



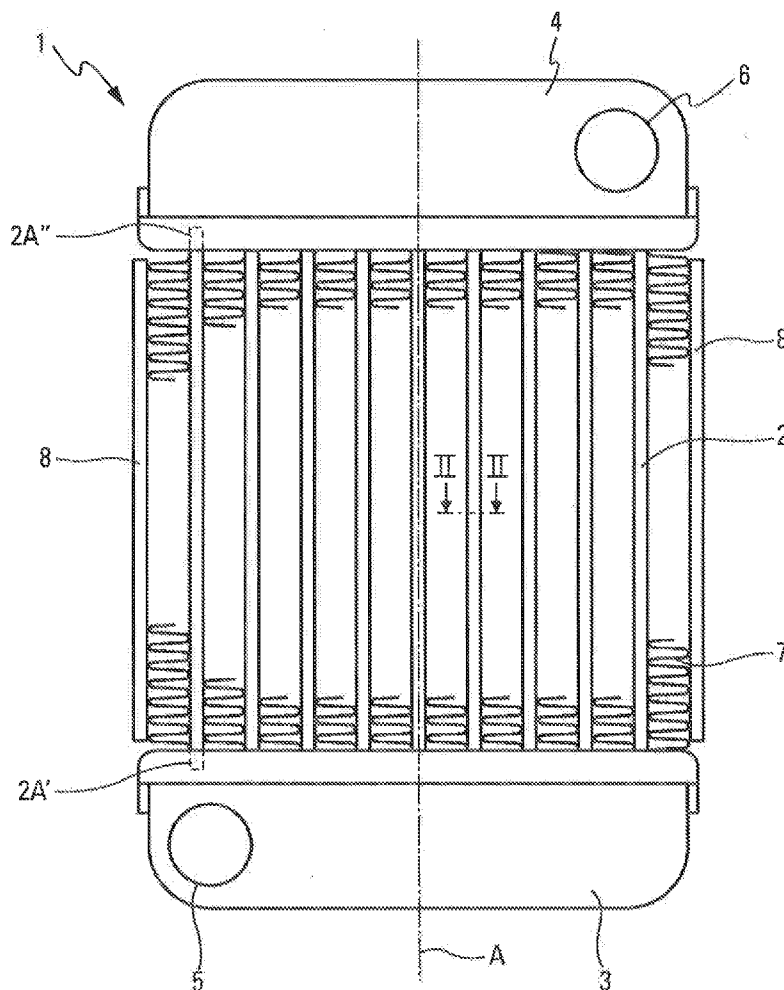
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(19) **United States**(12) **Patent Application Publication****Denoual et al.**(10) **Pub. No.: US 2014/0190675 A1**(43) **Pub. Date: Jul. 10, 2014**(54) **HEAT EXCHANGER PIPE AND HEAT EXCHANGER INCORPORATING SUCH PIPES****Publication Classification**(51) **Int. Cl.**
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USPC **165/181**(76) Inventors: **Christophe Denoual**, Noyen Sur Sarthe (FR); **Alain Pourmarin**, La Suze Sur Sarthe (FR)(21) Appl. No.: **14/130,847**(22) PCT Filed: **Jul. 4, 2012**(86) PCT No.: **PCT/EP2012/063060**§ 371 (c)(1),
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(57) **ABSTRACT**

The invention relates to a pipe (2) of a heat exchanger (1) comprising a strip (9) bent about itself such as to define an internal volume (10) of the pipe (2). The strip (9) comprises first and second edge portions (15, 16) joined such as to divide the internal volume (10) into at least two channels. The first edge portion (15) has two distinct parts, referred to as first and second contact parts (18, 22), in contact with the second edge portion (16) and a third contact part (20), located between the first and second contact parts (18, 22). The third contact part (20) is in contact with a zone of the strip (9) opposite the second edge portion (16) across the internal volume (10) of the pipe (2). The invention also relates to a heat exchanger (1) incorporating such pipes (2).



