



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.11.2016 Bulletin 2016/47

(51) Int Cl.:
F28D 1/03 (2006.01) F28F 1/02 (2006.01)

(21) Application number: **16168980.7**

(22) Date of filing: **10.05.2016**

(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:
MA MD

(72) Inventors:
• **Berger, Thierry**
57100 Thionville (FR)
• **Ayad, Fadil**
57685 Augny (FR)
• **Fourile, Roger**
08200 WADELINCOURT (FR)

(30) Priority: **22.05.2015 FR 1554619**

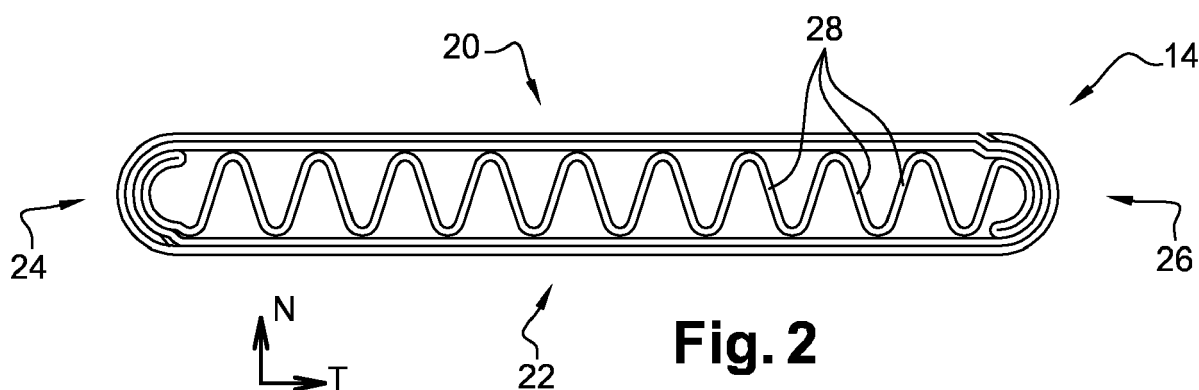
(71) Applicant: **Delphi Automotive Systems**
Luxembourg SA
4940 Bascharage (LU)

(74) Representative: **BRP Renaud & Partner mbB**
Rechtsanwälte Patentanwälte
Steuerberater
Königstraße 28
70173 Stuttgart (DE)

(54) **FLAT TUBE FOR A HEAT EXCHANGER**

(57) A flat tube (14) adapted to be arranged in a heat exchanger (10) has an elongated section comprising two long sides (20, 22), two short sides (24, 26) and internal partitions (28). The flat tube (14) is made by shaping with-

out cutting a single sheet (30) of metal such that the short sides (24, 26) have a thickness greater than the thickness of the long sides (20, 22).



Description

TECHNICAL FIELD

[0001] The present invention relates to an automobile heat exchanger and more specifically to the manufacturing of its flat tubes by folding.

TECHNOLOGICAL BACKGROUND OF THE INVENTION

[0002] An automobile heat system comprises several exchangers arranged in the vehicle so as to enable exchanges between separate fluids, some heating, others cooling. A condenser comprises a plurality of flat tubes arranged in parallel between two tanks. Flat tubes typically have an oblong cross-section with two long and flat sides and two short and rounded sides. Moreover, the inner space of each tube is subdivided by the inner walls into a plurality of channels. Lastly, in the inter-tube spaces, cooling fins are arranged in contact with the tubes. Thus, a heat transfer fluid can flow through a circuit passing through the two tanks and inside the tubes, by following the inner channels, while a flow of air crosses the exchanger by passing between the tubes and the fins. Throughout the circuit, the fluid cools while the air warms.

[0003] Ideally, these exchangers, generally arranged in the front of the vehicle, should combine several properties. The short, rounded sides should be sufficiently strong to not be overly damaged by projectiles, such as rocks. The long, flat sides can be thinner to contribute sufficient rigidity while lightening the tube and facilitating fluid and air exchanges. The inner walls extending between the long sides can be even thinner to aid in the transfer of heat towards the long sides while channeling the flow and without increasing the total mass of the exchanger. Lastly, these tubes should be shaped and manufactured with a minimum of components. Making flat tubes by folding a single metal sheet multiple times is for example presented in US5186251, EP1941954; however, these tubes are forced to compromise with the ideal situation so as to facilitate production and reduce costs. The tubes resulting from these compromises do not correspond to a "happy medium," but simply to the best that can be done.

SUMMARY OF THE INVENTION

[0004] The present invention aims to remedy the disadvantages mentioned previously by proposing a flat tube adapted to be arranged in a heat exchanger comprising two parallel and separate tanks connected by a plurality of said flat tubes that are parallel to each other and that extend along a longitudinal axis, each of these tubes comprising inner partitions separating the inside of the tube into a plurality of channels and cooling fins also being arranged between the tubes. The exchanger is provided so that a heat transfer fluid circulating in the

tube channels exchanges heat with an air flow F passing between the flat tubes and through the fins.

[0005] In addition, the flat tube has an elongated section comprising two long and parallel sides extending along a transverse axis and two short and flat or rounded sides, joining the ends of the long sides so as to define an inner space in which the internal partitions extend from one long side to the other.

[0006] Specifically, the flat tube is advantageously made by shaping without cutting a single sheet of metal so that the flat tube has short sides with a thicker thickness than the thickness of the long sides, so that, in use, the flat tube resists the impact of possible projectiles while having sufficient mechanical strength.

[0007] In addition, the inner partitions have a thickness that is equal to or less than the thickness of the long sides, so that the flow of heat transfer fluid and the heat transfer of said fluid towards the long sides is optimized.

[0008] Specifically, the inner partitions are made in a single thickness of the sheet and the short sides are made by stacking at least three thicknesses of the sheet.

[0009] More specifically, one of the short sides is made by stacking four thicknesses of the sheet or both of the short sides are made by stacking four thicknesses of the sheet.

[0010] In addition, the long sides are made by stacking two thicknesses of the sheet.

[0011] According to an embodiment, the inner partitions divide the inner space of the tube into at least ten channels, or even twenty.

[0012] The invention also relates to a heat exchanger comprising two parallel and separate tanks connected by a plurality of flat tubes that are parallel to each other, the tubes being made according to the previous paragraphs.

