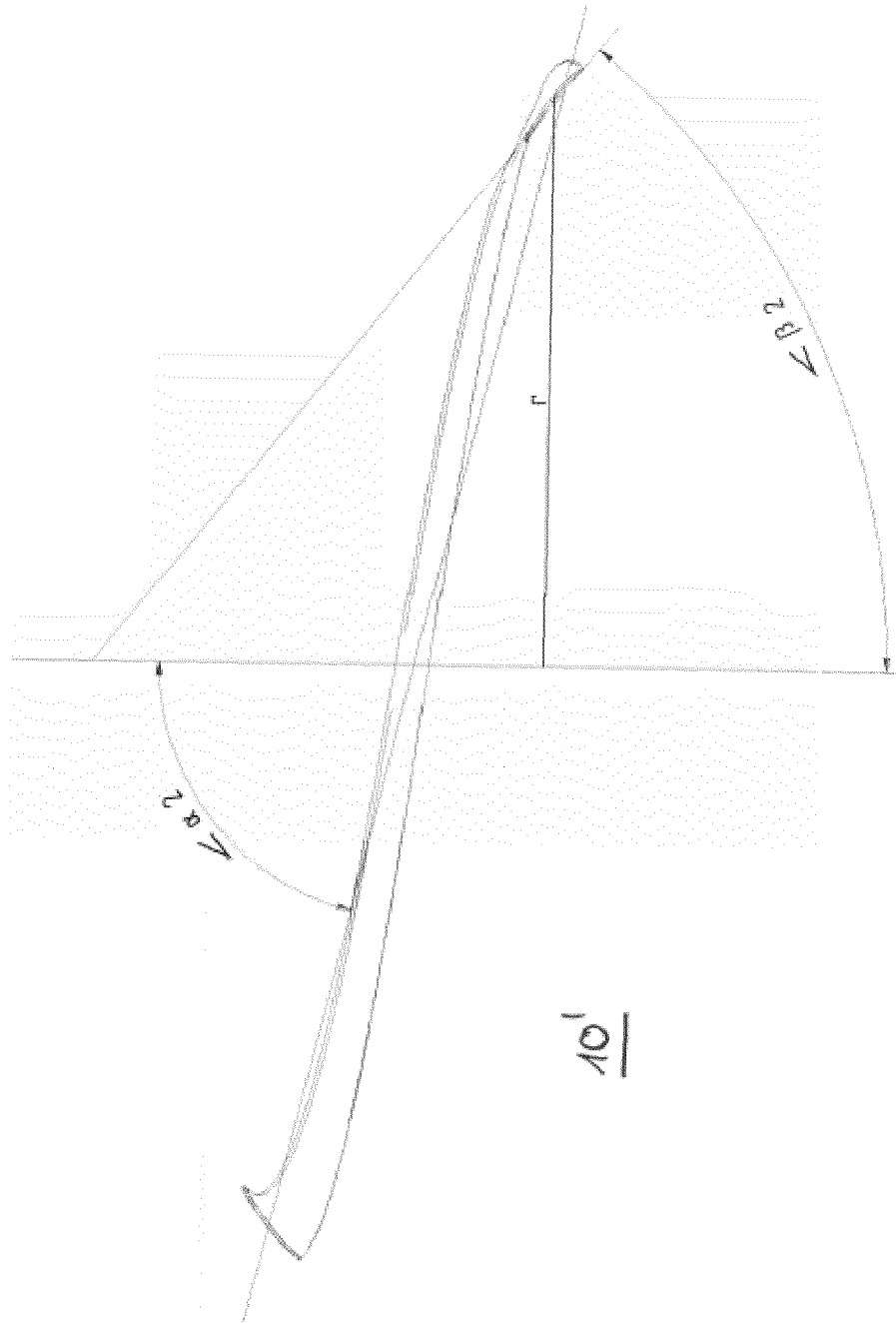


FIG. 4

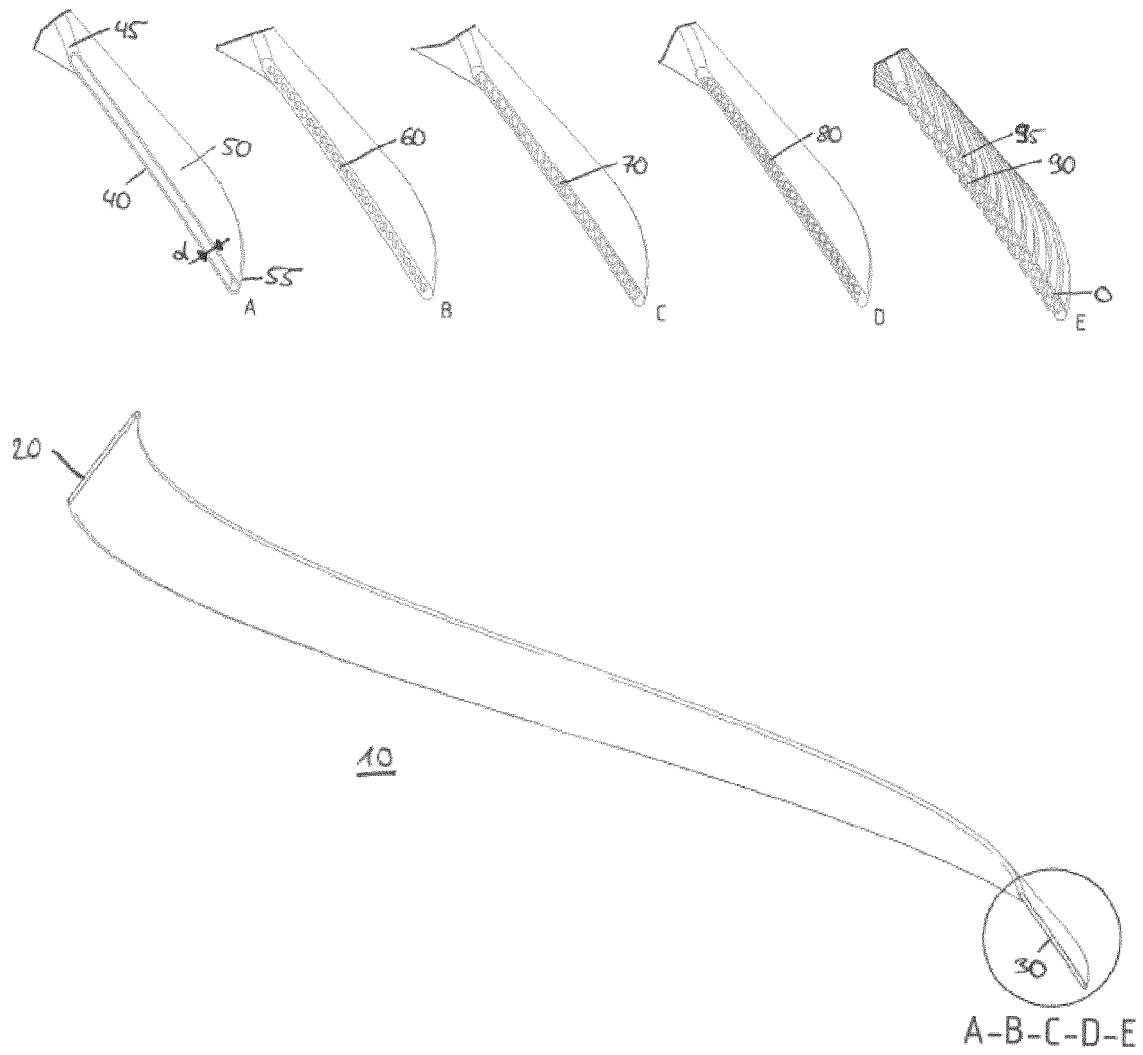


FIG. 5

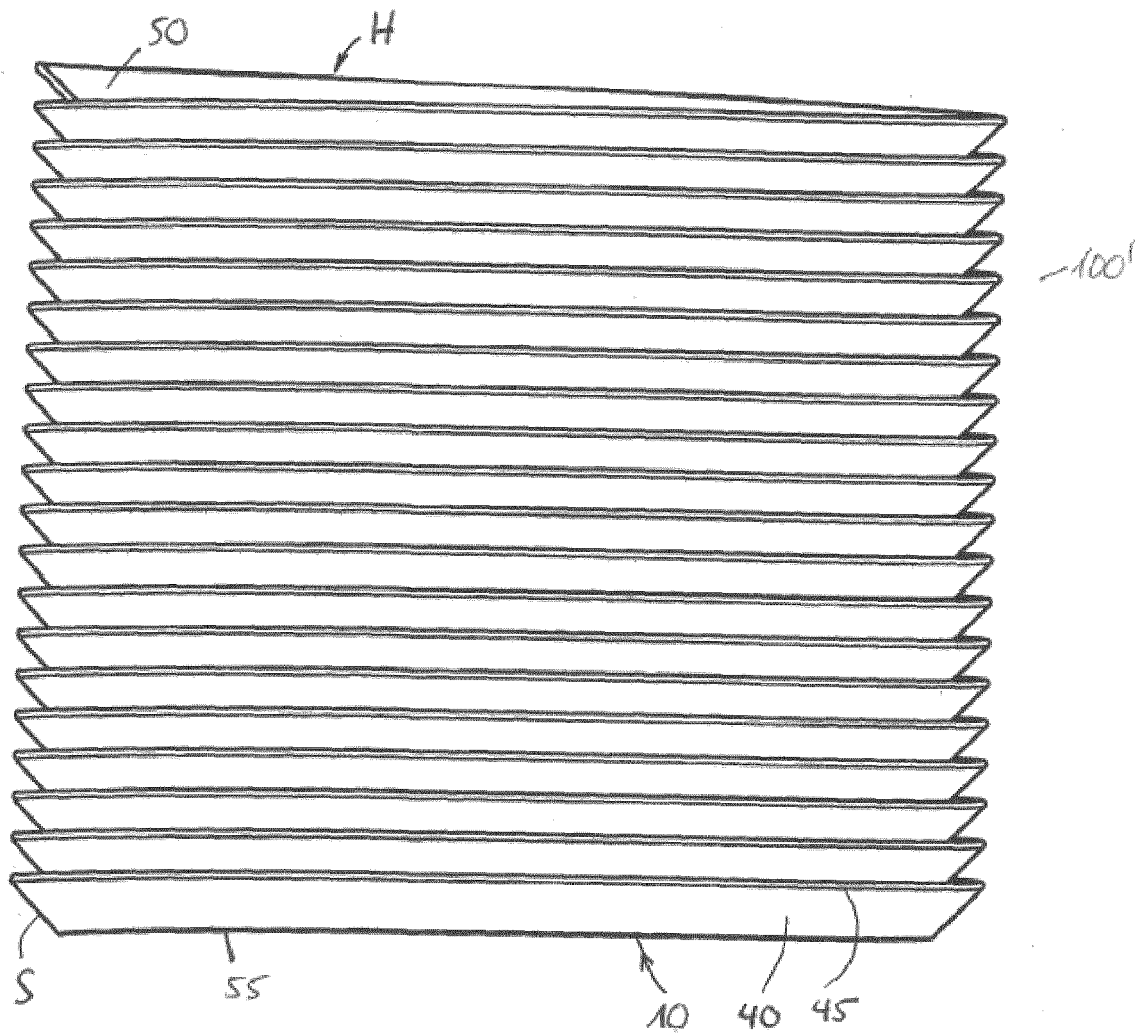


FIG. 6

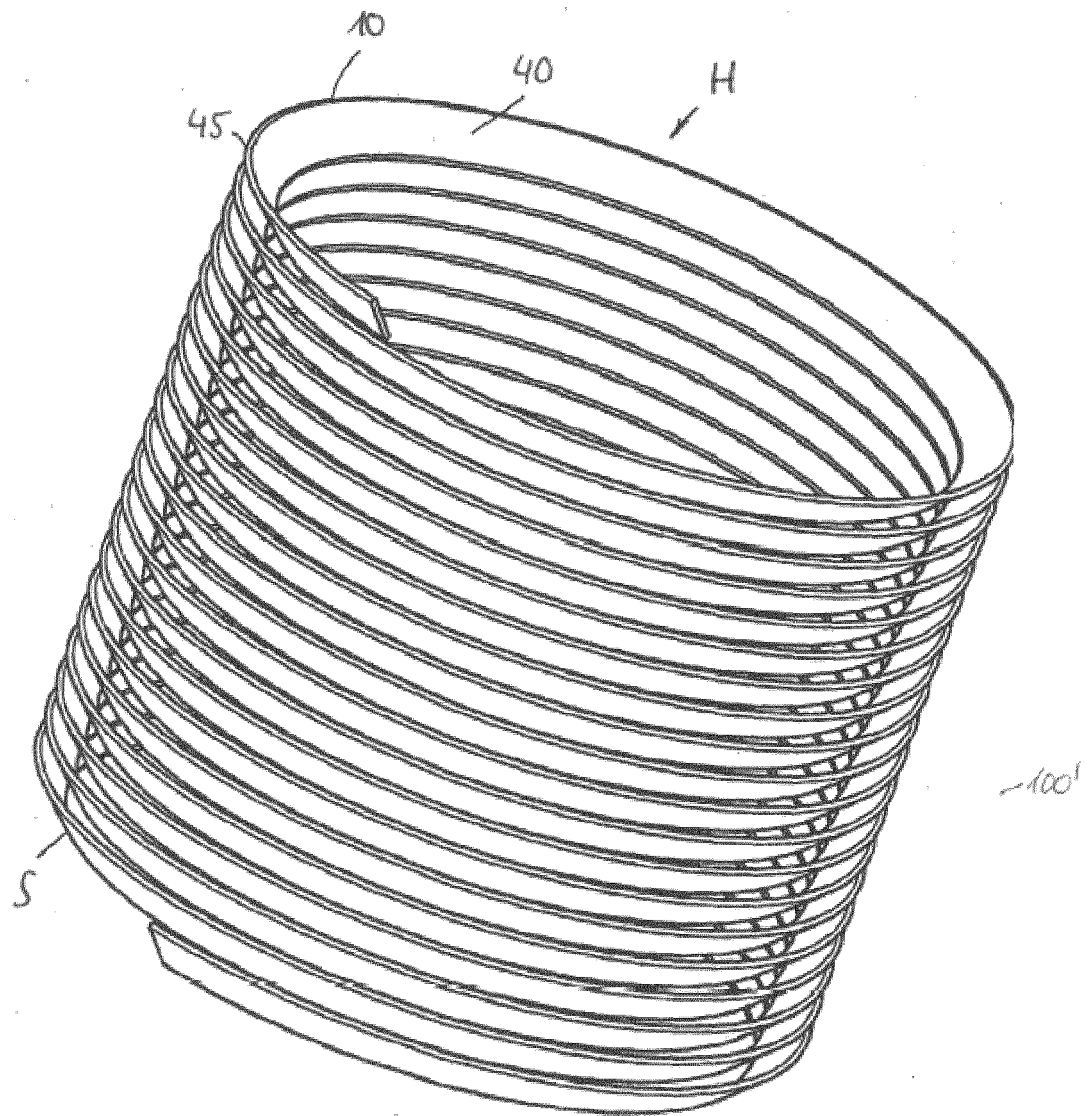