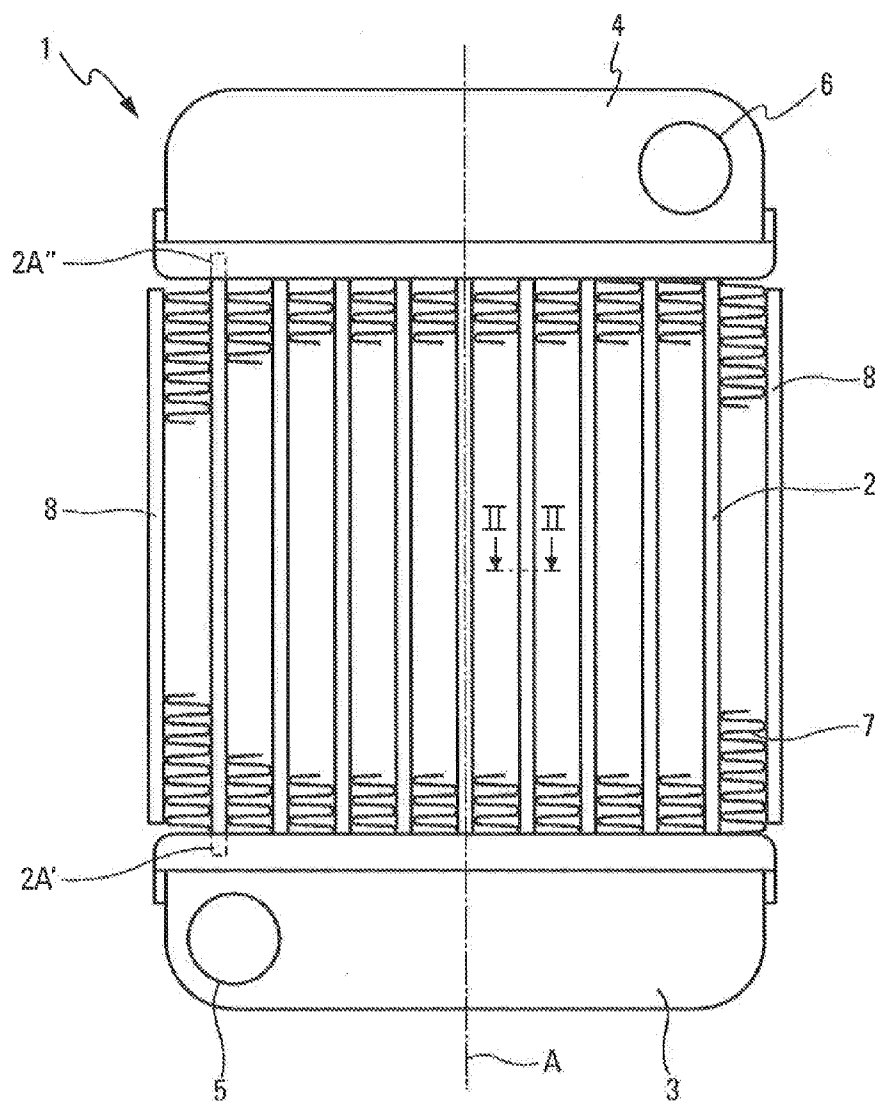


Fig. 1

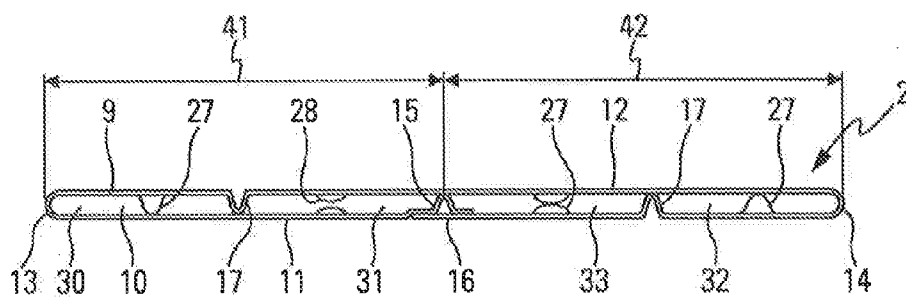


Fig. 2

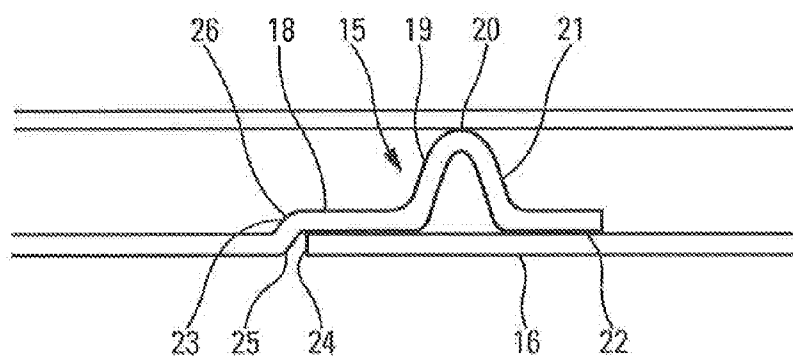


