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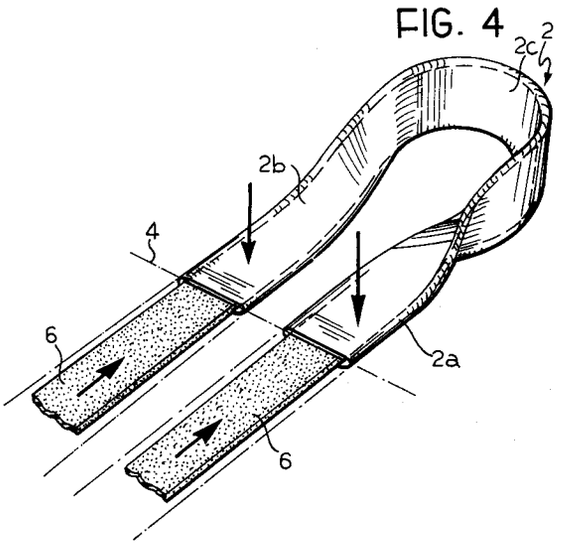
(54) A method of bending a pipe having an oblong cross-section and a heat exchanger with pipes having an oblong section and bent in a U-shape.

(57) A method of bending a pipe having an oblong cross-section for heat exchangers comprises the stages of causing a relative rotation which is substantially equal to 180° between two limbs (2a, 2b) of the pipe (2) about an axis (8) parallel to the longer axis (4) of the cross-section of the pipe so as to obtain two straight limbs (2a, 2b) connected to one another by a curved connecting portion (2c) and to cause a relative rotation which is substantially equal to 90° between each of the straight limbs (2a, 2b) and the connecting portion (2c).

FIG. 4



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The present invention relates to a method of bending a pipe having an oblong cross-section for heat exchangers.

In heat exchangers of the mechanical expansion type (in which the stack of fins is secured to the pipes by a pipe expanding or mechanical expansion process), the use of pipes bent in a U-shape (so-called forked pipes) enables a collector plate and a tank for recirculating the refrigerating fluid to be dispensed with, evidently saving material and increasing the reliability of the heat exchanger since, with the same number of pipes, the fluidtight points present as a whole are reduced by half.

The use of forked pipes is common today for aluminium or copper pipes with a circular section, whilst, for pipes having a flat or oblong section, it is difficult and, in fact, impracticable, when the flat pipe has to be bent in a U-shape and the two limbs of the fork maintained aligned along the longer axis of their cross-section.

The object of the present invention is to provide a method of bending a pipe having an oblong cross-section in a U-shaped arrangement which permits the two limbs of the pipe to be placed in a position in which the longer axes of the respective cross-sections are aligned with or parallel to one another without causing excessive stretching of the material in the bending zone.

According to the present invention, this object is achieved by a method characterised by the stages of:

- causing a relative rotation substantially equal to 180° between two limbs of the pipe about an axis parallel to the longer axis of the cross-section of the pipe, so as to obtain two straight limbs with longer axes of the respective cross-sections parallel to one another and connected to one another by a curved connecting portion; and
- causing a relative rotation between each of the straight limbs and the connecting portion about an axis coinciding with or parallel to the longitudinal axis of the straight limbs.

The present invention also relates to a heat exchanger comprising a stack of fins fixed to a plurality of pipes having an oblong cross-section, in which each pipe has two straight limbs and a curved connecting portion, the heat exchanger being characterised in that the longer axes of the respective cross-sections of the two straight limbs of each pipe are aligned with or parallel to one another, and in that the connecting portion has an oblong cross-section with a longer axis at a right-angle to the longer axes of the cross-sections of the straight limbs.

Further characteristics and advantages of the present invention will become clear from the following detailed description given purely by way of non-limiting example, with reference to the appended drawings, in which:

- Figure 1 is a schematic perspective view of a heat exchanger according to the present invention;
- Figures 2, 3 and 4 illustrate schematically the bending stages of a pipe;
- Figure 5 is a view of the connecting portion of a pipe along the arrow V of Figure 1; and
- Figure 6 is a view of the pipe bent along the arrow VI of Figure 5.

Referring firstly to Figures 2, 3 and 4, a method is described for bending a pipe having an oblong cross-section into a U-shape. In the example illustrated in the drawings, reference is made to a pipe with a flat section, however, it will be understood that the process according to the invention can generally be adapted to pipes with an oblong section, this term covering oval, ovoid, etc, sections and in general sections in which it is possible to differentiate between a longer axis and a shorter axis of different lengths.