[0013] The invention also relates to a method of manufacturing a flat tube adapted to be arranged in a heat exchanger comprising two parallel and separate tanks connected by a plurality of flat tubes parallel to each other, each of the flat tubes comprising inner partitions separating the inside of the tube into a plurality of channels, cooling fins being arranged between the tubes, the exchanger being provided so that a heat transfer fluid F circulating in the tube channels exchanges heat with an air flow F passing between the flat tubes through the fins, the method comprising the following steps:

- a) providing a rectangular metal sheet with a length L extending along the longitudinal axis L and a width T extending along the transverse axis T,
- b) folding the sheet so as to form a series of longitudinal undulations on the entire length L of the sheet and in a limited part of the sheet, the undulations being parallel to the length L of the sheet, the undulations forming a corrugated zone forming inner partitions while keeping the lateral parts of the sheet flat on both sides of said corrugated zone,
- c) folding the flat parts several times, by winding them

around the corrugated zone so that inner partitions are made in a single sheet thickness E, the long sides being made by stacking two sheet thicknesses and the short sides being made by stacking at least three sheet thicknesses.

[0014] In addition, step c) comprises at least one step during which the metal sheet winding reverses direction.

[0015] Lastly, a soldering step is carried out after the folding steps.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Other characteristics, objects and advantages of the invention will appear upon reading the following detailed description and with regard to the appended drawings given by way of non-limiting examples, in which:

Figure 1 is a general perspective view of a heat exchanger provided with flat tubes according to the invention.

Figure 2 is a cross-section of a flat tube according to a first embodiment of the invention.

Figures 3 to 11 are cross-sections of the flat tube from Figure 2, the figures detailing the steps of manufacturing said flat tube.

Figure 12 is a cross-section of a flat tube according to a second embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] A condenser 10 according to Figure 1 comprises two vertical tanks 12 extending along a normal axis N, represented vertically according to the arbitrary and non-limiting orientation of the figure, a plurality of flat tubes 14 extending between the tanks 12 along a longitudinal axis L and cooling fins 16 inserted in the inter-tube spaces made by corrugating thin bands of aluminum, the corrugated bands being arranged so that the tops of the fins 16 are in contact against a tube.

[0018] Once the ends of the tubes 14 are embedded in parallel slots 18 provided for this purpose and made in tanks 12 and once the fins 16 are arranged between the tubes 14, the assembly is soldered so as to form a sealed internal space within which a heat transfer fluid F1 can flow in the tanks and in the tubes, between an inlet and an outlet arranged in one of the tanks. The soldered assembly remains open between the tubes thus enabling an air flow F2 to traverse the exchanger 10 along a transverse axis T, the air flow passing between the fins 16; the normal N, longitudinal L and transverse T non-oriented axes form an orthogonal reference mark for the assembly of the present description.

[0019] Figure 2 represents the cross-section of a flat tube 14 made according to a first embodiment. The section is along a transverse plane TN orthogonal to the longitudinal axis L. The flat tube 14 presented was de-

veloped for condenser 10 but it may alternatively also be made for an evaporator.

[0020] Tube 14 has an oblong section defined by two long and straight sides 20, 22, extending parallel to one another along the transverse axis T and two short sides that are rounded in half circles 24, 26, joining the ends of the long sides 20, 22, and thus defining an inner space of the tube, a space between the four sides 20, 22, 24, 26, and divided into a plurality of channels by partitions 28 forming undulations and extending between the inner faces of long sides 20, 22.

[0021] In an alternative, not represented, the tube can have a rectangular cross-section, the short sides then extending in a straight line along the normal axis N. It also can have tapered short sides, or the tube may even not be symmetrical, the two short sides being different from one another. Tubes whose inner partitions are straight sections extending perpendicularly between the long sides are also known.

[0022] As a non-limiting example, automobile applications typically have an exchanger with dimensions on the order of 50 cm of longitudinal length L, 40 cm of normal height N and 2 cm of transverse thickness T. The exchanger may comprise between twenty and fifty tubes, each having a normal thickness on the order of 1.5 mm, corresponding to the distance along the normal axis N between the two long sides 20, 22 and a transverse width of 20 mm corresponding to the distance along the transverse axis T between the two short sides 24, 26, the inner space of the tubes may comprise about twenty channels.

[0023] It is noted from careful observation of Figure 2 that tube 14 is made by successively folding a single metal sheet 30. For the same automobile applications, a sheet of aluminum with a thickness E of 0.11 mm may be preferred, the latter specification only being given for the purposes of illustration, obviously a tube made in another metal, steel or copper for example, and in another sheet thickness may present a similar cross-section and follow the disclosures of the present invention.

[0024] In addition, the cross-section of tube 14 clearly shows that the long sides 20, 22 have a double sheet thickness E, the small rounded sides 24, 26 have a quadruple sheet thickness E and partitions 28 only have a single thickness E. This combination corresponds to an ideal arrangement offering reinforcement of the short sides 24, 26, subject to the impact of projectiles, thinning of the long sides 20, 22, promoting the transfer of heat towards fins 16 while maintaining a sufficient mechanical rigidity of the tubes and an excellent directional prevention of corrosion propagation, very thin inner partitions 28 maximizing the inner flow space and thus promoting this flow of heat transfer fluid F1 and the transfer of heat towards the long sides 20, 22.

[0025] The manufacturing method 100 is now detailed, from Figure 3 representing sheet 30, presented flat, before any shaping and folding. Sheet 30 is rectangular with a length L1 along the longitudinal axis L, width L2 along the transverse axis T and thickness E along the normal

axis N.

[0026] The first step 110, represented in Figures 4 and 5, corresponds to folding the sheet 30 in the longitudinal direction L by making several parallel and narrowly-spaced undulations, confined in a corrugated zone 32 arranged in the central part of width L2 of sheet 30 and from both sides of which two flat lateral parts 34, 36 extend. The undulations thus formed will constitute the future inner partitions 28. For reasons of symmetry of the stresses to be applied to sheet 30 throughout the manufacturing process, making the corrugated zone in the center of sheet 30, the lateral parts 34, 36 then being of equal dimensions, is preferred but not essential. The framework of the description follows this preference and alternatives could be indicated.

[0027] Figure 5 illustrates the first step 110 and thus presents the corrugated zone 32 centered between the lateral parts 34, 36, remaining flat, that we distinguish as the first lateral part 34 drawn to the left in Figure 5 and the second lateral part 36 drawn to the right in Figure 5. The first lateral part 34 thus extends along the transverse axis T from a first proximal end 38 situated nearest the corrugated zone 32 to a first distal end 40 corresponding to the edge of the sheet and, symmetrically, the second lateral part 36 extends in the opposite direction along the transverse axis T from a second proximal end 42 situated nearest the corrugated zone 32 to a second distal end 44.