Fig. 3

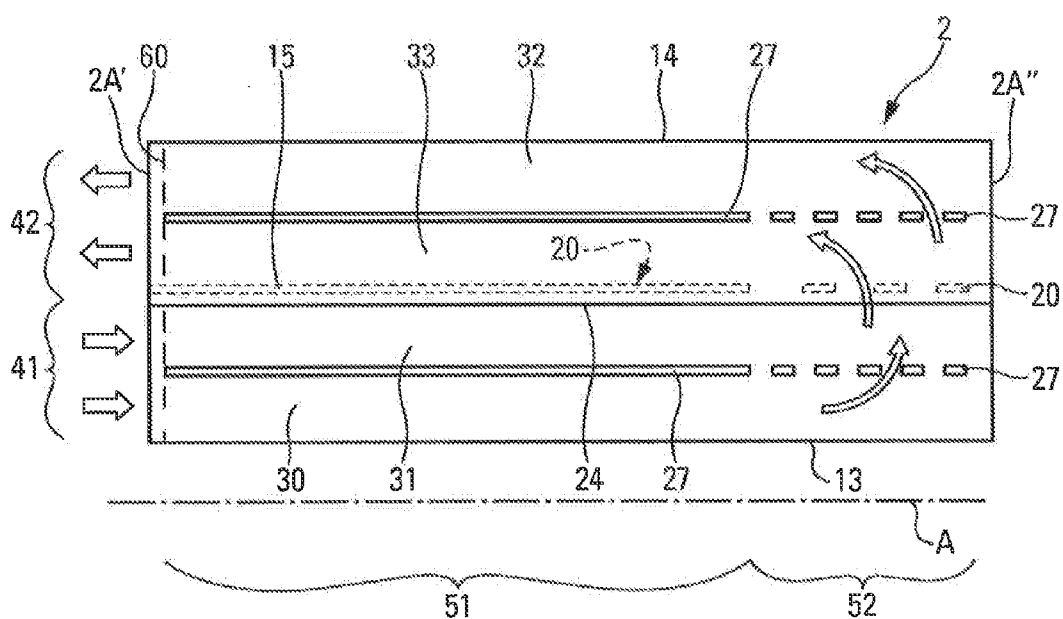
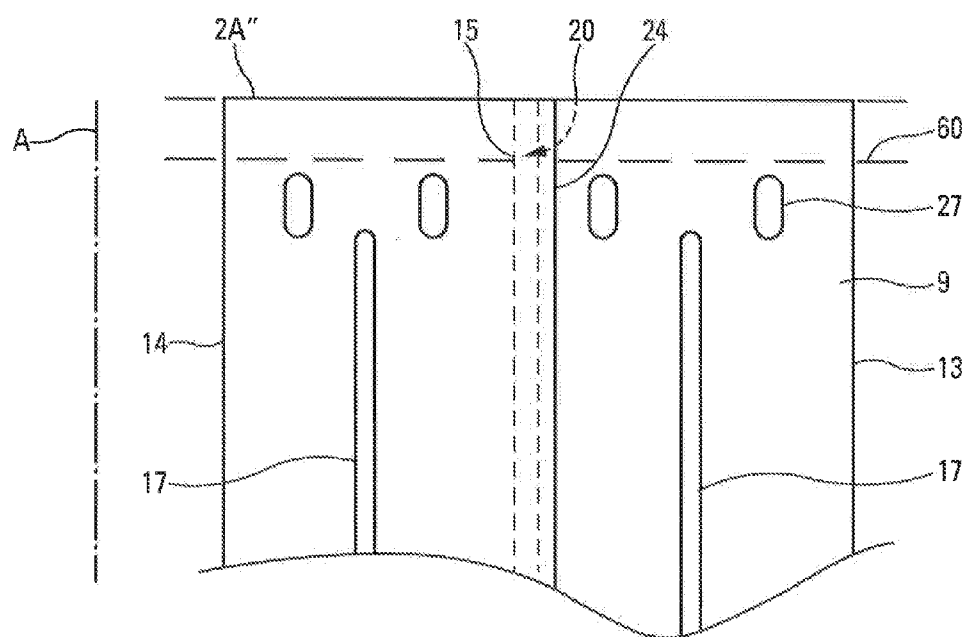
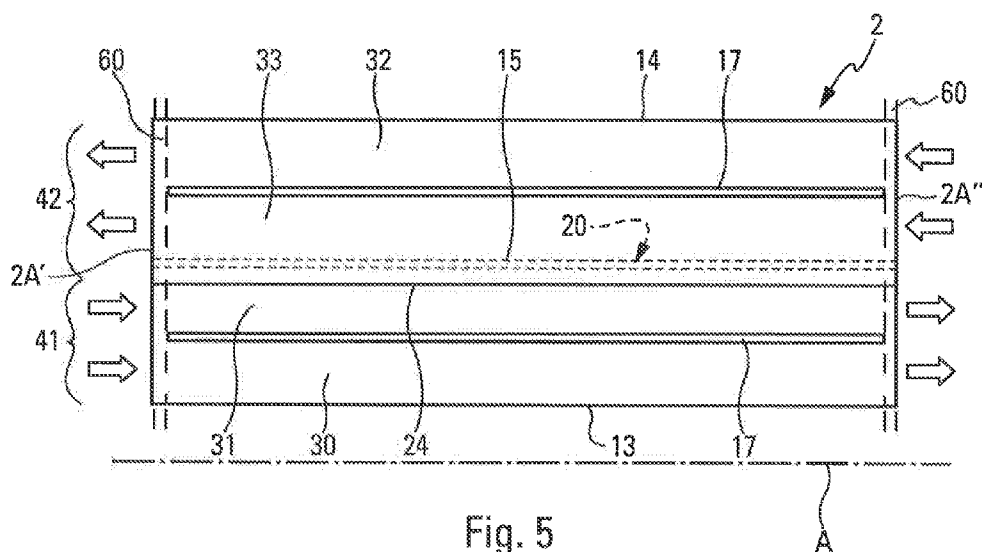


