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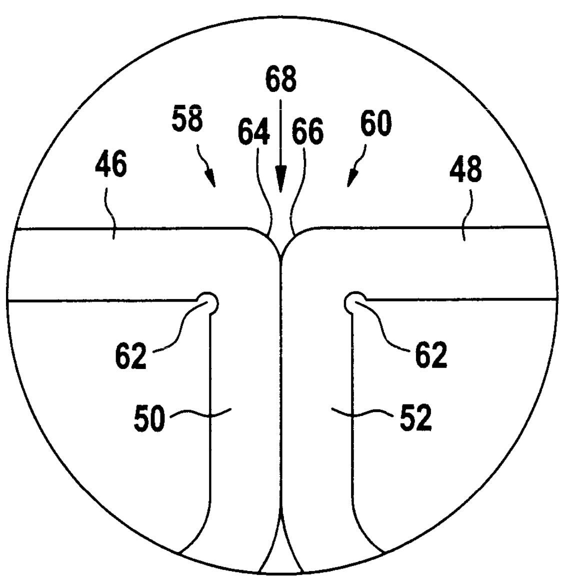
(54) **Method and tool for folding a metal strip**

(57) A method for folding a metal strip is proposed, the method comprising the steps of providing a metal strip (70) having a first surface and a second surface; providing the metal strip with a groove (62,62') in the first surface; folding the metal strip into a corner wherein the first surface forms a concave side of the corner and the second surface forms a convex side of the corner and the groove extends along the concave side of the corner; the metal strip being folded by means of at least one set of rollers. According to an important aspect of the invention, one of the rollers comprises a bead pressing the groove into said metal strip, the bead having a substantially rounded profile. The invention further concerns a folded tube having a groove with substantially rounded profile and a forming tool having a bead with substantially rounded profile.

Fig. 3



EP 1 362 649 A1

Description

Field of the invention

[0001] The present invention generally relates to a method and tool for folding a metal strip, in particular for folding a metal strip for forming a folded tube for a heat exchanger.

Background of the invention

[0002] Heat exchangers are well known in air conditioning systems, refrigerant systems, and in radiators, e.g. in automotive vehicles. Such heat exchangers comprise a pair of manifolds, which are fluidly connected by tubes extending between the manifolds. The tubes generally have two parallel large side walls, joined together by two small curved end walls, so as to form a cross-section of flattened shape. A bank of tubes is obtained by an alternate stacking of such tubes arranged in parallel and of corrugated spacers, forming heat-exchange fins, which extend between the side walls of the tubes.

[0003] A known method of forming a tube for a heat exchanger is to extrude the tube in an extrusion process, wherein internal ribs are formed during the extrusion. However, such extruded tubes are very expensive to produce. Another known method of forming a tube for a heat exchanger is to provide a flat, elongated metal strip and folding the ends of the strip so as to form a tube, generally referred to as folded tube.

[0004] Such a folded tube comprises a metal strip folded on itself so as to delimit two parallel channels separated by a spacer, the latter resulting from the joining of two marginal regions of the metal strip, each folded at right angles, from an outer face of the folded tube towards the inside of the folded tube. The ends of the tubes are received in appropriate openings in the manifolds. The assembly is then brazed in an appropriate furnace so as to constitute a heat exchanger.

[0005] When the two marginal regions of the metal strip are folded at right angles to the metal strip, a folded corner is formed. In the majority of known tubes of this type, the folded corner exhibits a circular-arc shape, which results from the folding operation. When the two marginal regions are brought together to form the spacer, a relatively deep depression is created at the surface of one of the two side walls of the tube, more precisely, at the place where the marginal regions are folded inwards.

[0006] However, in order to ensure leaktightness of the joint between the tubes and the manifolds of the heat exchanger, it is necessary to ensure continuity of each of the side walls of the tubes. The relatively deep depression in one of the side walls, in the region close to the spacer, must therefore be filled. Such operation raises practical difficulty, since it is difficult to fill in this depression conveniently with brazing alloy during the manufacture of the tube.

[0007] In order to minimize depth of the depression mentioned above, US-6,230,533 proposes to create a folded corner by folding a marginal region of the metal strip so that the marginal region forms an obtuse angle with respect to a central area of the metal strip. A rib is formed on the opposite side of the obtuse angle. This rib exhibits a rounded profile which is substantially in the shape of a circular arc and has to be deformed progressively in order to form a corner with a sharp-angled edge and a protruding swelling. This method allows forming a folded tube, which does not have a deep depression in one of its side walls. However, the side wall now comprises a protruding swelling in the region where the two marginal regions are joined. With a folded tube manufactured by this method, the leaktightness of the joint between the ends of the tubes and the manifolds is not ensured because of the protruding swelling. Indeed, due to the protrusion, the folded tube cannot engage in the receiving openings arranged in the manifold. Either, a notch for receiving the protruding swelling must be cut into the receiving openings in the manifolds, or the protruding swelling must be cut off at least at the ends of the folded tube. Furthermore, quite a complex assembly of rollers is needed to form the corner according to this method.

[0008] Another method for producing folded corners while avoiding or at least minimizing the depth of the depression in one of the side walls of the folded tube, is to provide the folded corner with a sharp outer edge, i. e. a folded corner with a very small outer radius of bend. Such a sharp outer edge can be obtained by providing the metal strip with a wedge shaped indentation on one side of the metal strip before folding. The wedge shaped indentation allows, through the reduced thickness of the metal strip at the location of fold, to obtain a sharper outer edge. The sharp outer edge allows to minimize the depth of the depression in the side wall of the folded tube and thereby ensures continuity of each of the side walls of the tubes and hence leaktightness of the joint between the folded tubes and the manifolds of the heat exchanger. However, the local reduction in thickness of the metal strip formed by the wedge shaped indentation is quite substantial, which means that the strength of the material is reduced. The folded corner is subjected to a high amount of material stress, and due to relatively high pressures in the folded tube, the folded tube is liable to break at the level of the indentations.