[0028] We also note that the entire manufacturing method generally consists of winding the lateral parts around the corrugated zone, the first proximal end 38 situated at the bottom of the last corrugation at the left, in the direction of the figure, while the second proximal end 42 extends from the top of the last corrugation at the right.

[0029] Figure 6, a figure centered on the corrugated zone 32, illustrates the second folding step 120 of method 100, a step that consists of folding the lateral parts 34, 36 in the clockwise direction, or in the negative direction of rotation in relation to the longitudinal axis L, around the proximal ends 38, 42. A semi-circular part 50, 52 is then formed at each of the proximal ends 38, 42, which depicts, in a sheet 30 thickness E, the future short sides 24, 26. In Figure 6, said circular parts 50, 52 each form an angular sector of about one half-turn at the ends of which the lateral parts 34, 36 extend tangentially.

[0030] Figure 7 illustrates the third folding step 130 of method 100, a step that consists of folding the lateral parts 34, 36 in the anti-clockwise direction or in the positive direction of rotation in relation to the longitudinal axis L, this folding being done around the ends of said circular parts 50, 52, such that the cross-section of plate 30 forms a tight half-turn bent at 180° at the bottom of each circular part 50, 52. After this 180° fold, the plate is wound against itself around the circular parts 50, 52, thus forming a second thickness 2E for the short sides 24, 26.

[0031] Figure 8, in an enlarged view similar to Figure 5, illustrates the fourth folding step 140 of method 100, a step that consists of bringing the flat parts 34, 36 back

to the transverse axis T in the extension of corrugated zone 32, by rotating in the negative direction said lateral parts 34, 36 around the proximal parts 38, 42.

[0032] Figure 9 illustrates the fifth folding step 150 of method 100, a step that consists of shaping the lateral parts 34, 36 to make a semi-circular boss in a symmetrical manner in their respective middles, the first boss 54 extending to the top of the figure and the second boss 56 extending to the bottom of the figure, as well as curving the distal ends 40, 44 of the two lateral parts 34, 36 by making a half-circle at each of the ends. Thus, the first distal end 40 is found at the end of a first half-circle 46 turning towards the bottom of Figure 9 and the second distal end 44 is at the end of a second half-circle 48 turning towards the top of Figure 9. The semi-circular bosses 54, 56 enable additional engagement with the semi-circular parts 50, 52 and the half-circles 46, 48, forming hooks that will be used in any process end.

[0033] In the previously-mentioned alternative in which tube 14 would have a rectangular cross-section, the distal ends 40, 44, would then be shaped appropriately, for example by a single right-angle fold, or even terminated by a small 90° flap forming a hook.

[0034] Figure 10 illustrates the sixth folding step 160 of method 100, a step that consist of winding, by turning in the positive direction, the previously-shaped lateral parts 34, 36 around the corrugated zone 32. The lateral parts 34, 36 are folded on both sides of the corrugated zone 32 forming a first thickness 1E of long sides 20, 22. The semi-circular bosses 54, 56 additionally engage around the semi-circular parts 52, 50, thus forming a third thickness 3E to said semi-circular parts 50, 52. Beyond the semi-circular parts 50, 52, the distal parts of the lateral parts 34, 36 not yet wound extend along the normal axis N towards the top of the figure for one and towards the bottom of the figure for the other.

[0035] Figure 11 illustrates the seventh and last folding step 170 of method 100, a step that consists of terminating the previously-started winding, still by turning in the positive direction, the distal parts of lateral parts 34, 36, thus forming a second thickness 2E at the long sides 20, 22 and after this seventh step 170, hooks 46, 48, formed during the fifth step 150 - Figure 9 - at the distal ends 40, 44, additionally engage and adjust around the first and second circular parts 50, 52, thus forming a fourth thickness 4E of the short sides 24, 26.

[0036] It is easily understood that the winding process can be continued with the aim of making a tube that would have inner partitions 28 of a single thickness and long sides of three, four or even more thicknesses and even thicker short sides.

[0037] In an alternative method, as indicated previously, the corrugated zone 32 can be laterally offset relative to sheet 30, the folding method then consisting of winding the longer lateral part around the corrugated zone.

[0038] In an alternative, not represented, a tube that would only have a single sheet thickness on the long sides and three thicknesses on the short sides may be

easily made by following the steps previously described and represented by Figures 4 to 10 and by interrupting the process at the end of the sixth step 160.

[0039] It is easily understood that many variations and alternatives can be made by following the disclosures of this description, the method essentially corresponding to making the corrugated zone 32 and then winding the lateral parts 34, 36, in either one direction or the other, until the necessary number of layers corresponding to the desired thickness is obtained. For example, according to a second embodiment represented in Figure 12, a tube 14 is made to have short sides 24, 26 with three thicknesses E and long sides 20, 22 with two thicknesses E. To make it, one only has to skip the third step 130 - Figure 7 - and reverse the direction of winding the hooks and then fold the lateral parts 34, 36 so as to surround the corrugated zone 32 in the clockwise direction, each lateral part making a full turn.

[0040] In addition, some steps can be carried out in different manners. Thus the 180° half-turn made at the end of the third step 130 could only have been made after having folded the lateral parts against themselves, the circular parts then already making two thicknesses 2E of sheet 30.

LIST OF REFERENCES USED

[0041]

L longitudinal axis
N normal axis
T transverse axis
E thickness
L1 length
L2 width
F1 heat transfer fluid
F2 air flow

10 heat exchanger
12 tank
14 flat tube
16 cooling fin
18 slots
20 first long side
22 second long side
24 first short side
26 second short side
28 inner partition
30 metal sheet
32 corrugated zone
34 first lateral part
36 second lateral part
38 first proximal end
40 first distal end
42 second proximal end
44 second distal end
46 first half-circle
48 second half-circle

50 first circular part
52 second circular part
54 first semi-circular boss
56 second semi-circular boss

5
100 manufacturing method
110 first folding step
120 second folding step
130 third folding step
10 140 fourth folding step
150 fifth folding step
160 sixth folding step
170 seventh folding step
180 eighth folding step
15 190 ninth folding step.