Fig. 4



HEAT EXCHANGER PIPE AND HEAT EXCHANGER INCORPORATING SUCH PIPES

[0001] The invention relates to a heat exchanger pipe and a heat exchanger incorporating such pipes.

[0002] The invention applies to all heat exchangers, in particular those used in motor vehicles, such as heating radiators or air conditioning evaporators in motor vehicles.

[0003] Pipes formed from a metal strip bent about itself to define an internal volume of the pipe are known in this field. The pipe includes two longitudinal walls opposing one another across the internal volume of the pipe and two lateral walls connecting the longitudinal walls.

[0004] This type of pipe raises the problem of preventing the deformation of the walls under the pressure of the fluid flowing through the pipes, such deformation placing the pipe under stress that may lead to a leak.

[0005] To overcome this problem, document U.S. Pat. No. 6,513,586B1 provides a leg, defined by the strip, connecting the longitudinal walls of the pipe. The leg is perpendicular to the two longitudinal walls to provide sufficient mechanical support to withstand the pressures exerted by the fluid flowing through the pipes.

[0006] Below a minimum internal height of the pipe, i.e. a minimum distance between the two longitudinal walls, it is not mechanically possible to obtain a leg between the two contact parts that is perpendicular to the two longitudinal walls.

[0007] The purpose of the invention is to overcome this drawback.

[0008] For this purpose, it proposes a heat exchanger pipe comprising a strip bent about itself such as to define an internal volume of the pipe, said strip comprising first and second edge portions joined such as to divide said internal volume into at least two channels.

[0009] According to the invention, said first edge portion has two distinct parts, referred to as first and second contact parts, in contact with the second edge portion and a third contact part, located between said first and second contact parts, said third contact part being in contact with a zone of the strip opposite the second edge portion across the internal volume of the pipe.

[0010] According to one aspect of the invention, the second edge portion is flat. Consequently, it is not necessary to perform a specific bending and/or stamping operation to obtain the second edge portion.

[0011] According to another aspect of the invention, the first contact part and the second contact part are flat. Thus, the contacts between the second edge portion and firstly the first contact part and secondly the second contact part are flat-on-flat contacts, optimizing the link between these elements.

[0012] According to one example embodiment, the pipe has two flat walls opposite one another across the internal volume, the second edge portion defining a part of one of said walls. The first contact portion is therefore in contact with the two flat walls.

[0013] According to one aspect of the invention, the first edge portion also includes a shoulder oriented towards the inside of the pipe such that a distal extremity of the second edge portion is arranged to face the shoulder.

[0014] According to another aspect, said first contact part is linked to said third contact part by means of a first inclined leg and said second contact part is linked to said third contact part by means of a second inclined leg. The presence of two legs

inclined from vertical makes it possible to reduce the internal height of the pipe, while retaining sufficient mechanical strength in the pipe.