Object of the invention

[0009] The object of the present invention is to provide a method for folding a metal strip so as to provide a strong folded corner having a sharp outer edge. This object is achieved by a method as claimed in claim 1.

[0010] Another object of the present invention is to provide a folded tube having a strong folded corner with a sharp outer edge. This object is achieved by a folded tube as claimed in claim 18.

[0011] A further object of the present invention is to provide a forming tool for forming a metal strip into a strong folded corner having a sharp outer edge. This object is achieved by a forming tool as claimed in claim 24.

Summary of the invention

[0012] According to the invention, a method for folding a metal strip is proposed, the method comprising the steps of providing a metal strip having a first surface and a second surface; providing the metal strip with a groove in the first surface; folding the metal strip into a corner wherein the first surface forms a concave side of the corner and the second surface forms a convex side of the corner and the groove extends along the concave side of the corner. According to an important aspect of the invention, the groove is pressed into the metal strip by means of a bead having a substantially rounded profile. The groove in the metal strip allows the formation of a folded corner with a sharp outer edge when the metal strip is folded about the groove. Due to the substantially rounded profile of the bead, a groove having a substantially rounded profile is pressed into the thickness of the metal strip, in the first surface thereof. With a groove of such shape, the amount of stress at the folded corner is reduced, so that a strong folded corner is obtained, which is able to withstand high pressures.

[0013] The bead preferably has circular or elliptical arc profile. It is however also possible to have the substantially rounded profile of the bead formed by polygonal surfaces.

[0014] The metal strip can have a thickness between about 0.15 mm and about 0.40 mm, preferably about 0.25 mm. The bead can have a radius between about 0.8 and about 1.0 times the thickness of the metal strip. The bead can have a protruding height between about 0.5 and about 1.1 times the thickness of the metal strip. The radius of the bead is preferably about 1.0 times the thickness of the metal strip and the protruding height of the bead is preferably about 0.66 times the thickness of the metal strip. With such a bead, it is possible to form a groove which is deep enough to form a folded corner having a sharp edge, but which does not compromise the strength of the folded corner. For a metal strip having a thickness of 0.30 mm, the protruding height of the bead can e.g. be 0.21 mm, whereby a groove having a depth of 0.10 mm is created in the metal strip. It has to be noted that only part of the bead is pressed into the thickness of the metal strip. Indeed, the protruding height of the bead does not correspond to the depth of the groove created in the metal strip. Although, compared to the depth of the wedge shaped indentation of prior art methods, which can be about 0.06 mm, the depth of the groove can be bigger, the folded corner obtained via the claimed method is much stronger due to the rounded shape of the groove of the metal strip at the folded corner.

[0015] Preferably, the groove is located so as to delimit a marginal region of the metal strip from a central region of the metal strip, the marginal region forming on the concave side of the corner an obtuse angle with respect to the central region, i.e. an angle between 90 degrees and 180 degrees. The obtuse angle is preferably between about 135 and about 150 degrees, but is more preferably about 135 degrees.

[0016] The central region of the metal strip is advantageously bow shaped. As the metal strip is further folded in a further folding operation, e.g. as it is folded into a folded tube, the unfolded parts of the central region can undergo some deformation due to the further folding operation. Due to the bow shape of the central region, the unfolded parts are deformed into a substantially plane part during the further folding operation. The bow shape has to be designed according to the further folding operation that the metal strip will undergo.

[0017] The metal strip is advantageously further folded so that the marginal region forms a substantially right angle with respect to the central region.

[0018] According to an aspect of the invention, the metal strip is provided with two grooves in the first surface, a first groove delimiting a first marginal region from the central region and a second groove delimiting a second marginal region from the central region, the first and second marginal regions being on opposite ends of the metal strip. Both marginal regions can then be folded at right angles to the central region.

[0019] The central region of the metal strip is then preferably folded such that the first and second marginal regions meet and the free ends of the marginal regions come into contact with the first surface of the central region, so as to form a folded tube. By folding the central region of the metal strip in this way, the marginal regions, which have previously been folded at right angles to the central region, come into contact with each other. Furthermore, the free ends of the marginal regions are brought into contact with the first surface of the central region and form an internal wall, separating a first fluid channel from a second fluid channel within the folded tube. The internal wall is generally located in the centre of the tube. Such a folded tube is generally referred to as a "B-type" folded tube. It will be appreciated that many other configurations are possible. The internal wall could e.g. be off-centre, so as to create fluid channels of different cross-sections. It is also possible to provide longer marginal regions having a plurality of folded corners. The marginal region can e.g. extend down from the first side wall to the second side wall, extend along the second sidewall and extend back up from the second side wall to the first side wall. Folded tubes having more than two fluid channels therein can thereby be formed. Many such configurations are well known in the art. The individual corners of the marginal regions can be configures as strong folded corners with sharp outer edge according to the present method.

[0020] The metal strip is advantageously made from aluminium or aluminium alloy.

[0021] Preferably, at least the second surface of the metal strip comprises cladding material thereon. Alternatively, both the first and the second surfaces of the metal strip comprise cladding material thereon.