Claims

20 1. A flat tube (14) adapted to be arranged in a heat exchanger (10) comprising two parallel and separate tanks (12) connected by a plurality of said flat tubes (14) parallel to each other and extending along a longitudinal axis (L), each of the tubes (14) comprising inner partitions (28) separating the inside of the tube (14) into a plurality of channels, cooling fins (16) being arranged between the tubes (14), the exchanger (10) being provided so that a heat transfer fluid (F1) circulating in the tube channels exchanges heat with an air flow (F2) passing between the flat tubes (14) through the fins (16),
25 the flat tube (14) has an elongated section comprising two long and parallel sides (20, 22) extending along a transverse axis (T) and two short and flat or rounded sides (24, 26), joining the ends of the long sides (20, 22) so as to define an inner space in which the internal partitions (28) extend from one long side to the other,
30 **characterized in that**
40 the flat tube (14) is made by shaping without cutting a single sheet (30) of metal such that:

45 The flat tube (14) has short sides (24, 26) of a thickness greater than the thickness of the long sides (20, 22) such that, in use, the flat tube (14) resists the impact of possible projectiles while having sufficient mechanical strength.

50 2. The flat tube (14) according to the previous claim in which the inner partitions (28) have a thickness that is equal to or less than the thickness of the long sides (20, 22), so that the flow of heat transfer fluid (F1) and the heat transfer of said fluid towards the long sides (20, 22) is optimized.

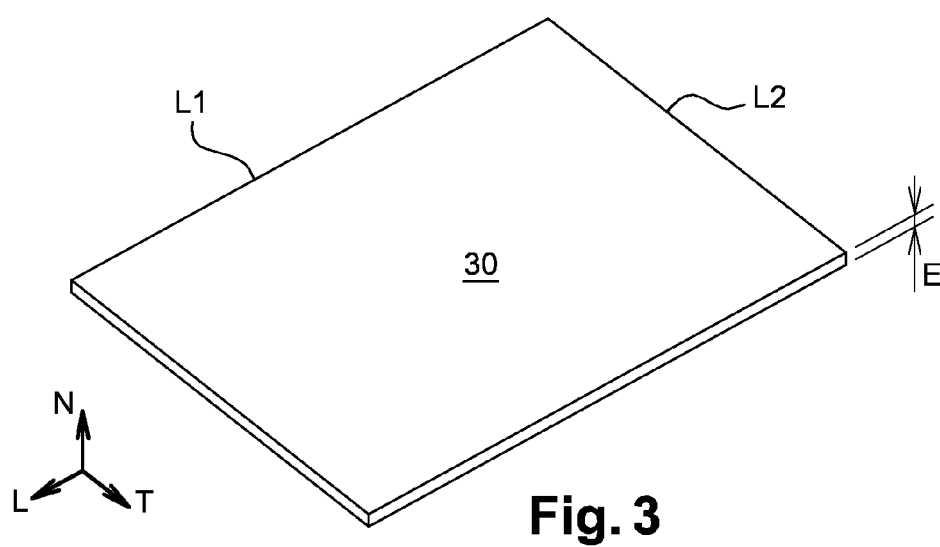
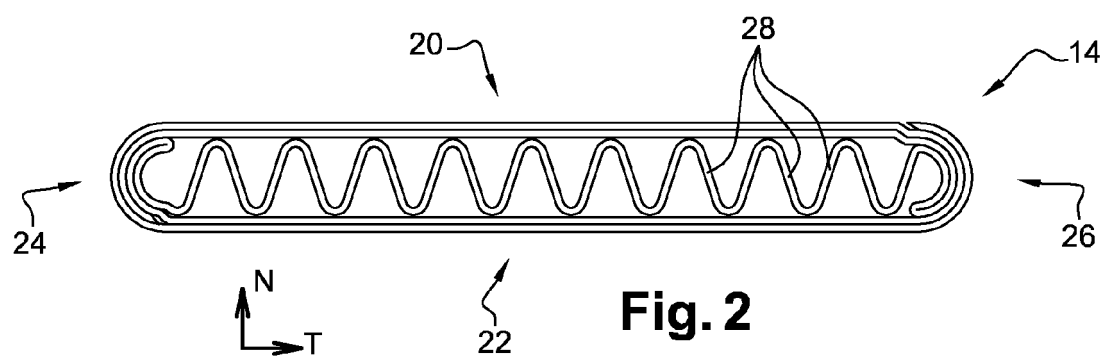
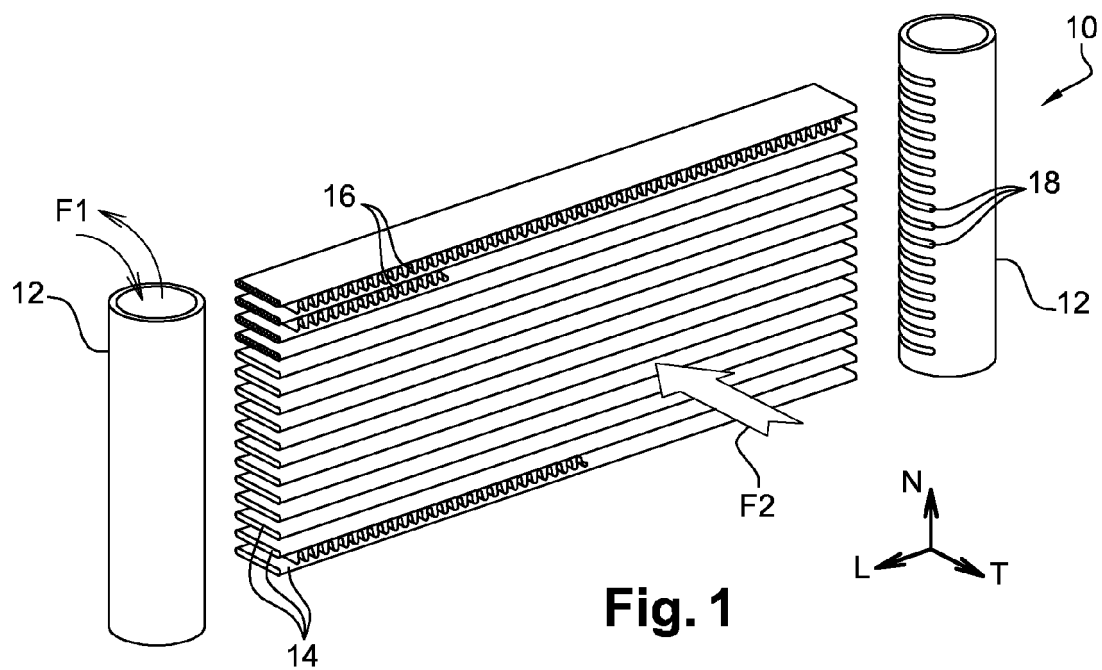
55 3. The flat tube (14) according to any one of the previous claims in which:

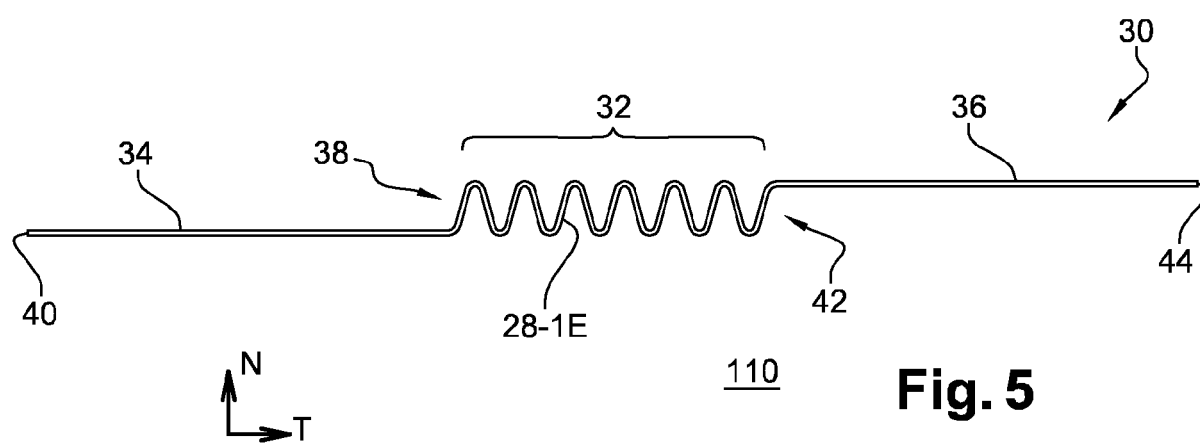
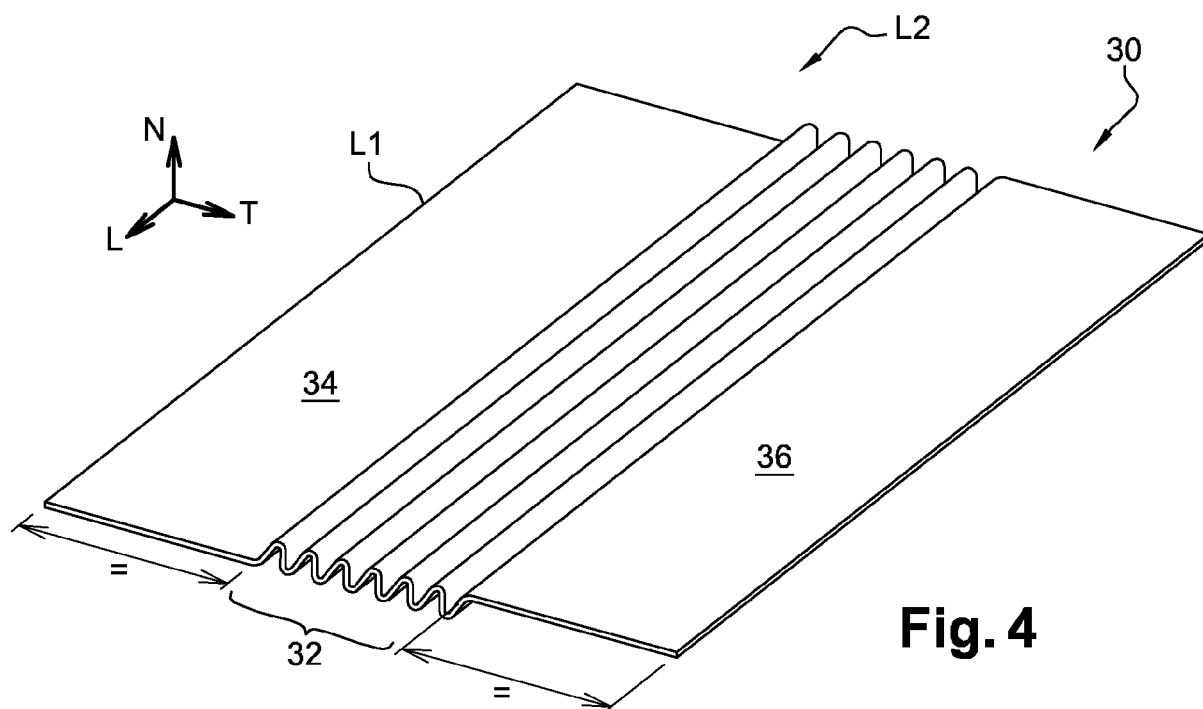
the inner partitions (28) are made in a single thickness (E) of the sheet (30) and,
The short sides are made by stacking at least three thicknesses of the sheet (30).