In the drawings, the pipe is indicated by the reference numeral 2 whilst the longer axis of the cross-section of the pipe is indicated 4.

With reference to Figure 2, a reinforcing core 6 consisting of a flexible element of a shape such that it freely and slidingly engages the hole in the pipe is inserted in the initially straight pipe 2. The reinforcing core 6 is inserted over a length such that it extends over at least the entire pipe-bending zone. When the core has been inserted, a relative rotation substantially equal to 180° of two limbs 2a, 2b of the pipe 2 is caused about a bending axis 8 parallel to the axis 4 of the cross-section of the pipe (Figure 3).

The pipe 2 is bent by a known tool comprising a wheel having a radius equal to the radius of curvature of the pipe and a movable shaping member which urges the pipe against the edge of the wheel, creating the curved connecting portion 2c between the two straight limbs 2a, 2b.

When the pipe has been bent into the U-shape, the two straight limbs 2a, 2b are located with the longer axes 4 of the respective cross-sections parallel to one another. After this first bending of the pipe 2, the reinforcing core 6 is partially removed such that the reinforcing core only extends over one of the two limbs of the pipe and that the end of the core is located approximately in correspondence with the part in which the straight limb starts to curve. A second core 6' (Figure 4) which is introduced into the limb approximately as far as the point at which the limb joins the curved connecting portion 2c is disposed in the limb which does not have the reinforcing core.

At this point, a relative rotation of 90° of each of the two limbs 2a, 2b relative to the curved connecting portion 2c is caused about an axis which coincides with or, generally, is parallel to the longitudinal axis of the straight limbs 2a, 2b. This relative rotation is performed by immobilising the connecting portion 2c and holding the straight limbs 2a, 2b from the exterior with gripper members which impart the necessary rotation. At the end of this operation, the pipe assumes the shape shown in Figure 4, with the longer axes 4 of the straight limbs 2a, 2b aligned relative to one another or, in general, parallel to one another. The reinforcing cores 6, 6' are then withdrawn and a plurality of fins which are secured to the pipes by expansion of the pipes, according to a known technology, are then fitted on the straight limbs 2a, 2b of a series of parallel pipes.

During the pipe-bending process, the object of the flexible reinforcing core is to prevent the pipe from yielding. The same result can be obtained by introducing a material which melts at a temperature far lower than the melting temperature of the material forming the pipe into the pipe. This material is introduced into the pipe in the liquid state and is solidified before the bending process is performed. At the end of the bending operations, this material is removed again in the liquid state by heating the pipe.

Figure 1 shows schematically a heat exchanger with pipes having an oblong section and bent according to the process described above. The flow of air strikes the heat exchanger in the direction indicated by the arrows A in Figure 1 and the pipes are located with their longer axis parallel to the direction of the air flow in a manner similar to that which occurs in heat exchangers having two collector tanks situated at the opposite ends of the stack of sheets. The fact that the longer axes 4 of the pipes are aligned with or parallel to one another enables a liquid inlet zone and a return zone to be provided in the collector tank by means of a simple longitudinal separating plate schematically indicated 10 in Figure 6.

Claims

1. A method of bending a pipe having an oblong cross-section for heat exchangers, characterised in that it comprises the stages of:
- causing a relative rotation substantially equal to 180° between two limbs (2a, 2b) of the pipe (2) about an axis (8) parallel to the longer axis (4) of the cross-section of the pipe, so as to obtain two straight limbs with longer axes (4) of the respective cross-sections parallel to one another and connected to one another by a curved connecting portion (2c); and
- causing a relative rotation between each of the above straight limbs (2a, 2b) and the connecting portion (2c) about an axis coinciding with or parallel to the longitudinal axis of the straight limbs.

2. A method according to Claim 1, characterised in that the relative rotation between each of the straight limbs (2a, 2b) and the connecting portion is substantially equal to 90°.

3. A method according to Claim 1, characterised in that the pipe (2) is bent by inserting a reinforcing core (6, 6') in the pipe (2) beforehand.

4. A method according to Claim 3, characterised in that the reinforcing core is a flexible element (6, 6') which can slide freely in the pipe (2).

5. A method according to Claim 3, characterized in that the reinforcing core (6, 6') is produced by a material which melts at a temperature which is substantially lower than the melting temperature of the material constituting the pipes, the material being introduced into the pipe (2) in the liquid state and being made to solidify before the bending method is performed, the molten material then being removed from the pipe (2) in the liquid state by heating the pipe (2).