[0022] The folded tube is advantageously brazed so as to secure the first and second marginal regions to one another and to the first surface of the central region.

[0023] According to the invention, a folded tube is proposed, comprising a first side wall having a first and a second portion; a second side wall extending substantially parallel to the first side wall; and a first and a second end wall for connecting the first side wall to the second side wall. The folded tube is formed in one piece from a metal strip and the first and second portions of the first side wall each have a marginal region on their respective free ends, the marginal regions being folded into a corner so as to extend inwardly from the first side wall towards the second side wall; a groove being arranged on the concave side of the corner. According to an important aspect of the invention, the groove has substantially rounded profile. The groove in the metal strip allows the formation of a folded corner with a sharp outer edge when the metal strip is folded about the groove. Due to the substantially rounded profile of the groove, the amount of stress at the folded corner is reduced, so that a strong folded corner is obtained, which is able to withstand high pressures.

[0024] The groove preferably has circular or elliptical arc profile. It is however also possible to have the substantially rounded profile of the groove formed by polygonal surfaces.

[0025] The groove can have a depth between about 0.1 and about 0.4 times the thickness of the metal strip. The depth of the groove is preferably about 0.2 times the thickness of the metal strip.

[0026] The folded tube is preferably folded according to the above method.

[0027] According to the invention, a forming tool for forming a metal strip is proposed, the forming tool comprising a bead for pushing a groove into the metal strip at a desired location of bend. According to an important aspect of the invention, the bead has substantially rounded profile. The groove in the metal strip allows the formation of a folded corner with a sharp outer edge when the metal strip is folded about the groove. Due to the substantially rounded profile of the bead, a groove having a substantially rounded profile is pressed into the thickness of the metal strip, in the first surface thereof. With a groove of such shape, the amount of stress at the folded corner is reduced, so that a strong folded corner is obtained, which is able to withstand high pressures.

[0028] The bead preferably has circular or elliptical arc profile. It is however also possible to have the substantially rounded profile of the bead formed by polygonal surfaces.

[0029] The forming tool is preferably a roller assembly comprising a first and second roller, the first roller comprising the bead. The second roller can comprise a cut-out for receiving some of the metal displaced by the bead of the first roller.

[0030] The bead can have a protruding height between about 0.5 and about 1.1 times the thickness of the metal strip. The protruding height of the bead is preferably about 0.66 times the thickness of the metal strip.

[0031] The cut-out can have a depth between about 0 and about 0.5 times, preferably about 0.3 times the thickness of the metal strip.

Brief description of the drawings

[0032] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

- Fig.1: is a side view of a heat exchanger comprising folded tubes formed in accordance with the method of the invention;
- Fig.2: is an end view of a folded tube of Fig.1;
- Fig.3: is an enlarged view of Fig.2 showing the folded corners of the folded tube;
- Fig.4: shows manufacturing steps from a metal strip to a folded tube according to the invention;
- Fig.5: is a front view of a forming tool for pre-forming a metal strip;
- Fig.6: is an enlarged view of Fig.5 showing the bead for pressing a groove into the metal strip; and
- Fig.7: is an enlarged view of a front view of a forming tool for pre-forming a metal strip according to a further embodiment.

Detailed description of a preferred embodiment

[0033] A side view of a heat exchanger comprising folded tubes according to the invention is shown in Fig. 1. Such a heat exchanger 10 comprises a pair of manifolds 12 which are spaced apart and which extend in a direction substantially parallel to one another. A number of folded tubes 14 extend between the manifolds 12. The folded tubes 14 are spaced apart and extend in a longitudinal direction X substantially parallel to one another, and substantially perpendicular to the axial direction of the manifolds 12. Each end 16 of each folded tube 14 is located in a corresponding receiving opening 18 formed in the manifolds 12 to allow fluid flow between the folded tubes and the manifolds. A fluid inlet pipe 20 is connected to one of the manifolds 12, and a fluid outlet pipe 22 is connected to the other manifold 12 (or alternatively to the same manifold as the inlet fluid pipe). One or more baffle plates 24 may be secured inside the manifolds 12 to provide predetermined fluid flow path through the manifolds and the folded tubes 14. Sinusoidal fins 26 are positioned between, and in contact with, adjacent folded tubes 14. The fins 26 act to provide improved heat transfer between the fluid in the folded tubes 14 and air flowing through the heat exchanger 10 between the folded tubes. A pair of reinforcement plates 28 may extend between the manifolds 12 outwardly of the folded tubes 14. End caps 34 are positioned at each end 30 of the manifolds 12 to fluidly close the manifolds. The heat exchanger 10 is manufactured by assembling the above mentioned components and then brazing to secure the components together and form fluid tight joints where required.

[0034] Each folded tube 14 is formed in one piece from a metal strip, which can be aluminium or aluminium alloy. The metal strip has a cladding material on at least one side, and is substantially rectangular before formation into the folded tube 14. The metal strip is folded to form the folded tube 14, with the clad side of the metal strip being outermost (when clad on one side only). As can be seen in Figure 2, the folded tube 14 is formed with a first side wall 40 and a second side wall 42 which extend in the longitudinal direction substantially parallel to one another, are substantially planar, and which are connected by end walls 44. The first side wall 40 has first and second portions 46, 48, which are folded inwardly at their free end to form internal walls 50, 52 internally of the side walls 40, 42 and the end walls 44. Each of the internal walls 50, 52 extends in the longitudinal direction X and contacts the first and second side walls 40, 42. The internal walls 50, 52 are preferably substantially perpendicular to the side walls 40, 42. With this arrangement, the folded tube 14 has two separate fluid channels 54, 56 extending through the folded tube in the longitudinal direction X. The presence of the cladding secures the internal walls 50, 52 together during the brazing process.