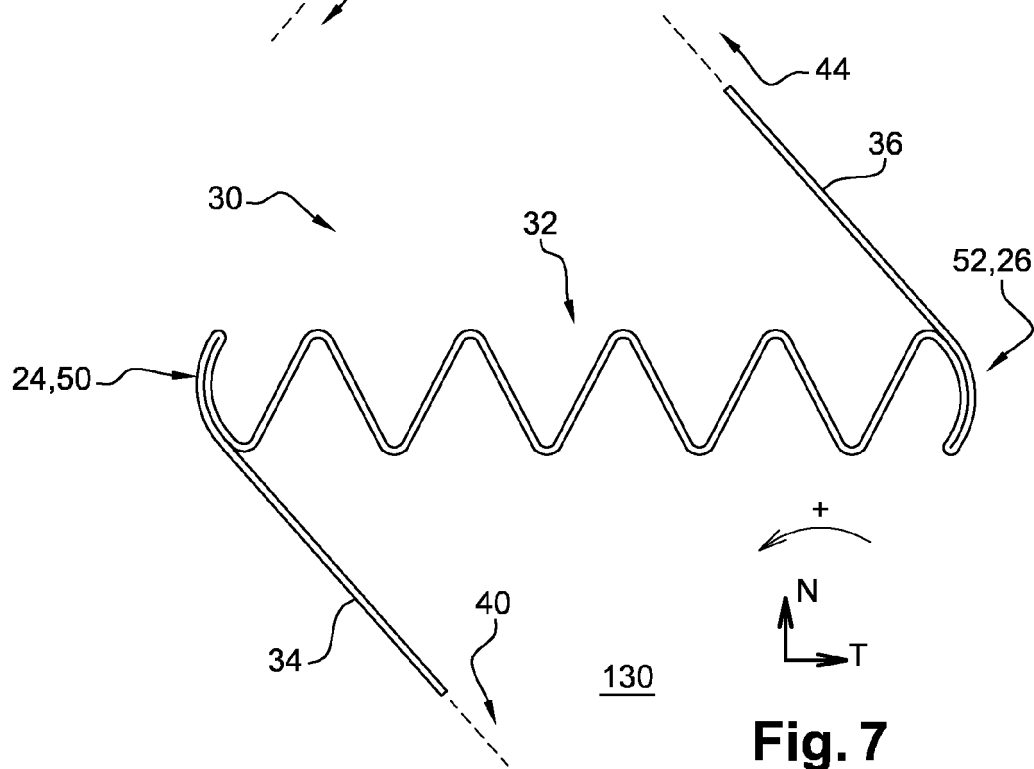
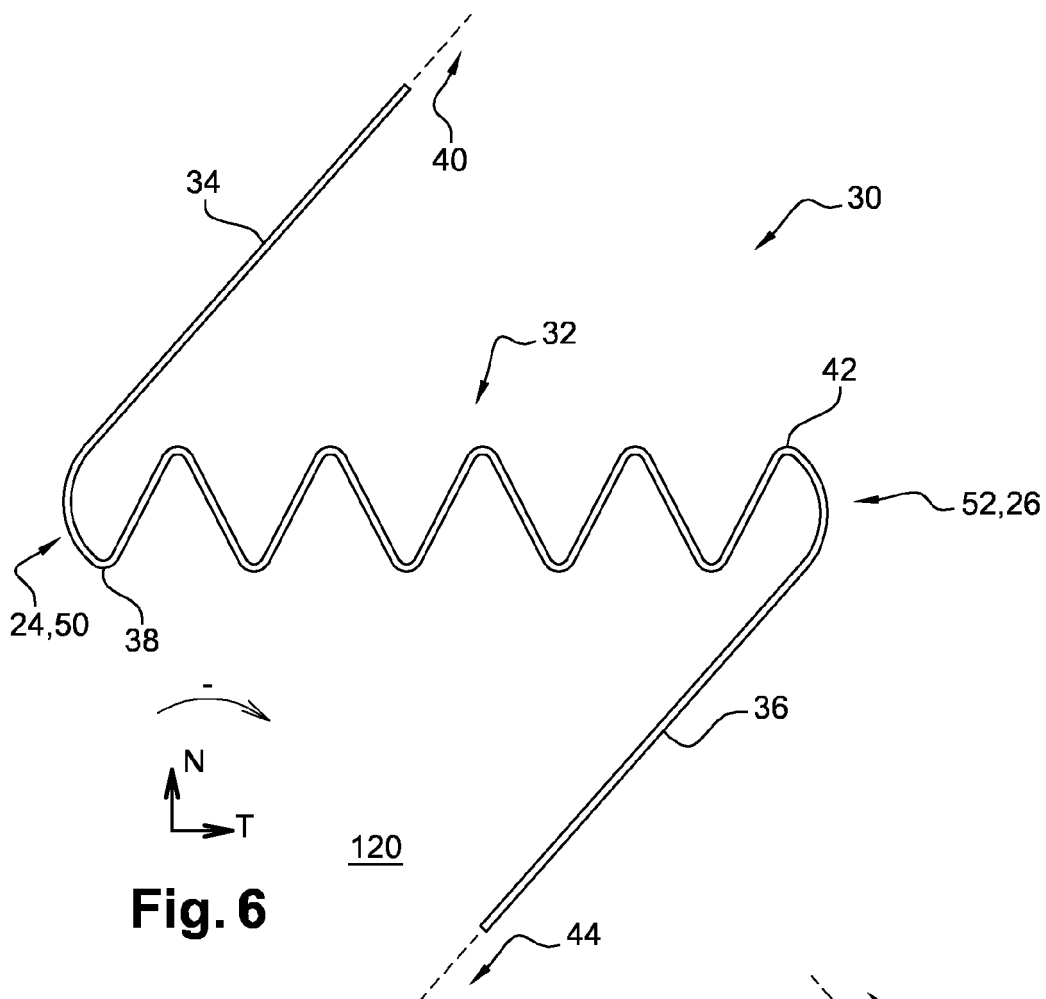
4. The flat tube according to claim 3 in which one of the short sides (24, 26) is made by stacking four thicknesses (E) of sheet (30). 5
5. The flat tube according to claim 4 in which the two short sides (24, 26) are made by stacking four thicknesses (E) of sheet (30). 10
6. The flat tube (14) according to any one of the previous claims in which the long sides (20, 22) are made by stacking two thicknesses (E) of sheet (30). 15
7. The flat tube (14) according to any one of the previous claims in which the inner partitions (28) divide the inner space of the tube (14) into at least ten channels. 20
8. A heat exchanger (10) comprising two parallel and separate tanks (12) connected by a plurality of flat tubes (14) that are parallel to each other, the tubes (14) being made according to any one of the previous claims. 25
9. A method of manufacturing (100) a flat tube (14) adapted to be arranged in a heat exchanger (10) comprising two parallel and separate tanks (12) connected by a plurality of flat tubes (14) parallel to each other, each of the flat tubes (14) comprising inner partitions (28) separating the inside of the tube into a plurality of channels, cooling fins (16) being arranged between the tubes (14), the exchanger (10) being provided so that a heat transfer fluid (F1) circulating in the tube channels exchanges heat with an air flow (F2) passing between the flat tubes through the fins, the method (100) comprising the following steps: 30
 - a) providing a rectangular metal sheet (30) with a length (L1) extending along the longitudinal axis (L) and a width (L2) extending along the transverse axis (T), 45
 - b) folding the sheet (110) so as to form a series of longitudinal undulations on the entire length (L1) of the sheet and in a limited part of the sheet (30), the undulations being parallel to the length (L1) of the sheet, the undulations forming a corrugated zone (32) forming inner partitions (28) while keeping the lateral parts (34, 36) of the sheet flat on both sides of said corrugated zone (32), 50
 - c) folding the flat parts (34, 36) several times (120-170), by winding them around the corru- 55