[0015] According to an example embodiment, the first inclined leg, the third contact part and the second inclined leg are arranged consecutively and form a “V” shape in a plane perpendicular to the axis of longitudinal extension of the pipe. The “V” shape will be more or less open as a function of the gradient of each leg from vertical.

[0016] According to another example embodiment, the distance between the two flat walls is less than or equal to 1.5 mm, and in particular less than or equal to 1.0 mm. In this case, the distance is measured along an axis perpendicular to the planes containing the two flat walls. Such dimensions can be used without jeopardizing the mechanical strength of the flat walls notably on account of the presence of the two legs, in particular if said legs are inclined. The invention nonetheless also applies to pipes with greater internal height.

[0017] According to another example embodiment of the invention, the third contact part is located in a central zone of the pipe. Thus, the channels defined inside the pipe on either side of the first edge portion have substantial identical cross sections.

[0018] According to one aspect of the invention, said strip has portions that come into contact with parts of the strip opposing one another across the internal volume of the pipe to define supplementary channels.

[0019] According to another aspect, said strip has stamped portions that may or may not come into contact with the parts of the strip opposing one another across the internal volume of the pipe. The stamped portions thus create disturbances in the fluid flow inside the pipes, in particular to improve the efficiency of the heat exchange between the two fluids flowing through the exchanger.

[0020] The invention also relates to a heat exchanger including at least one pipe according to any one of the preceding claims.

[0021] The attached figures help to understand how the invention can be carried out. In these figures, identical reference signs refer to similar elements.

[0022] FIG. 1 is an overview of a radiator for which a pipe according to the present invention is intended.

[0023] FIG. 2 shows a pipe according to the invention, along the cross section II-II in FIG. 1.

[0024] FIG. 3 is a view similar to FIG. 2 showing in detail a first and a second edge portion of the strip used to define the pipe.

[0025] FIG. 4 is a worm’s eye view of a pipe according to the invention.

[0026] FIG. 5 is a view similar to FIG. 4 showing an alternative embodiment.

[0027] FIG. 6 is a partial view of an alternative embodiment of the pipe in FIG. 4.

[0028] The invention may be used in a heat exchanger 1 as shown in FIG. 1. In particular a passenger-compartment heater of a motor vehicle. It includes a set of parallel tubes 2. Each tube 2 has a first extremity 2A' and a second extremity 2A" each attached sealingly to manifold chambers, in this case respectively an input chamber 3 and an output chamber 4 according to the flow direction of a heat transfer fluid flowing through the pipes 2. An inlet flange 5 and an outlet flange 6 are added to these manifold chambers 3, 4 respectively.

[0029] Specifically, the pipes 2 through which the heat transfer fluid flows extend longitudinally along an axis A, referred to as the axis of longitudinal extension A of the pipe 2. Inserts 7 that increase the heat exchange surface between the heat transfer fluid flowing through the pipes 2 and a second fluid, in particular air, passing through the exchanger 1 are arranged between the pipes 2.

[0030] The heat exchanger includes, for example, two side panels 8, also referred to as cross members, that frame the set of pipes 2 and are arranged parallel thereto.

[0031] The pipes 2, the manifold chambers 3, 4 and the side panels 8 are, for example, made of aluminium or aluminium alloy.

[0032] A pipe 2 according to the invention is shown in FIG. 2. Such a pipe 2 includes a metal strip 9 bent about itself to define an internal volume 10 of the pipe 2. The strip 9 has two flat walls, referred to as the lower wall 11 and the upper wall 12. The flat walls are substantially parallel to one another. The pipe 2 also includes two sidewalls, referred to as the left wall 13 located on the left in FIG. 2 and the right wall 14 located on the right in FIG. 2, linking the two flat walls 11, 12 together. The sidewalls 13, 14 are in particular semi-circular such that the pipe 2 has a substantially oblong cross section. The thickness of the walls of the strip 9 is for example between 0.15 and 0.3 mm, in particular 0.2 mm.

[0033] The strip 9 has an internal face oriented towards the internal volume 10 of the pipe 2 and an external face oriented towards the outside of the pipe 2. The external face of the strip 9 may be covered with a fusible alloy intended to sealingly braze the pipe 2 to other elements of the heat exchanger, such as the inserts and/or the manifold chambers, and to braze different parts of the pipe together, as set out in greater detail below.

[0034] The internal face of the strip 9 may have a corrosion-resistant coating to limit the risk of leaks caused by corrosion inside the pipe 2. It may also have a fusible alloy, covering the corrosion-resistant coating, used to braze certain zones of the internal face of the strip 9 together.