[0035] Folded corners 58, 60 are created where the internal walls 50, 52 are folded inwards. An enlarged view, showing these folded corners 58, 60 in more detail, can be seen in Fig.3. During forming of the folded tube, a groove 62, 62' is pressed into the metal strip on the surface that is to become the inside of the folded tube 14. This groove 62, 62' ensures that when the internal walls 50, 52 are folded substantially perpendicular to the first and second portions 46, 48, a strong folded corner 58, 60 with a sharp outer edge 64, 66 is created. In other words, the folded corner 58, 60 has a very small outer radius of bend. Between the two folded corners 58, 60, a depression 68 is formed in the first side wall 40. Due to the fact that the folded corners 58, 60 have a sharp outer edge 64, 66, the depth of the depression 68 is very limited and the depression 68 can easily be filled with brazing alloy, so that leaktightness at the joint between the folded tube 14 and the manifold 12 is ensured. Furthermore, due to its shape, the groove 62, 62' does not substantially reduce the material thickness of the metal strip in the folded corner 58, 60, and there is no substantial amount of stress in the folded corners 58, 60. The folded corners 58, 60 are hence not liable to breaking when higher fluid pressures are applied within the fluid channels 54, 56.

[0036] Fig.4 schematically shows the folded tube in individual process stages, i.e. from a flat metal strip (in Fig.4a) to a folded tube (in Fig.4d). Fig.4a shows a flat metal strip 70 having a first surface 72 and a second surface 74, the metal strip 70 comprising a central region 76 and two marginal regions 78, 80. At least the second surface 74 has cladding material (not shown) thereon. The flat metal strip 70 passes through a first roller assembly as shown in Fig.5 and is folded into a folded metal strip 70 as shown in Fig.4b. In the first roller assembly, the marginal regions 78, 80 are folded upwards so as to form an obtuse angle α with respect to the central region 76, the obtuse angle α being on the side of the first surface 72 of the metal strip 70. The obtuse angle α is generally between about 135 and about 150 degrees, preferably about 135 degrees. As the metal strip 70 is folded in this way, two folded corners 58, 60 are formed. One of the rollers of the first roller assembly comprises a first bead for pressing a first groove 62 into the metal strip 70 on the first surface 72, between the first marginal region 78 and the central region 76, and a second bead for pressing a second groove 62' into the metal strip 70 on the first surface 72, between the second marginal region 80 and the central region 76. The first and second beads have a substantially rounded profile so as to create grooves 62, 62' having substantially rounded profile in the metal strip 70. The folded metal strip 70 then passes through a second roller assembly to be folded into a folded metal strip 70 as shown in Fig.4c. In the second roller assembly, the marginal regions 78, 80 are folded upwards so as to form a right angle with respect to the central region 76. Due to the grooves 62, 62', the folded corners 58, 60 have a sharp outer edge 64, 66, i.e. the folded corner 58, 60 has a very small outer radius of bend. The folded metal strip is then folded into a folded tube, as shown in Fig. 4d. The central region 76 is folded, so that the marginal regions 78, 80 come into contact with each other

[0037] Fig.5 partly shows a roller assembly 82 comprising a first roller 84 and a second roller 86 for forming a metal strip (as shown in Fig.4a) into a formed metal strip (as shown in Fig.4b). The first and second rollers 84, 86 rotate in opposite directions about respective parallel axes 88, 90. According to one embodiment of the invention, the central region of the metal strip can be curved. In order to achieve this, the first and second rollers 84, 86 of the roller assembly 82 comprise a bow shaped profile 92. In order to form the grooves in the metal strip, the first roller 84 comprises at its end portions 94, 96 a bead 98, 100. The bead 100 can be closer described by referring to Fig.6, which is an enlarged view of the end portion 96 of the first roller 86, with the corresponding end portion 106 of the second roller 86. The end portion 96 of the first roller 84 comprises a first surface 102 and a second surface 104 forming an obtuse angle between them. The second roller 86 has a corresponding end portion 106 having a third surface 108 and a fourth surface 110. The first surface 102 is parallel to the third surface 108. Similarly, the second surface 104 is parallel to the fourth surface. The metal strip is folded into a folded corner between the two rollers 84, 86; the central region is formed between the first and third surfaces 102, 108, whereas the marginal region is formed between the second and fourth surfaces 104, 110. In order to form a groove in the first surface of the metal strip, the end portion 96 of the first roller 84 comprises a bead 100, on the corner where the first and second surfaces 102, 104 meet. The bead 100 has a substantially rounded profile having a height h of 0.21 mm. According to one embodiment of the invention, the end portion 106 of the second roller 86 comprises a cut-out 112 having a depth d of 0.12 mm. The cut-out 112 comprises a fifth surface 114 connected to the third surface 108 and a sixth surface 116 connected to the fourth surface 110. Ideally, third surface 108 is at an angle of 8 degrees with respect to the axis of the roller, whereas the fifth surface 114 is at an angle of 22 degrees. The fourth surface 110 is at an angle of 33 degrees with respect to the axis of the roller, whereas the sixth surface 116 is at an angle of 45 degrees. As the bead 100 presses a groove into the first surface of the metal strip, the second surface can deform. The deformation of the second surface further helps to achieve a folded corner with a sharp outer edge. Although, due to the deformation, the folded corner comprises a protrusion after the metal strip has passed this roller assembly, this protrusion disappears as the folded corner is further folded so as to form a right-angled corner. The protrusion helps to form a sharper outer edge of the folded corner. It is further to be noted that the meeting point 120 between the first and second surfaces 102, 104 and the meeting point 122 between the third and fourth surfaces 108, 110 are slightly offset on the horizontal axis.