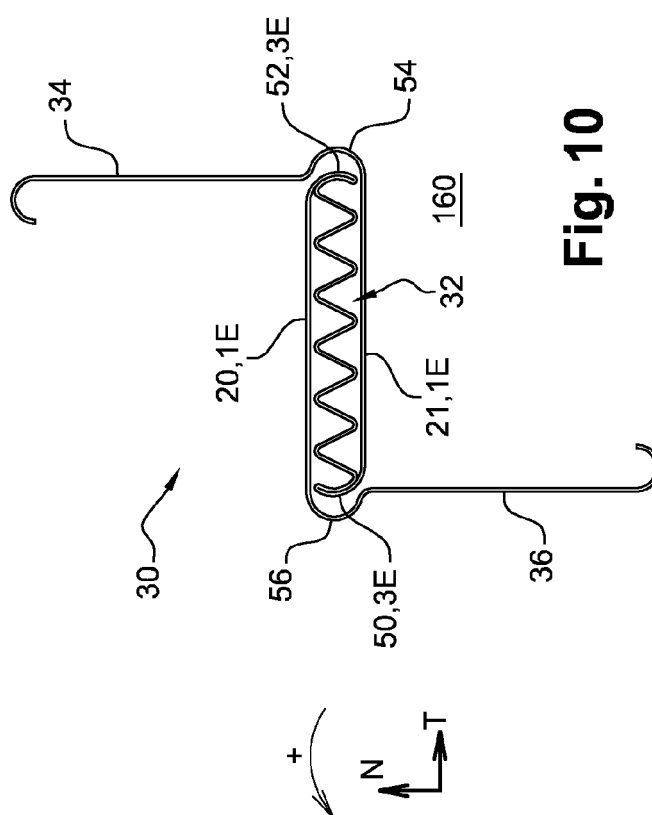
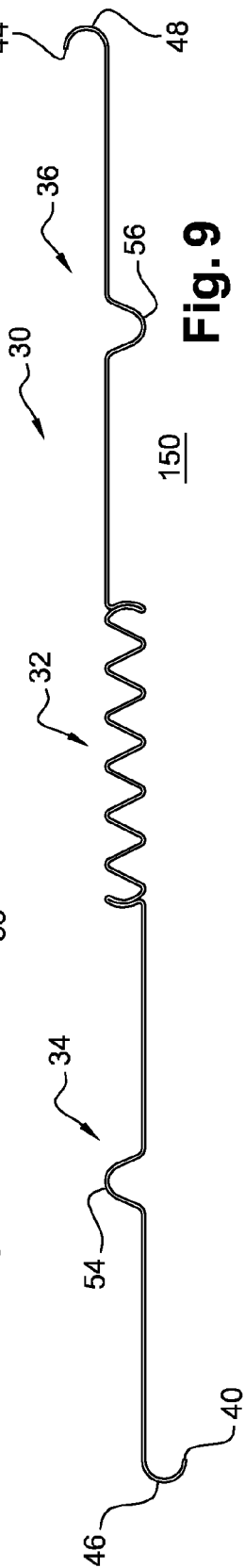
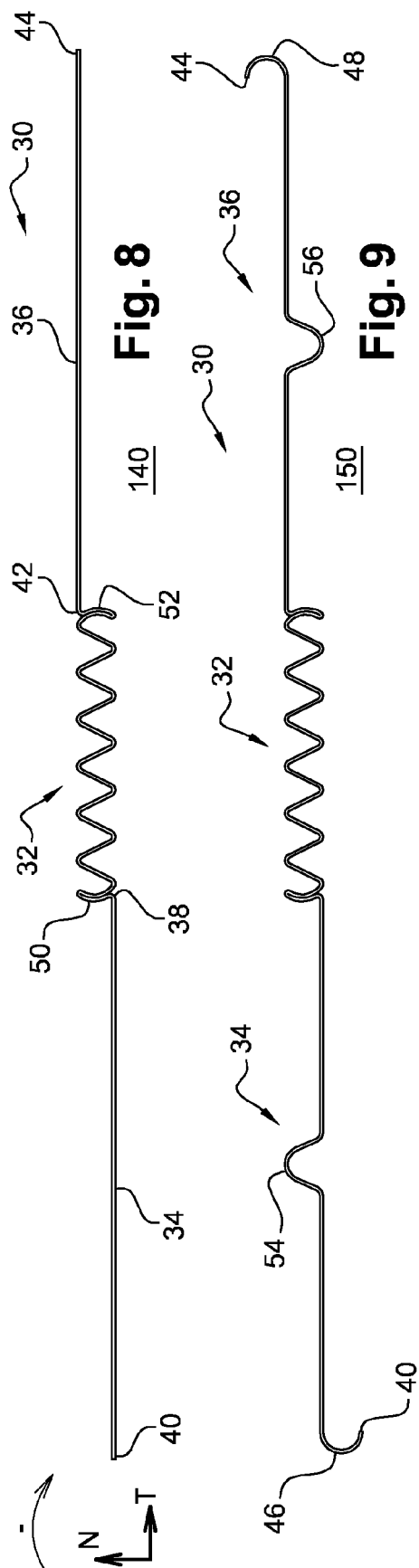
gated zone (32) so that inner partitions (28) are made in a single sheet (30) thickness (E), the long sides being made by stacking two sheet thicknesses and the short sides (24, 26) being made by stacking at least three sheet thicknesses (E).