FIG. 7

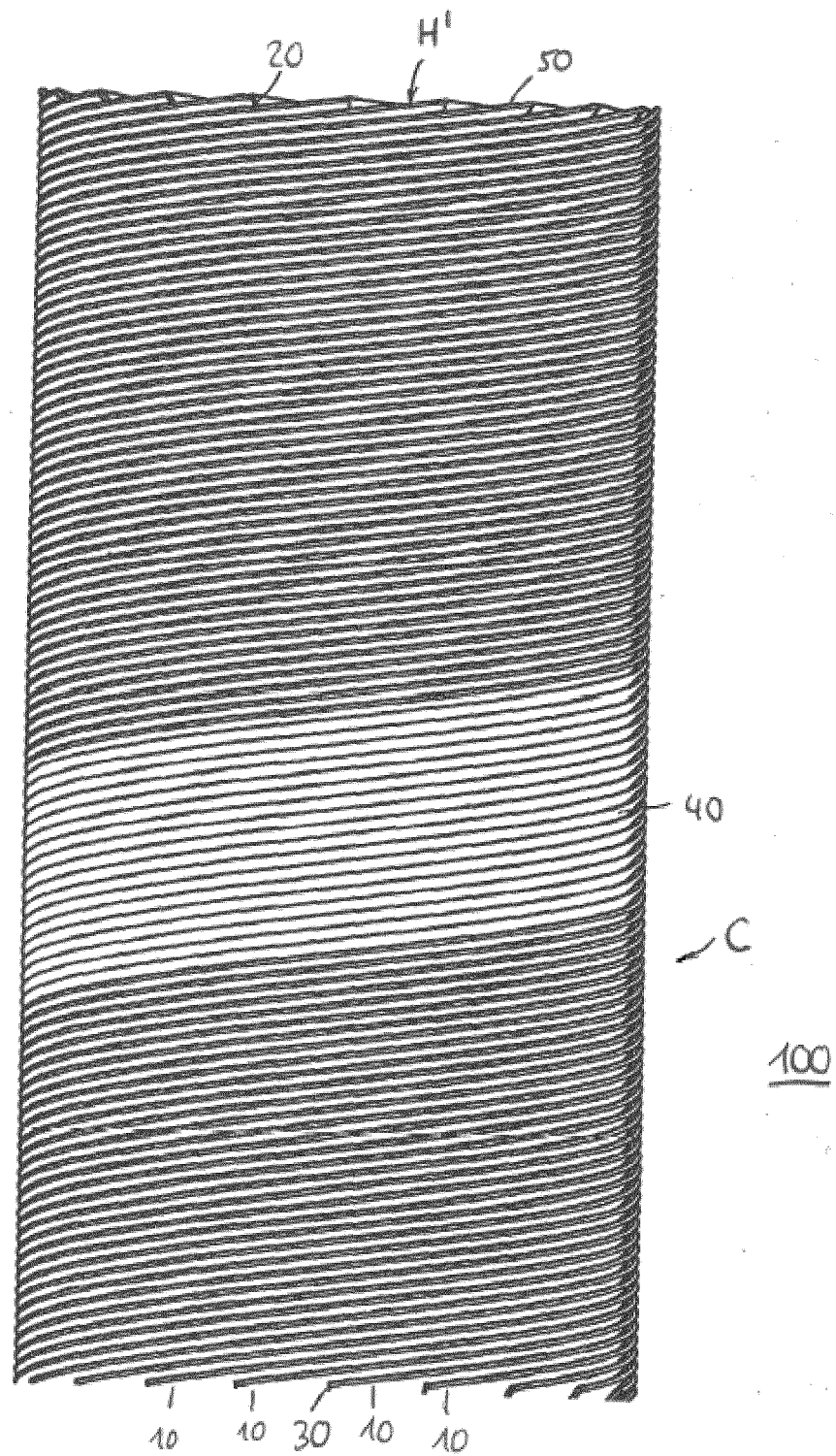


FIG. 8

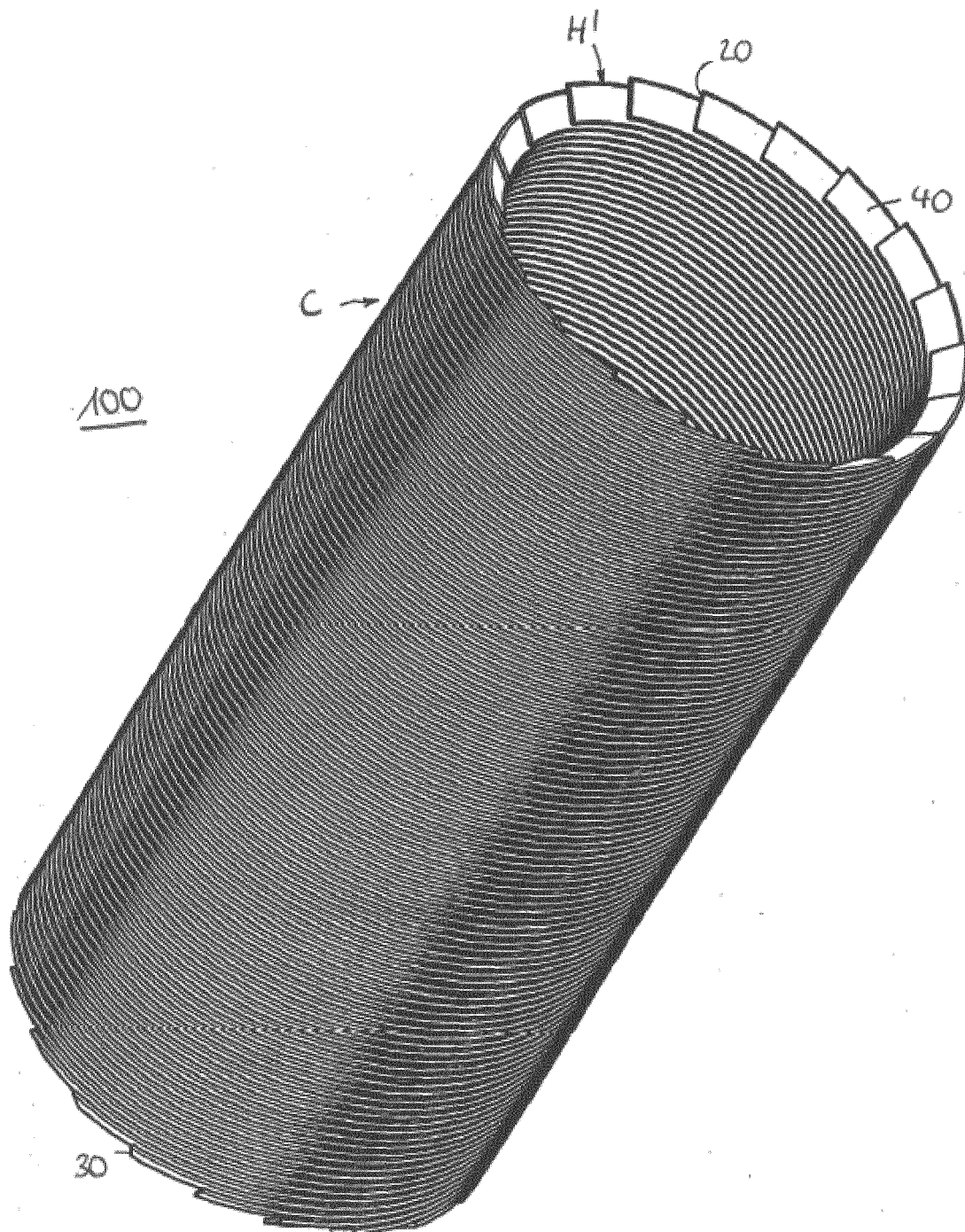


FIG. 9

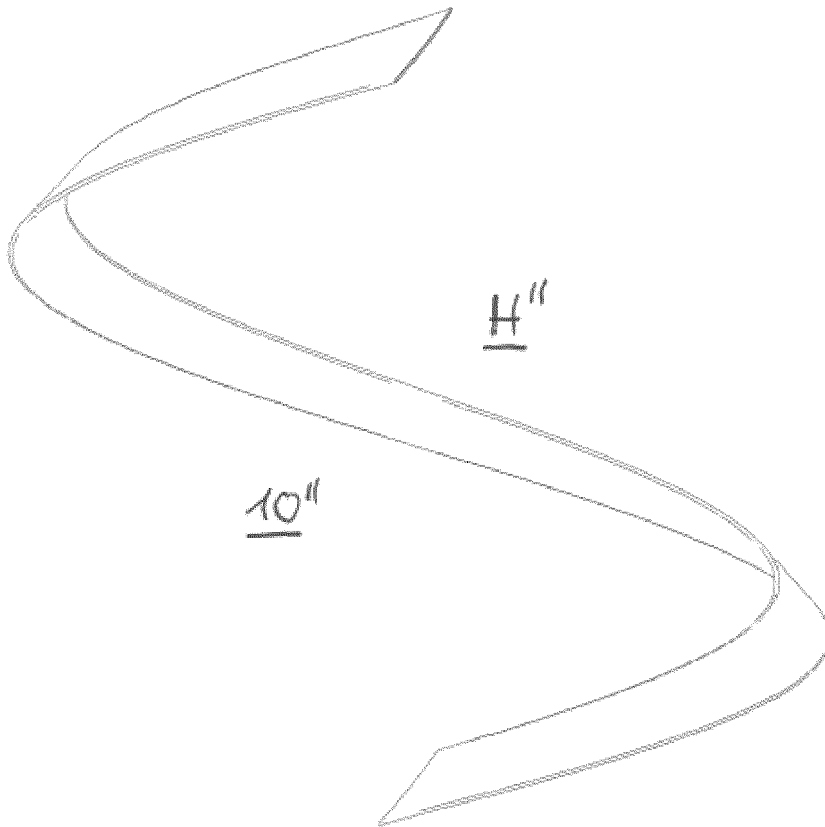


FIG. 10

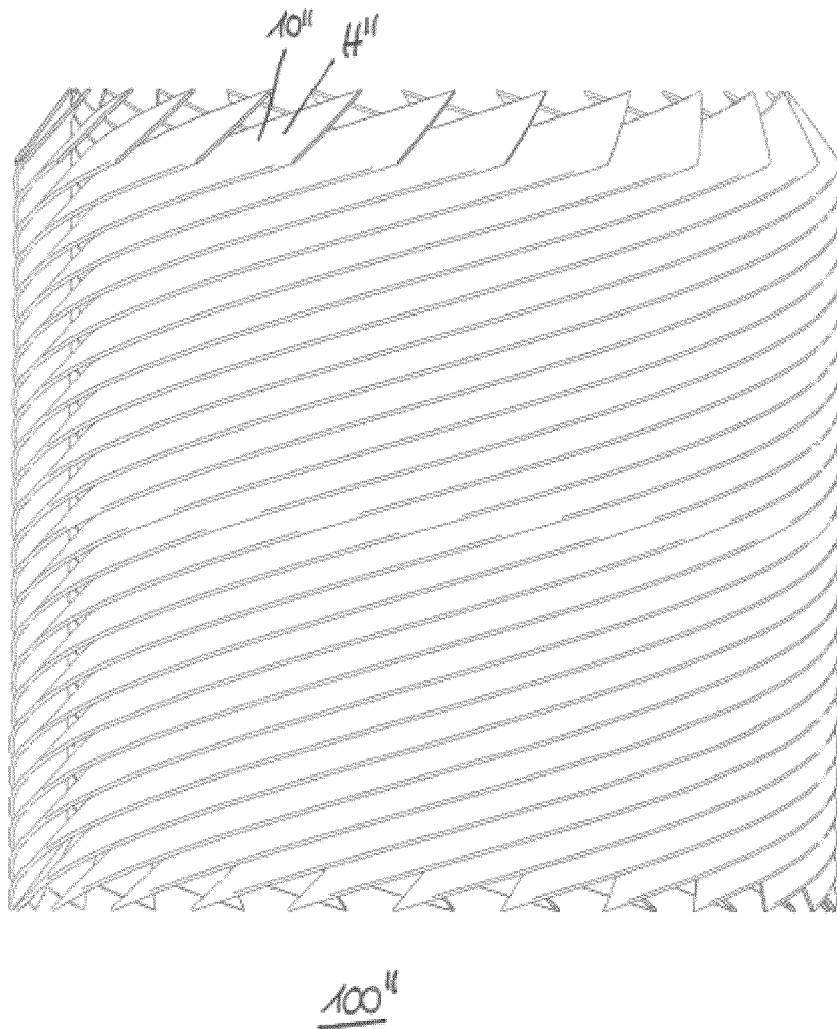