[0038] Another embodiment of the roller assembly 82 is shown in Fig.7. The second roller 86' of the roller assembly 82' does not comprise a cut-out 112 as indicated in Fig.6. Fig.7 also shows a metal strip 124 between the two rollers 84, 86'. It can be seen that the gap between the two rollers 84, 86' is bigger than the thickness of the metal strip 124. It follows tat only part of the bead is pressed into the metal strip, i.e. the protruding height of the bead 100 does not correspond to the depth of the groove created in the metal strip 124.

Claims

1. A method for folding a metal strip comprising the steps of:

providing a metal strip having a first surface and a second surface;

providing said metal strip with a groove in said first surface;

folding said metal strip into a corner wherein said first surface forms a concave side of said corner and said second surface forms a convex side of said corner and said groove extends along said concave side of said corner;

characterized in that
said groove is pressed into said metal strip by means of a bead having a substantially rounded profile.

2. Method according to claim 1, wherein said bead has a circular arc profile.

3. Method according to claim 1, wherein said bead has an elliptical arc profile.

4. Method according to claim 1, wherein the substantially rounded profile of the bead is formed by polygonal surfaces.

5. Method according to any of the previous claims, wherein said metal strip has a thickness between 0.15 mm and 0.40 mm, preferably 0.25 mm.

6. Method according to any of the previous claims, wherein said bead has a radius between about 0.8 and about 1.0, preferably about 1.0 times the thickness of said metal strip.

7. Method according to any of the previous claims, wherein said bead has a protruding height between about 0.5 and about 1.1, preferably about 0.66 times the thickness of said metal strip.

8. Method according to any of the previous claims, wherein said groove is located so as to delimit a marginal region of said metal strip from a central region of said metal strip, said marginal region forming on said concave side of said corner an obtuse angle with respect to said central region.

9. Method according to claim 8, wherein said obtuse angle is between about 135 and about 150 degrees, preferably about 135 degrees.

10. Method according to any of the previous claims, wherein said central region of said metal strip is bow shaped.

11. Method according to any of the previous claims, wherein said metal strip passes through a second set of rollers, wherein said marginal region is folded so that said marginal region forms on said concave side of said corner a substantially right angle with respect to said central region.

12. Method according to any of the previous claims, wherein said metal strip is provided with two grooves in said first surface, a first groove delimiting a first marginal region from said central region and a second groove delimiting a second marginal region from said central region, said first and second marginal regions being on opposite ends of said metal strip.

13. Method according to claim 12, wherein said central region of said metal strip is folded such that the first and second marginal regions meet and that the free ends of the marginal regions come into contact with the first surface of the central region, so as to form a folded tube.

14. Method according to any of the previous claims, wherein said metal strip is made from aluminium or aluminium alloy.

15. Method according to any of the previous claims, wherein said metal strip comprises cladding material on at least said second surface.

16. Method according to any of the previous claims, wherein said metal strip comprises cladding material on said first and said second surfaces.

17. Method according to claims 13 or 14, wherein said folded tube is brazed so as to secure said first and second marginal regions to one another and to said first surface of said central region.

18. Folded tube comprising:

a first side wall having a first and a second portion;

a second side wall extending substantially parallel to said first side wall;

a first and a second end wall for connecting said first side wall to a second side wall;

wherein said folded tube is formed in one piece from a metal strip;
wherein said first and second portions of said first side wall each have a marginal region on their respective free ends, said marginal regions being folded into a corner so as to extend inwardly from said first side wall towards said second side wall;
wherein a groove is arranged on the concave side of said corner
characterized in that
said groove has substantially rounded profile.

19. Folded tube according to claim 18, wherein said groove has a circular arc profile.

20. Folded tube according to claim 18, wherein said groove has a elliptical arc profile.

21. Folded tube according to claim 18, wherein the substantially rounded profile of the groove is formed by polygonal surfaces.

22. Folded tube according to any of claims 18 to 21, wherein said groove has a depth between about 0.1 and about 0.4, preferably about 0.2 times the thickness of said metal strip.

23. Folded tube according to any of claims 18 to 22, wherein said folded tube is folded according to any of claims 1 to 17.

24. Forming tool for forming a metal strip, wherein said forming tool comprises a bead for pushing a groove into said metal strip at the desired location of bend
characterized in that
said bead has substantially rounded profile.

25. Forming tool according to claim 24, wherein said bead has a circular arc profile.

26. Forming tool according to claim 24, wherein said bead has a elliptical arc profile.

27. Forming tool according to claim 24, wherein the substantially rounded profile of the bead is formed by polygonal surfaces.

28. Forming tool according to any of claims 24 to 27, wherein said forming tool is a roller assembly comprising a first and second roller, said first roller comprising said bead.

29. Forming tool according to claim 27, wherein said second roller comprises a cut-out for receiving some of the metal displaced by said bead of said first roller.

30. Forming tool according to any of claims 24 to 29, wherein said bead has a protruding height between about 0.5 and about 1.1, preferably about 0.66 times the thickness of said metal strip.

31. Forming tool according to claim 29 or 30, wherein said cut-out has a depth between about 0 and about 0.5, preferably about 0.3 times the thickness of said metal strip.