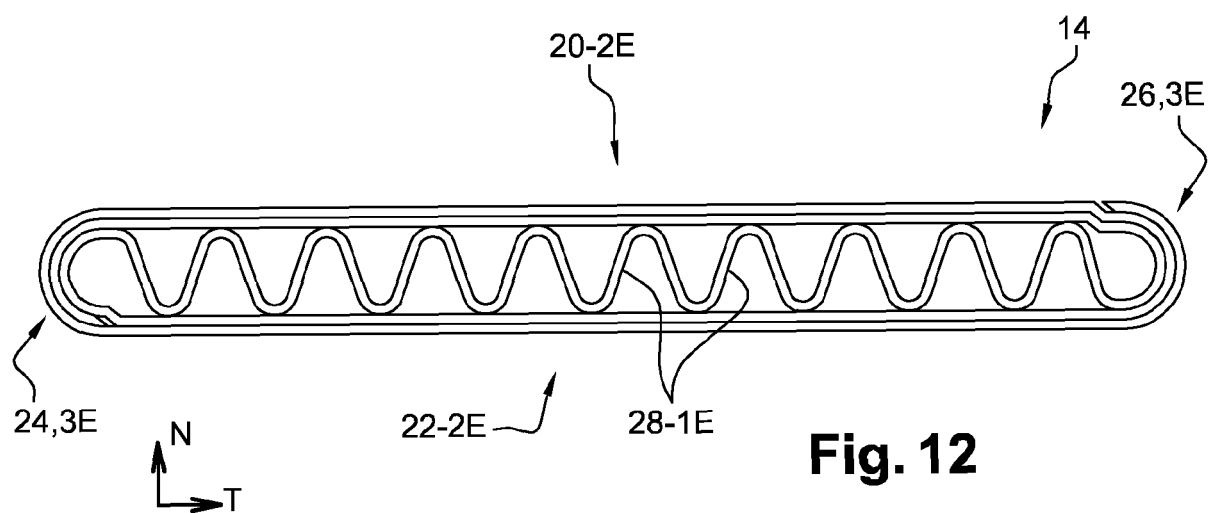
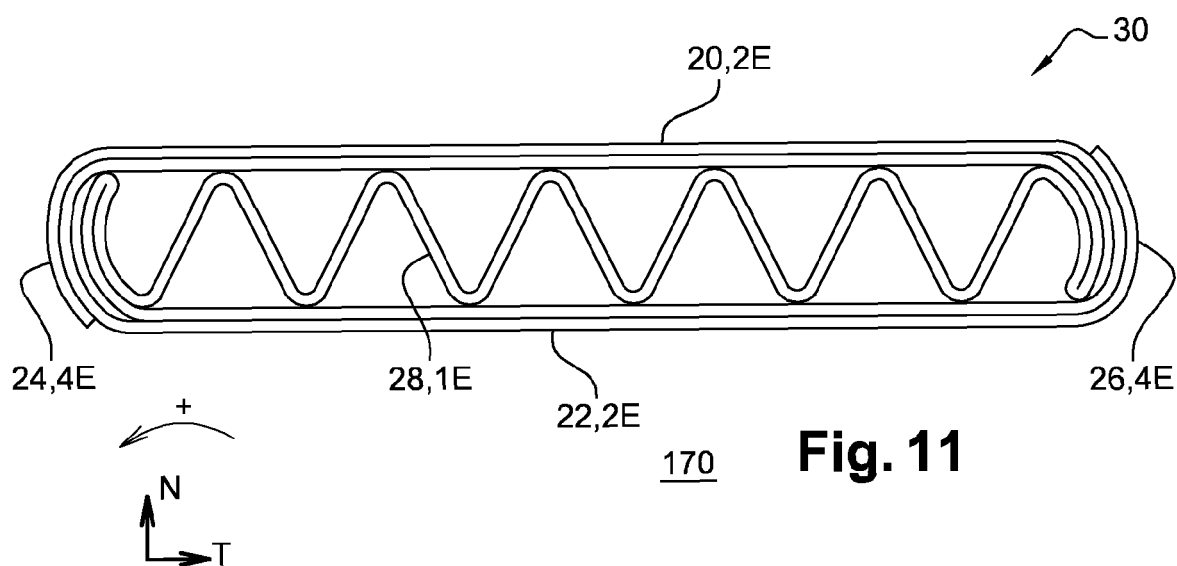
10. The method (100) according to claim 9 in which step c) comprises at least one step (130) during which the metal sheet (30) winding reverses direction.
11. The method (100) according to claim 10 also comprising a soldering step performed after the folding steps.













EUROPEAN SEARCH REPORT

Application Number
EP 16 16 8980

5

10

15

20

25

30

35

40

45

50

55

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	WO 2008/011115 A2 (MODINE MFG CO [US]; KALBACHER KLAUS [DE]; BRAEUNING THOMAS [DE]; SCHUT) 24 January 2008 (2008-01-24) * paragraph [0145] * * paragraph [0161] * * paragraph [0179] * * paragraph [0185] * * paragraph [0336] *	1-6,9-11	INV. F28D1/03 F28F1/02
X	US 2010/206533 A1 (SAKAKIBARA TETSUYA [JP] ET AL) 19 August 2010 (2010-08-19) * paragraph [0048] - paragraph [0054]; figures 1,5 *	1-3,7-9	
X	EP 2 639 539 A1 (DENSO CORP [JP]) 18 September 2013 (2013-09-18) * figures 1,8 *	1-3,7-9	
X	WO 2012/131038 A1 (VALEO SYSTEMES THERMIQUES [FR]; ZANCHETTA PATRICK [FR]; GARCIA JEAN-JA) 4 October 2012 (2012-10-04) * page 1, line 14 - line 21; figure 2b *	1	TECHNICAL FIELDS SEARCHED (IPC) F28D F28F
X	DE 10 2008 033883 A1 (BEHR GMBH & CO KG [DE]) 16 April 2009 (2009-04-16) * figures 5,6 *	1	
X	WO 2006/016704 A1 (SHOWA DENKO KK [JP]; NUMASAWA MAKOTO [JP]; KAIMURA SATORU [JP]; TANAKA) 16 February 2006 (2006-02-16) * page 4, line 3 - line 7; figure 4 *	1	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 September 2016	Examiner Bain, David
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 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 16 8980

5

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.

12-09-2016

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008011115 A2	24-01-2008	EP 2047199 A2 WO 2008011115 A2	15-04-2009 24-01-2008
US 2010206533 A1	19-08-2010	BR PI1000088 A2 JP 2010185636 A US 2010206533 A1	29-03-2011 26-08-2010 19-08-2010
EP 2639539 A1	18-09-2013	BR 112013010570 A2 CN 103201582 A EP 2639539 A1 JP 5527169 B2 JP 2012102948 A US 2013220585 A1 WO 2012063443 A1	09-08-2016 10-07-2013 18-09-2013 18-06-2014 31-05-2012 29-08-2013 18-05-2012
WO 2012131038 A1	04-10-2012	CN 103688123 A EP 2691722 A1 FR 2973490 A1 JP 2014514529 A US 2015107812 A1 WO 2012131038 A1	26-03-2014 05-02-2014 05-10-2012 19-06-2014 23-04-2015 04-10-2012
DE 102008033883 A1	16-04-2009	NONE	
WO 2006016704 A1	16-02-2006	DE 112005001950 T5 US 2008264620 A1 WO 2006016704 A1	05-07-2007 30-10-2008 16-02-2006

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5186251 A [0003]
- EP 1941954 A [0003]