[0035] The strip 9 also includes a first edge portion 15 and a second edge portion 16 joined together to divide the internal volume 10 into at least two channels along all or part of the length of the pipe 2. The first side 41 of the pipe 2 is the side of the pipe 2 located between the first edge portion 15 and the left wall 13 and the second side 42 of the pipe 2 is the side between the first edge portion 15 and the right wall 14.

[0036] In the example shown in FIG. 2, the strip 9 also has folds 17, in particular two folded portions 17, located on the flat wall and coming into contact with the parts of the strip 9 opposing one another across the internal volume 10 such as to improve the mechanical strength of the flat walls 11, 12 of the pipe 2. In this case, such folded portions 17 are located along all or part of the length of the pipe 2 and help to define supplementary channels in addition to the two channels defined by the edge portions 15, 16. In the case shown in which the strip 9 includes two folded portions 17, the pipe 2 is thus divided into four channels. In this case, one of the two folded portions 17 is located on the first side 41 of the pipe 2 on the upper wall 12, while the other is located on the second side 42 of the pipe 2 on the lower wall 11.

[0037] The first channel 30 is the channel located between the left wall 13 and the folded portion 17 located on the upper wall 12, and the second channel 31 is the channel located between this folded portion 17 and the first edge portion 15. The third channel 33 is the channel located between the

folded portion 17 on the lower wall 11 and the first edge portion 15, and the fourth channel 32 is the channel located between the right wall 14 and this folded portion 17.

[0038] In this case, the strip 9 includes stamped portions 27, 28 formed by unbroken and/or discontinuous stamping. These stamped portions may come into contact with the parts of the strip 9 opposing one another across the internal volume 10 of the pipe 2. In this case, they are referred to as stamped touching portions 27. In FIG. 2, two examples of stamped touching portions 27 coming from a flat wall of the pipe and linked to the opposing flat wall are shown in the first channel 30 and the fourth channel 32. Two stamped touching portions 27 can also be arranged opposite and in contact with one another, as in the third channel 33.

[0039] Other stamped portions 27, 28 may not come into contact with the parts of the strip 9 opposing one another across the internal volume 10 of the pipe 2, in which case they are referred to as free stamped portions 28. Two examples of free stamped portions 28 are shown in FIG. 2 in the second channel 31. These free stamped portions 28 may be located on the lower wall 11 and/or on the upper wall 12. They may be located opposite one another across the internal volume 10 or not.

[0040] The first edge portion 15, the folded portion or portions 17 and the stamped portion or portions 27, 28 are obtained, for example, by bending and/or stamping.

[0041] FIG. 3 is a more detailed view of the zone of the pipe 2 in which the first and the second edge portions 15, 16 are joined.

[0042] The first edge portion 15 is inside the pipe 2. In this case, the first edge portion 15 has a first contact part 18 that is in particular flat and in contact with the second edge portion 16. A first inclined leg 19, inclined in relation to vertical, extends the first contact part 18 to a third contact part 20, in contact with the internal face of the upper wall 12 opposite the second edge portion 16 across the internal volume 10 of the pipe 2. The first edge portion 15 then extends by means of a second leg 21, inclined in relation to vertical, and ends with a second contact part 22, that is for example flat and in contact with the second edge portion 16. According to the invention, the third contact part 20 is located between the first and second contact parts 18, 22 and in particular between the first and second inclined legs 19, 21. This increases the mechanical strength of the pipe.

[0043] The first inclined leg 19, the third contact part 20 and the second inclined leg 21 are arranged consecutively and have a "V" shape in a plane perpendicular to the axis of longitudinal extension A of the pipe 2. In other words, the first inclined leg 19, the third contact part 20 and the second inclined leg 21 make a "V" shape in a cross section made in a plane perpendicular to the axis of longitudinal extension A of the pipe 2.

[0044] The height of the pipe 2 thus depends on the gradient of the inclined legs 19, 21 in relation to vertical such as to flatten the "V" shape. This makes it possible to obtain an internal height of the pipe 2, i.e. a distance between the internal face of the lower wall 11 and the internal face of the upper wall 12, that is less than 1.5 mm, and in particular less than 1.0 mm, while guaranteeing sufficient mechanical support of the walls of the pipe 2 to withstand the pressure exerted by the fluid flowing through the pipes 2.