Fig. 1

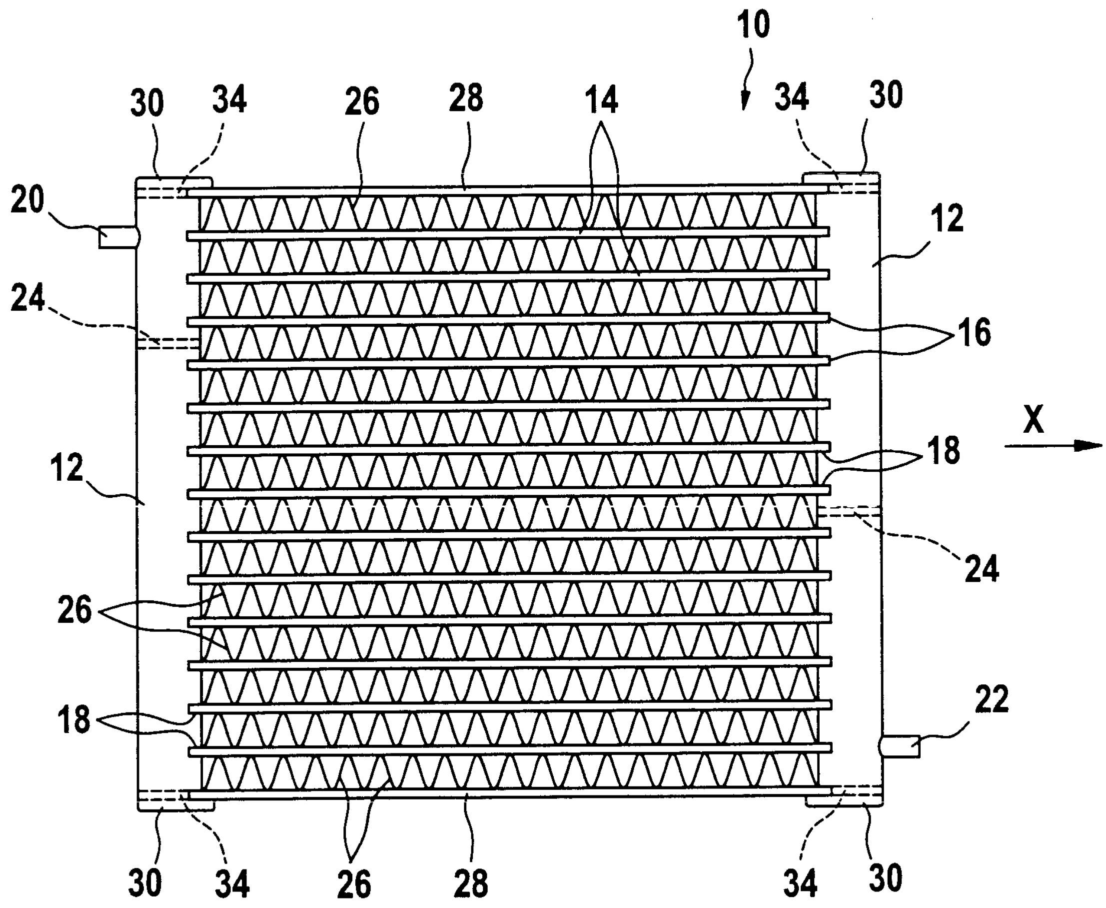


Fig. 2

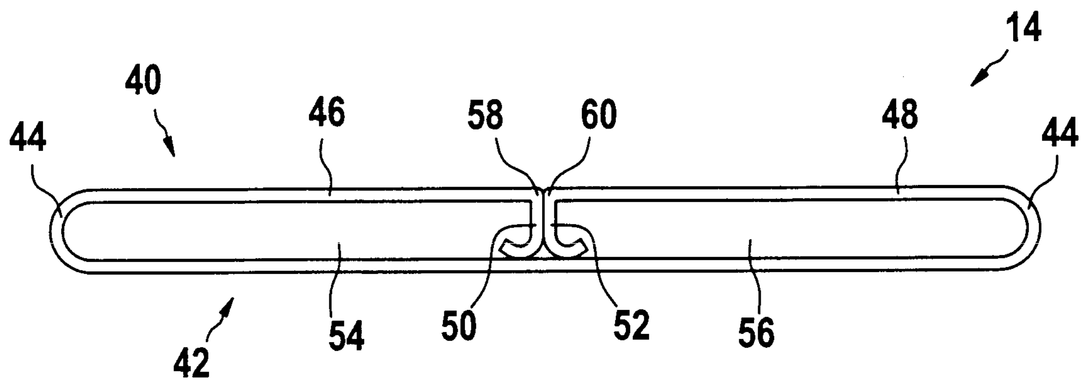


Fig. 3

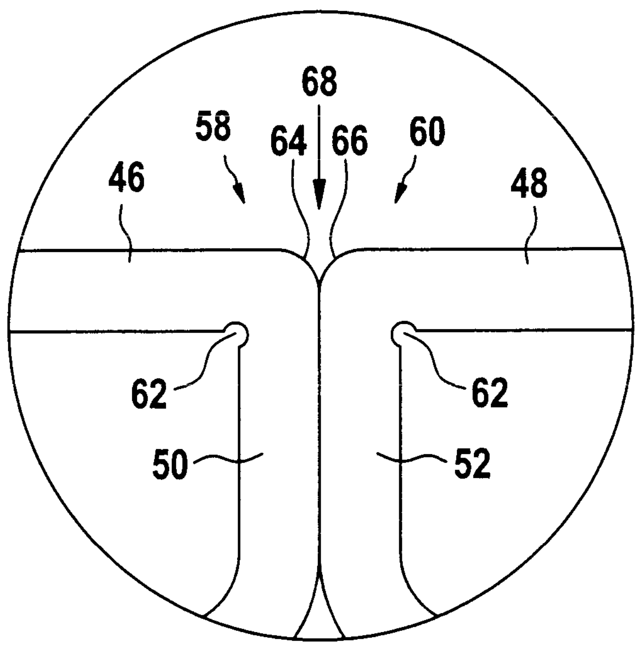
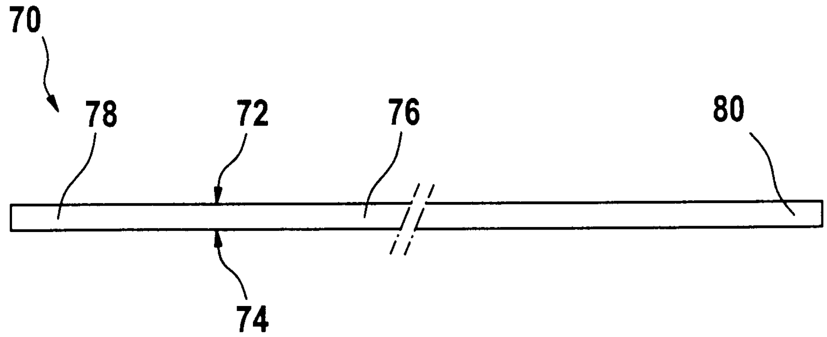
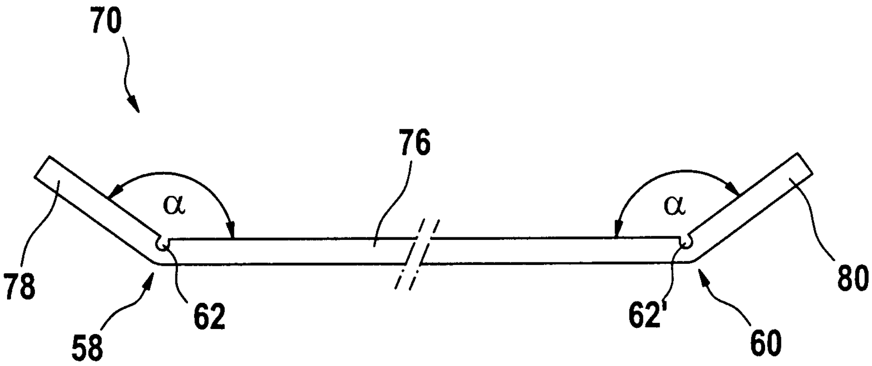


Fig. 4

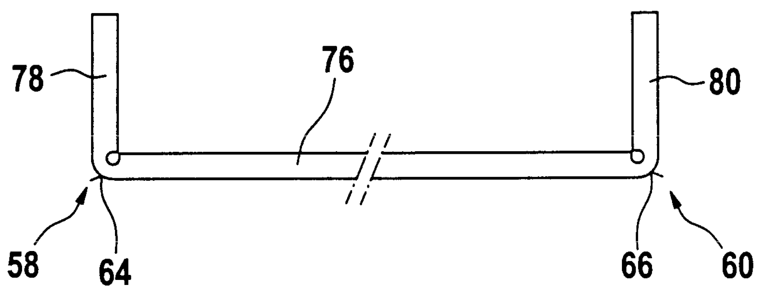
a)


70
78
72
76
80
74

b)


70
76
α
α
78
62
58
62'
60
80

c)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d)

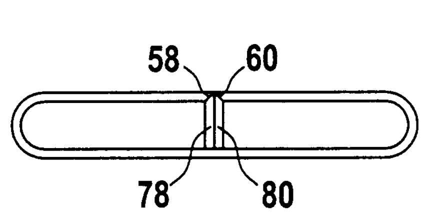
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Fig. 5