6. A heat exchanger comprising a stack of fins secured to a plurality of pipes (2) having an oblong cross-section, in which each pipe (2) has two straight limbs (2a, 2b) and a curved connecting portion (2c), characterised in that the longer axes of the respective cross-sections of the two straight limbs (2a, 2b) of each pipe (2) are aligned with or parallel to one another, and in that the connecting portion (2c) has an oblong cross-section with a longer axis at a right-angle to the longer axes of the cross-sections of the straight limbs (2a, 2b).

FIG. 1

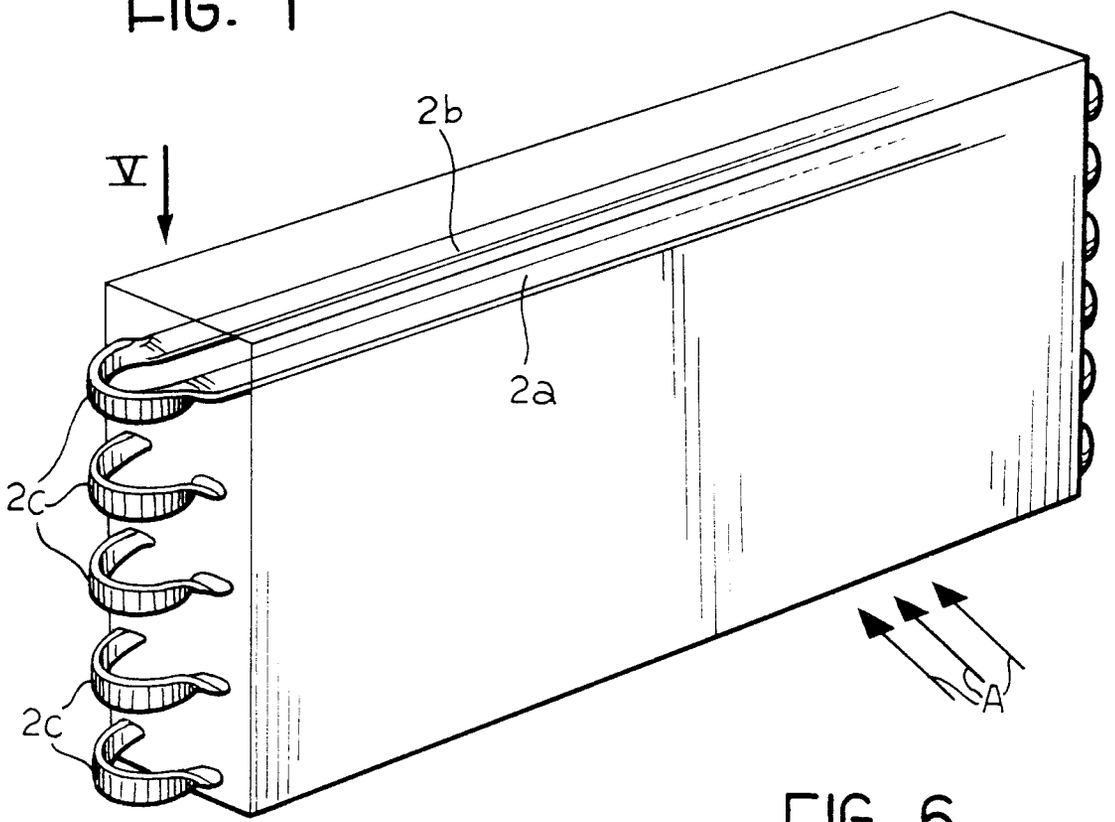


FIG. 6

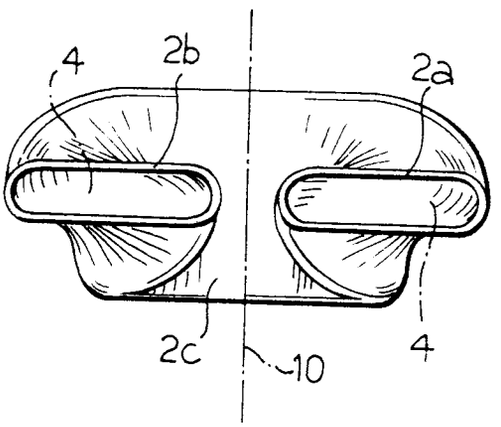


FIG. 5

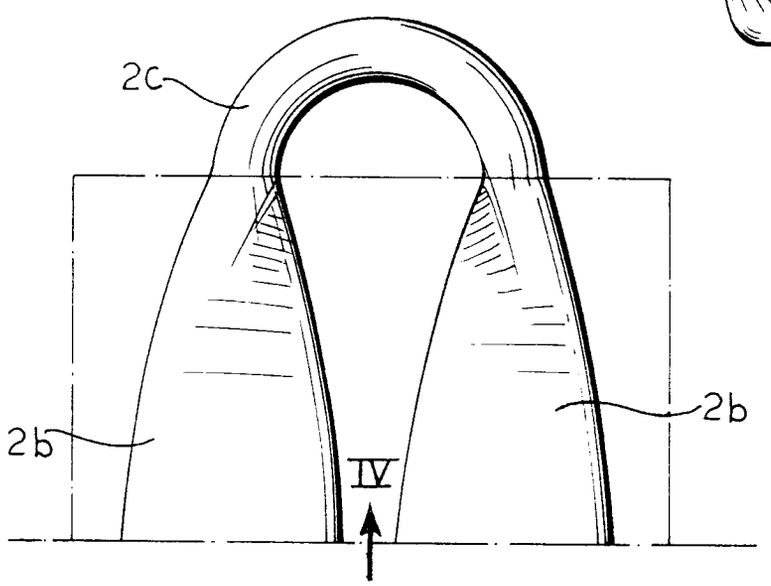


FIG. 2

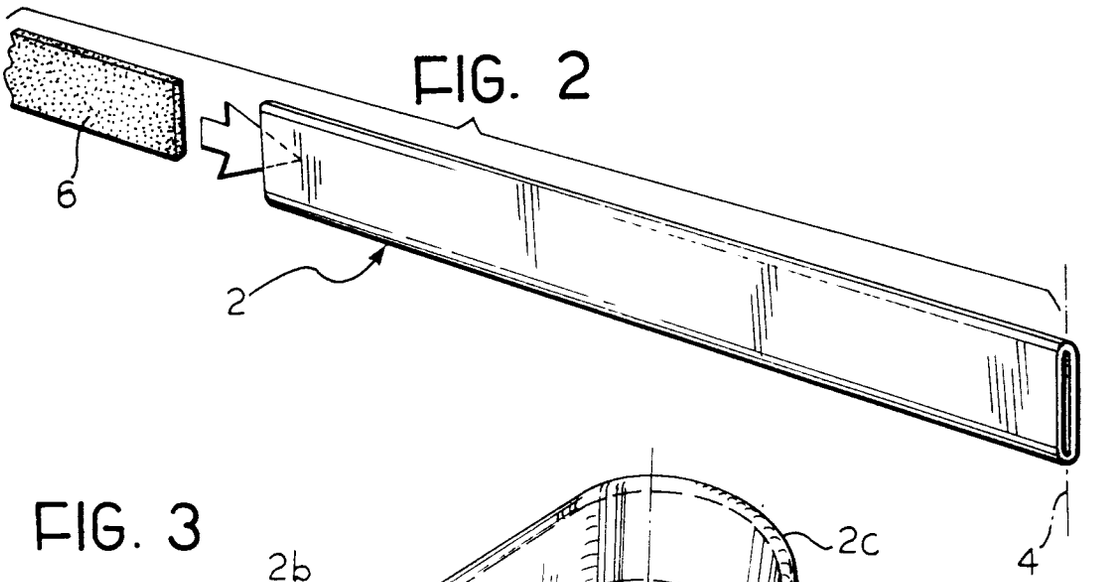


FIG. 3

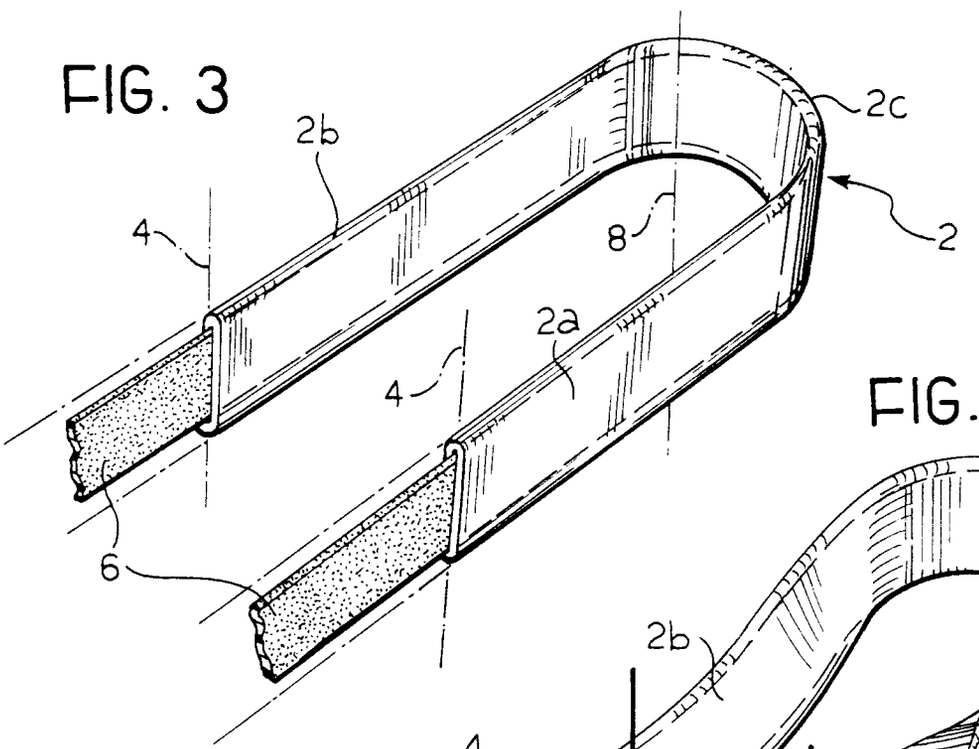
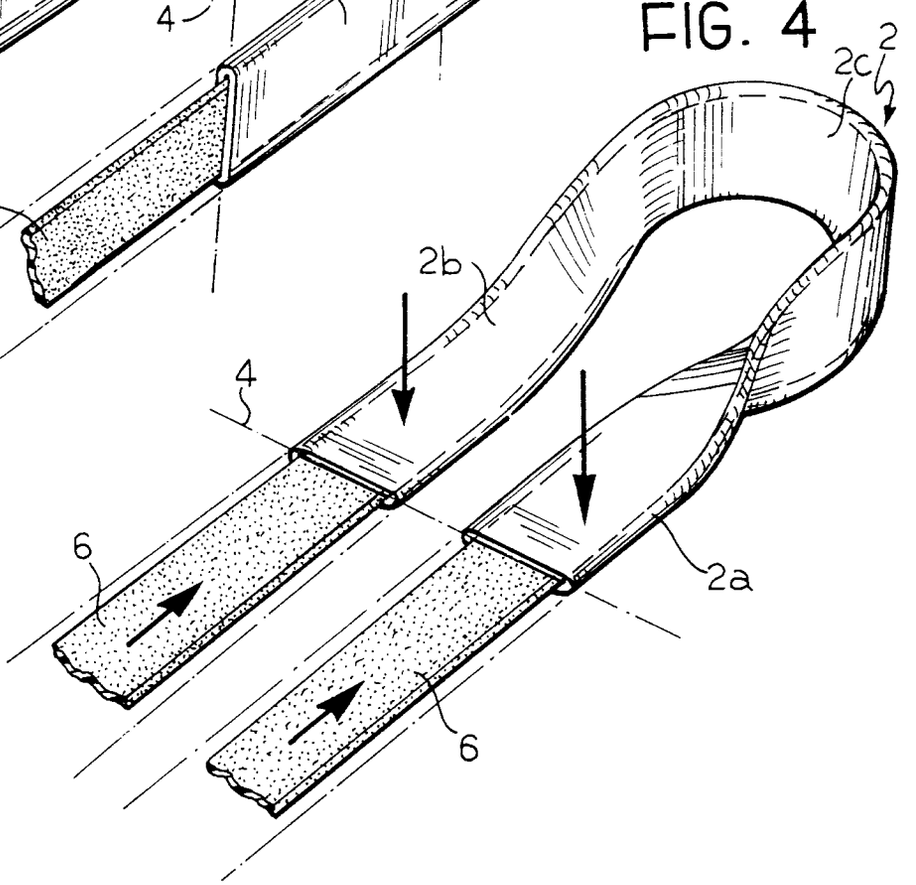


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 94 11 7924

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR-A-1 108 189 (WESTERN ELECTRIC) * claims; figures *	1	B21D53/08 F28F9/26 F28D1/047
A	FR-A-2 321 345 (SERINOX) * claims; figures *	3-5	B21D9/01 B21D11/14
A	FR-A-2 547 751 (SNECMA) * claims *	3-5	
A	US-A-4 625 378 (MATSUSHITA REFRIGERATION COMPANY)	6	
A	FR-A-2 222 623 (CHAUSSON) * figure 3A *	6	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B21D
F28F
F28D
B21C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 February 1995	Peeters, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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