[0045] In this case, the second edge portion 16 is flat, and is in particular part of the lower wall 11. This facilitates the brazing between the second edge portion 16 and the first and

third contact parts **18**, **22**, which are also flat. Moreover, the face of the first and third contact parts **18**, **22** in contact with the second edge portion **16** is covered with the fusible alloy, as explained above, which helps to improve the quality of the bond between the first and the second edge portions **15**, **16**. Furthermore, in this arrangement, the face of the first edge portion **15** designed to be in contact with the heat transfer fluid flowing through the inside of the pipe **2** is in this case coated with the corrosion-prevention material and possibly the fusible alloy as explained above.

[0046] In the example shown, the first and second edge portions **15**, **16** are joined around the central zone of the pipe. Specifically, the third contact part **20** is located in the middle of the pipe **2** such that the first edge portion **15** and the second edge portion **16** divide the pipe **2** into two channels having a substantially identical cross section. These channels of identical cross section may also be subdivided, as seen previously, by the folded portions.

[0047] The first edge portion **15** also includes a shoulder **23** oriented towards the inside of the pipe **2** such that a distal extremity **24** of the second edge portion **16** is arranged to face the shoulder **23**.

[0048] The shoulder **23** thus includes a first fold **25** oriented towards the inside of the pipe **2** and a second fold **26** oriented towards the second edge portion **16** such that the first contact part **18** of the first edge portion **15** can be in contact with the second edge portion **16**.

[0049] FIG. 4 shows the external face of the lower wall **11** of an alternative embodiment of the pipe. The third contact part **20** is shown using a dotted line.

[0050] In this case, the heat transfer fluid flows in a U-shaped loop inside the pipe **2**. This type of pipe **2** is intended to be installed in a heat exchanger with just one manifold chamber (not shown) located on the side of the first extremity **2A'** and including partitions enabling it to be partitioned. More specifically, the partitions of the manifold chamber separate the incoming heat transfer fluid from the outgoing heat transfer fluid in a single pipe **2**. The heat transfer fluid thus passes from a first compartment of the manifold chamber to the inside of the first side **41** of the pipe **2**. It then flows along the axis of longitudinal extension **A** to the second extremity **2A''** of the pipe **2**, then in the opposite direction for the second side **42** of the pipe **2** as far as a second compartment of the manifold chamber.

[0051] In this example embodiment, the pipe **2** includes two unbroken stamped touching portions **27** on a longitudinal portion of the pipe, said first longitudinal portion **51** extending along most of the length of the pipe **2**, from the first longitudinal extremity **2A'** such that the two unbroken stamped portions **27** define the channels **30**, **31**, **32**, **33** with the first edge portion **15**. The pipe **2** also includes discontinuous stamped touching portions **27** located in a second longitudinal portion **52** of the pipe **2** that extends the first longitudinal portion **51** to the second extremity **2A''**. The discontinuous stamped portions **27** are, for example, located in the extension of the unbroken stamped portions **27**.

[0052] The discontinuous stamped portions **27** thus create flow passages for the fluid between the first channel **30** and the second channel **31** and between the third channel **33** and the fourth channel **32**.

[0053] The third contact part **20** extends in this case unbroken along the first longitudinal portion **51** of the pipe **2**. Around the second longitudinal portion **52** and in the extension of the unbroken part of the first edge portion **15**, the

portions of the third contact part **20** are discontinuous, such as to create fluid windows between the first and second channels **30**, **31** and the third and fourth channels **33**, **32**. The fluid can then pass from the first side **41** to the second side **42** of the pipe **2**. These discontinuous portions of the third contact part **20** can be obtained by stamping once the first edge portion **15** has been formed. They can also be formed by slotting prior to formation of the first edge portion **15**. In this case, by forming the first edge portion **15**, the zones in which the slots are located form the windows that enable the heat transfer fluid to pass from the first side **41** to the second side **42** of the pipe **2**.

[0054] Thus, as previously mentioned, once it has reached the second longitudinal extremity **2A''**, the heat transfer fluid passes from the first side **41** to the second side **42** and then passes through the pipe **2** in the opposite direction before being outputted from the first extremity **2A'** and entering the partitioned manifold chamber.

[0055] In the example shown in FIG. 5, the third contact part **20** and the two folded portions **17** are unbroken and extend from the first longitudinal extremity **2A'** to the second longitudinal extremity **2A''**. The heat exchanger in which the pipe **2** is intended to be installed is in this case provided with two manifold chambers (not shown), a first partitioned manifold chamber located at the first longitudinal extremity **2A'** and a second manifold chamber located at the second longitudinal extremity **2A''**.