FIG. 11

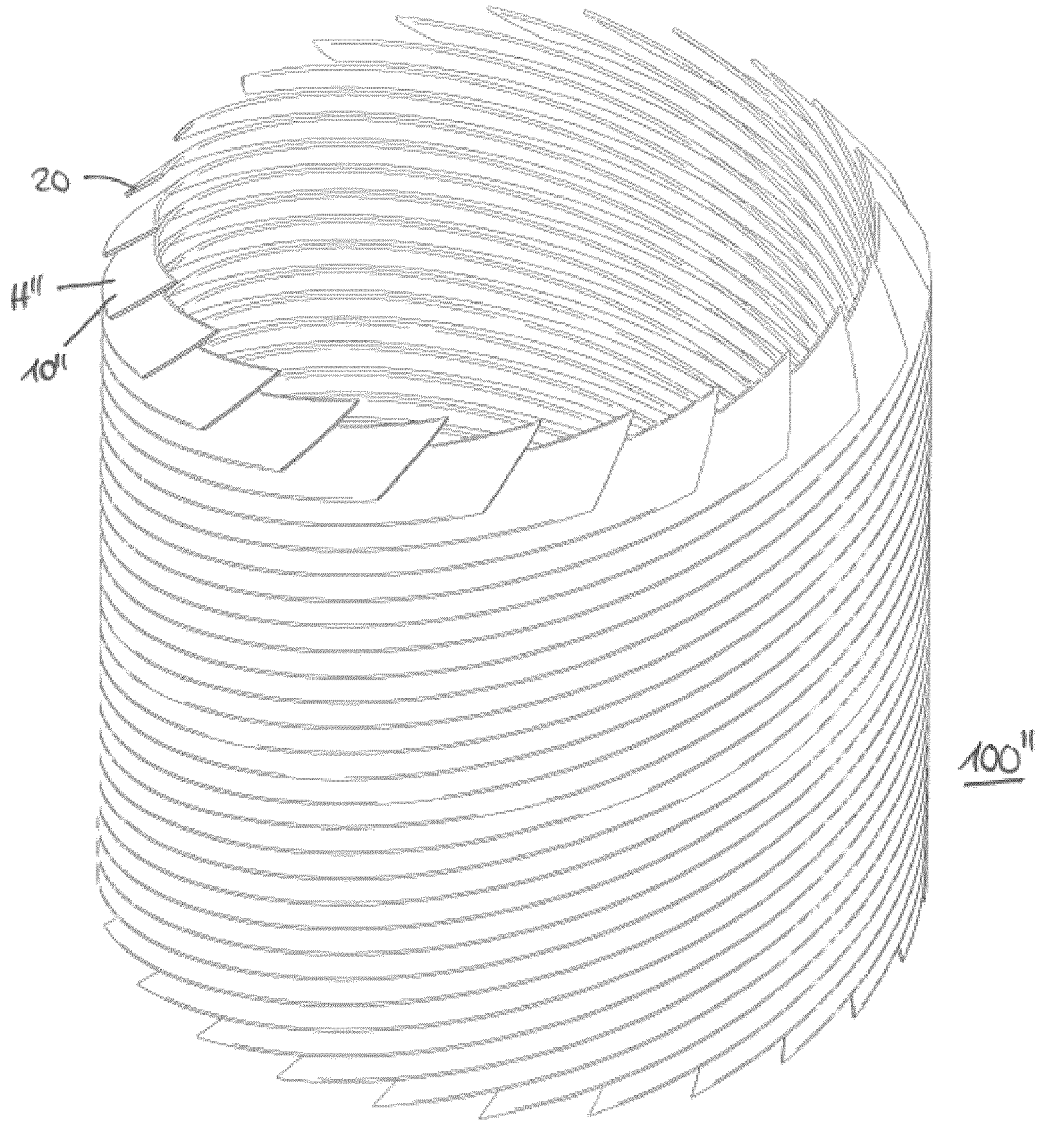


FIG. 12

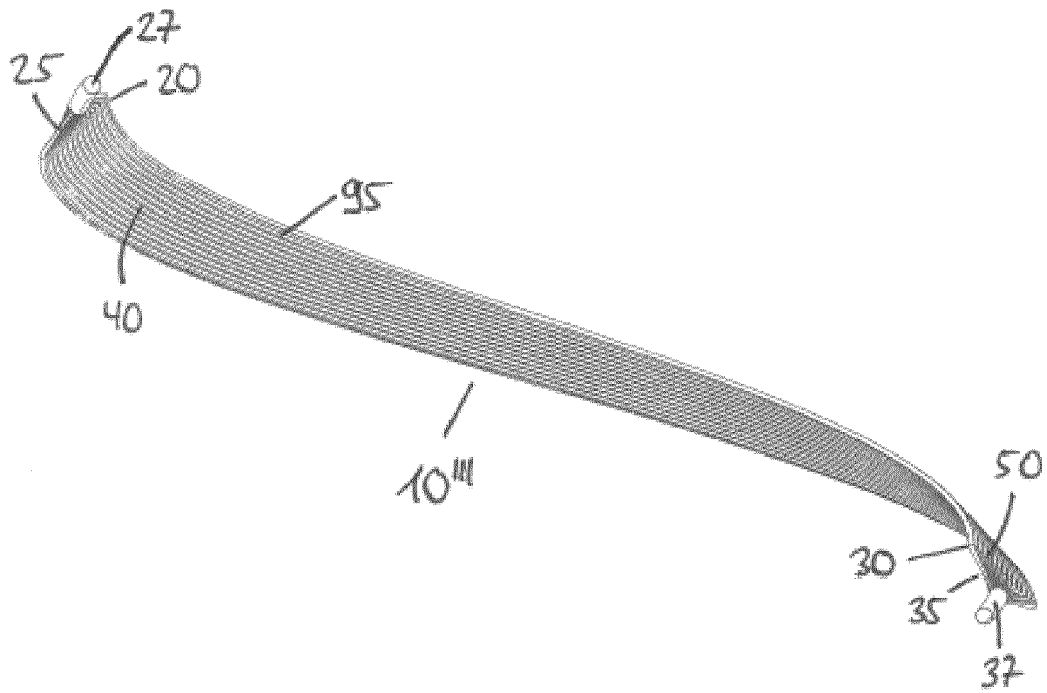


FIG. 13

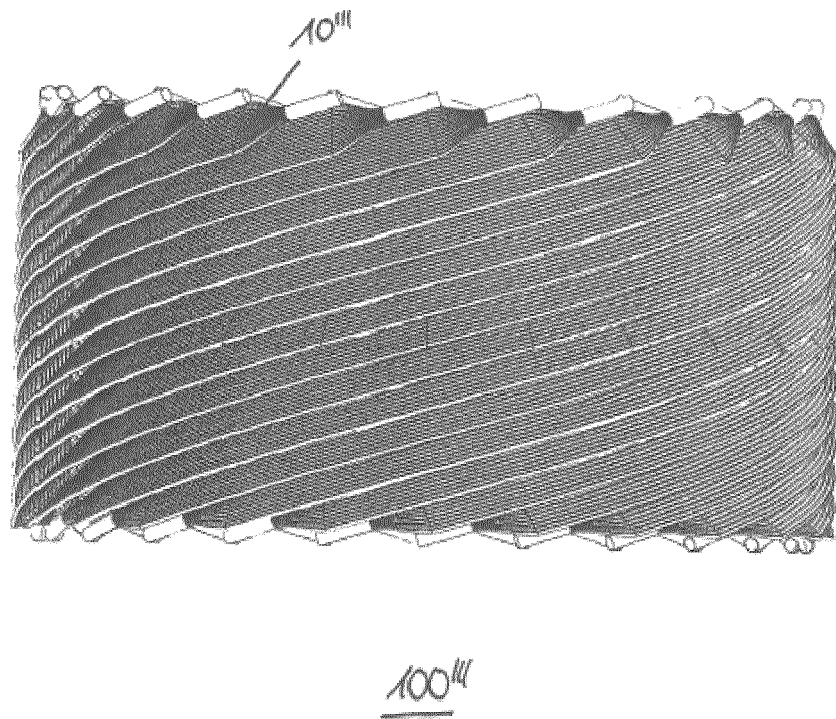


FIG. 14