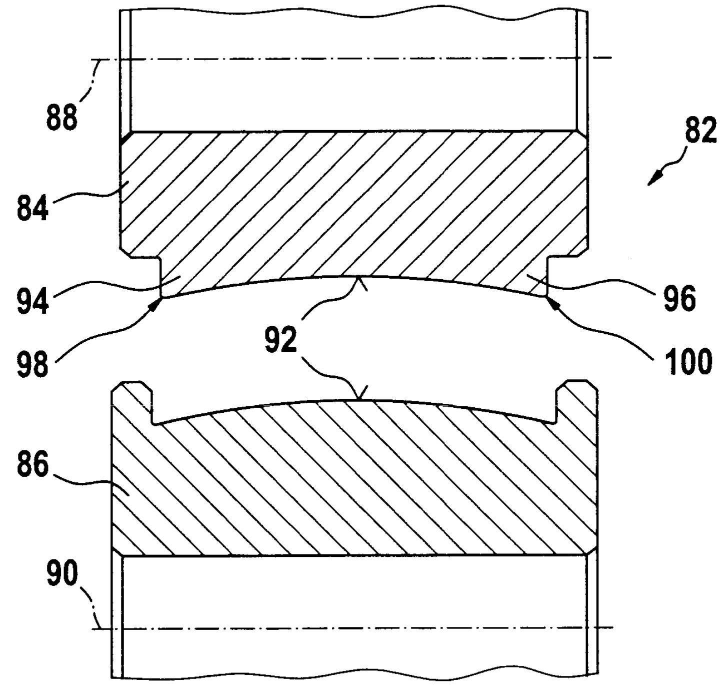
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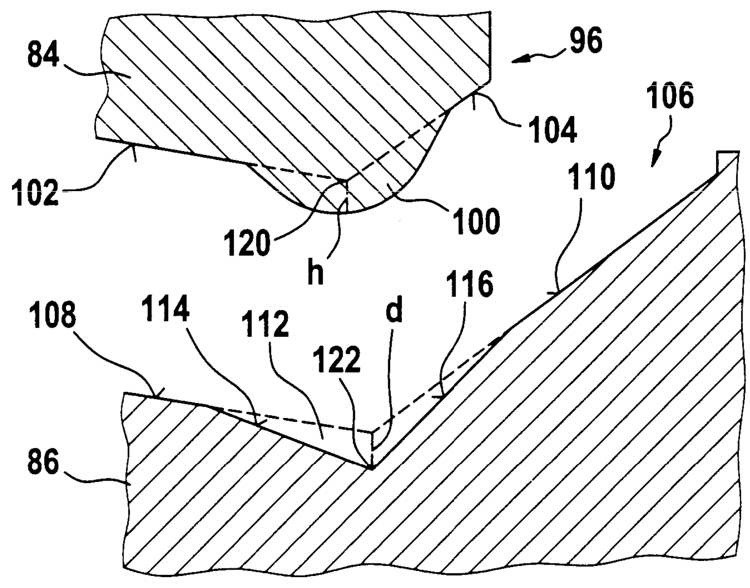
Fig. 6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h
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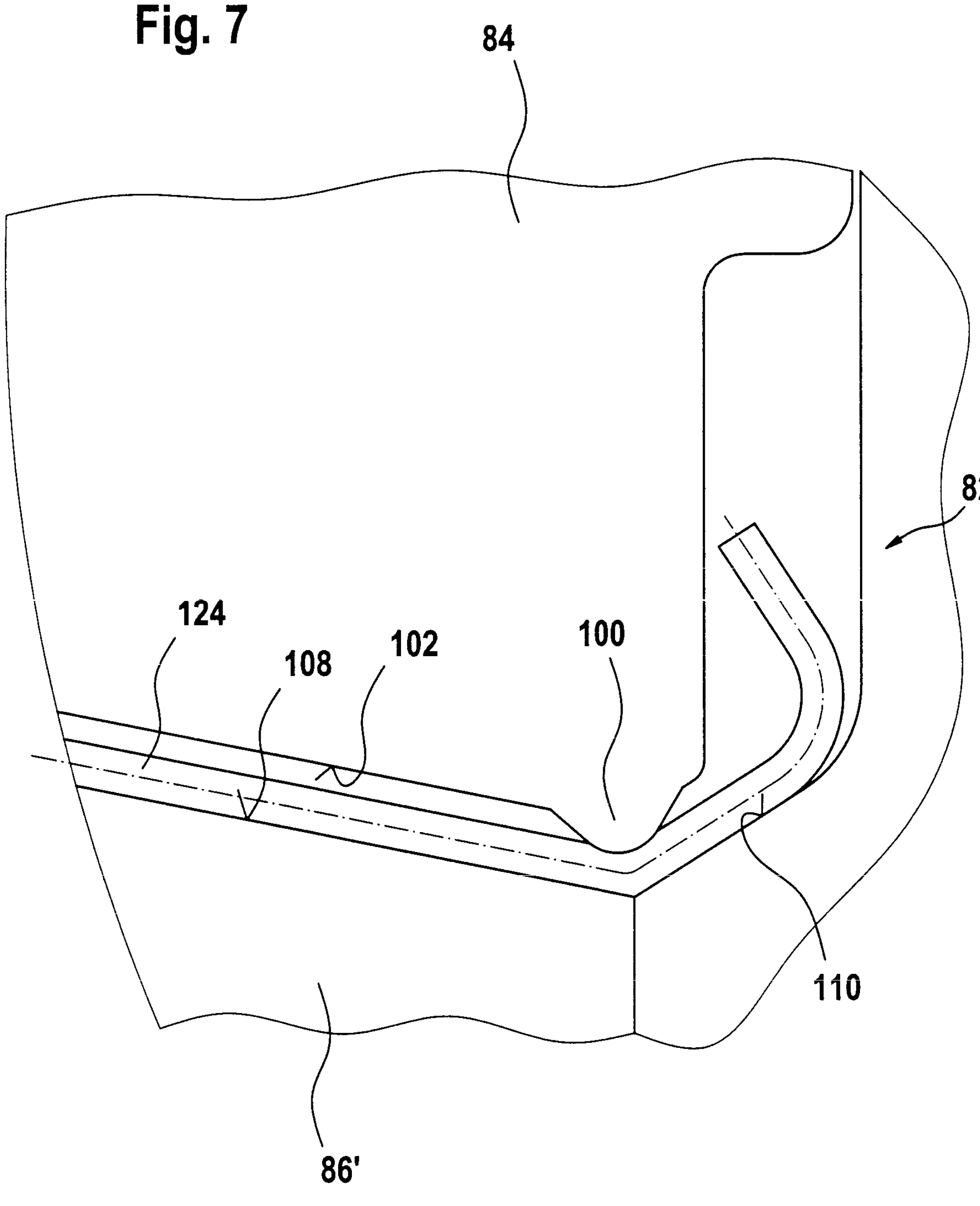
d
122
86

Fig. 7



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Application Number
EP 03 10 1099

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