[0056] In this case, the heat transfer fluid returns via the first manifold chamber at the first longitudinal extremity **2A'** to the inside of the first and second channels **30**, **31**. It passes through the pipe **2** and is outputted from the second longitudinal extremity **2A''** into the second manifold chamber. It passes into the third and fourth channels **33**, **32** of the same pipe **2**. The heat transfer fluid then passes through the pipe **2** in the other direction before being outputted from the first longitudinal extremity **2A'** and entering the first manifold chamber. The partitions of the first manifold chamber then direct it to an output orifice.

[0057] FIG. 6 is an example embodiment in which the strip **9** includes stamped touching portions **27**, in particular four stamped portions **27** located around the first longitudinal extremity **2A'** and/or the second longitudinal extremity **2A''**. These stamped portions **27** are arranged such as to reinforce the flat walls of the pipe **2** close to the extremity or extremities **2A'**, **2A''**. This ensures the good mechanical strength of the pipes **2** when the extremities of the pipes **2** are inserted into the manifold chamber or chambers.

[0058] According to the different examples envisaged, the first contact part **18** and the second contact part **22** are unbroken along the pipe, while the third contact part **20** may also be unbroken along the entire length of the pipe or be discontinuous.

[0059] In FIGS. 4, 5 and 6, the dotted lines **60** perpendicular to the axis of longitudinal extension **A** and close to the extremities **2A'**, **2A''** of the pipe **2** delimit therewith a zone of the pipe **2** intended to be inserted in the manifold chamber or chambers.

1. A pipe (2) of a heat exchanger (1), the pipe (2) comprising a strip (9) bent about itself to define an internal volume (10) of the pipe (2), the strip (9) having a first edge portion (15) and a second edge portion (16) joined together to divide the internal volume (10) into at least two channels, wherein the first edge portion (15) has first and second contact parts (18, 22), in contact with the second edge portion (16) and a third contact part (20), located between the first and second

contact parts (18, 22), the third contact part (20) being in contact with a zone of the strip (9) opposite the second edge portion (16) across the internal volume (10) of the pipe (2).

2. A pipe (2) according to claim 1, in which the second edge portion (16) is flat.

3. A pipe (2) according to claim 1, in which the first contact part (18) and the second contact part (22) are flat.

4. A pipe (2) according to claim 1, in which the pipe (2) has two flat walls (11, 12) opposing one another across the internal volume (10), with the second edge portion (16) defining a part of one of the walls (11, 12).

5. A pipe (2) according to claim 4, in which the distance between the two flat walls (11, 12) is less than or equal to 1.5 mm.

6. A pipe (2) according to claim 5, in which the distance between the two flat walls (11, 12) is less than or equal to 1.0 mm.

7. A pipe (2) according to claim 1, in which the first edge portion (15) includes a shoulder (23) oriented towards the inside of the pipe (2) such that a distal extremity (24) of the second edge portion (16) is arranged to face the shoulder (23).

8. A pipe (2) according to claim 1, in which the first contact part (18) is linked to the third contact part (20) by a first inclined leg (19), and the second contact part (22) is linked to the third contact part (20) by a second inclined leg (21).

9. A pipe (2) according to claim 8, in which the first inclined leg (19), the third contact part (20), and the second inclined leg (21) are arranged consecutively and form a “V” shape in a plane perpendicular to an axis of longitudinal extension (A) of the pipe (2).

10. A pipe (2) according to claim 1, in which the third contact part (20) is located in a central zone of the pipe (2).

11. A pipe (2) according to claim 1, in which the strip (9) has portions (17) that come into contact with the parts of the strip (9) opposing one another across the internal volume (10) of the pipe (2) to define supplementary channels (30, 31, 32, 33).

12. A pipe (2) according to claim 1, in which the strip (9) has stamped portions (27, 28) that may or may not come into contact with the parts of the strip (9) opposing one another across the internal volume (10) of the pipe (2).

13. A heat exchanger (1) including at least one pipe (2) according to claim 1.

14. A pipe (2) according to claim 2, in which the first contact part (18) and the second contact part (22) are flat.

15. A pipe (2) according to claim 2, in which the pipe (2) has two flat walls (11, 12) opposing one another across the internal volume (10), with the second edge portion (16) defining a part of one of the walls (11, 12).

16. A pipe (2) according to claim 3, in which the pipe (2) has two flat walls (11, 12) opposing one another across the internal volume (10), with the second edge portion (16) defining a part of one of the walls (11, 12).

17. A pipe (2) according to claim 14, in which the pipe (2) has two flat walls (11, 12) opposing one another across the internal volume (10), with the second edge portion (16) defining a part of one of the walls (11, 12).

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