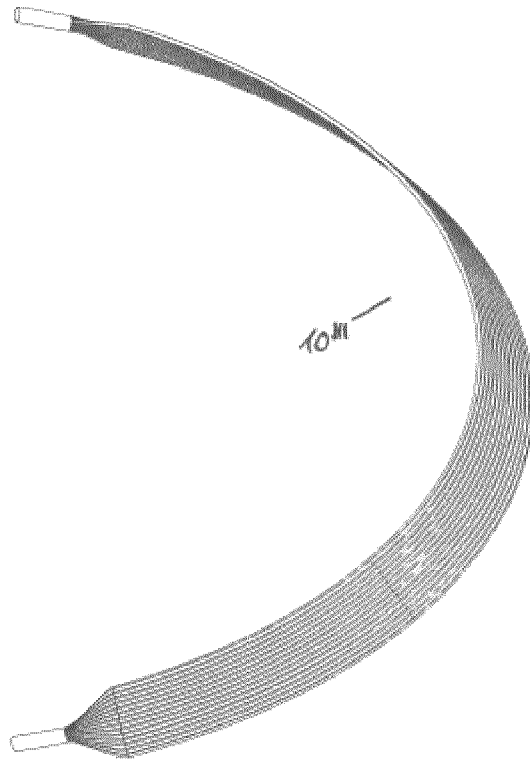


FIG. 15

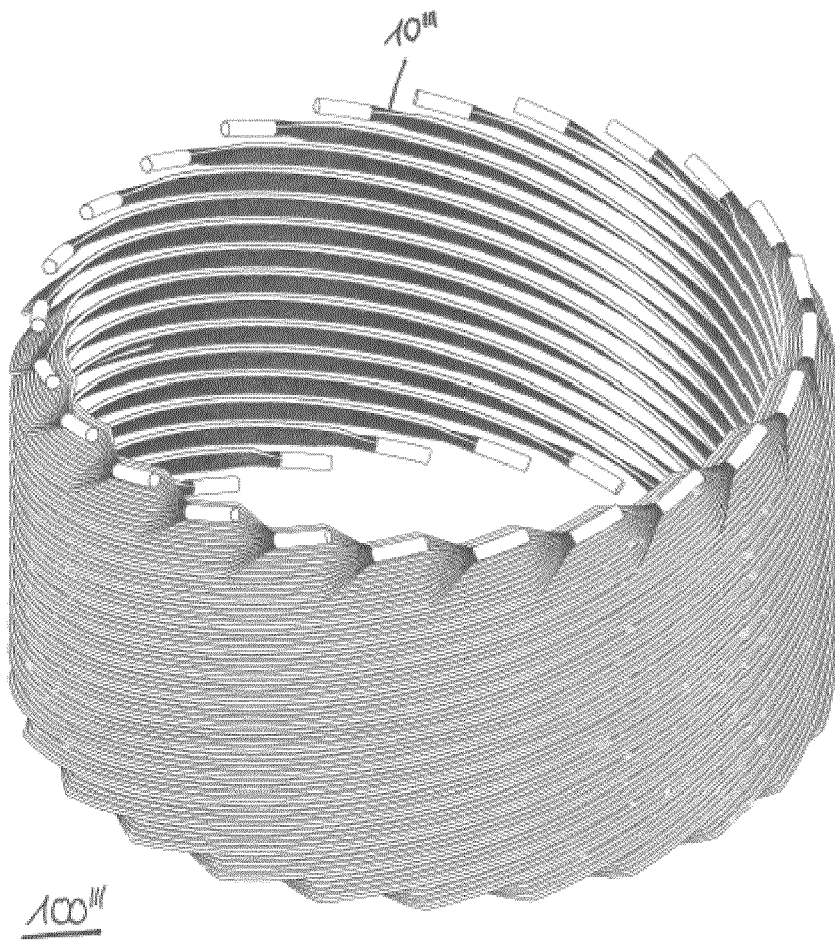


FIG. 16



EUROPEAN SEARCH REPORT

Application Number
EP 12 19 5015

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 2012/160465 A1 (WEBB FREDERICK MARK [AU]) 28 June 2012 (2012-06-28)	1-5, 10-15	INV. F28D1/047
Y	* paragraph [0031]; figures 9,19,18,19 * -----	6-8	F28F1/02
X	DE 38 15 647 A1 (SUEDEDEUTSCHE KUEHLER BEHR [DE]) 22 December 1988 (1988-12-22)	1-4,9-14	
	* figures 1-5 * -----		
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	* figures 3,4,5 * -----		
Y	JP 2002 153931 A (MITSUBISHI HEAVY IND LTD) 28 May 2002 (2002-05-28)	6-8	
	* figures 9,11,13 * -----		
			TECHNICAL FIELDS SEARCHED (IPC)
			F28D F28F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 June 2013	Examiner Martínez Rico, Celia
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EPO FORM 1503 03.82 (P04C01)

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