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(54) Shelf-type heat exchanger

(57) A manufactured article (10) for the manufacture of a heat exchanger having at least four shelves, the said manufactured article (10) being formed by at least one plate (18a, 18b) and a coil (20) and comprising a first and a second head portion (11, 12), foldable along fold lines (1e, 1f) to form respective shelves, and a central element (13), wherein the said central element (13) comprises at least two flat elements (15a, 15b), foldable along fold lines (1d, 1m) to form respective shelves, and

at least one brace (14, 14a, 14b) providing connection between the said first and second head portions (11, 12), the said coil (20) defining a fluid path along the said first and second head portions (11, 12), along the said at least one brace (14, 14a, 14b) and along the said at least two flat elements (15a, 15b), the said coil (20) being produced in a single length. A method for the manufacture of a heat exchanger having at least four shelves by folding the manufactured article (10) and a heat exchanger having at least four shelves thus obtained.

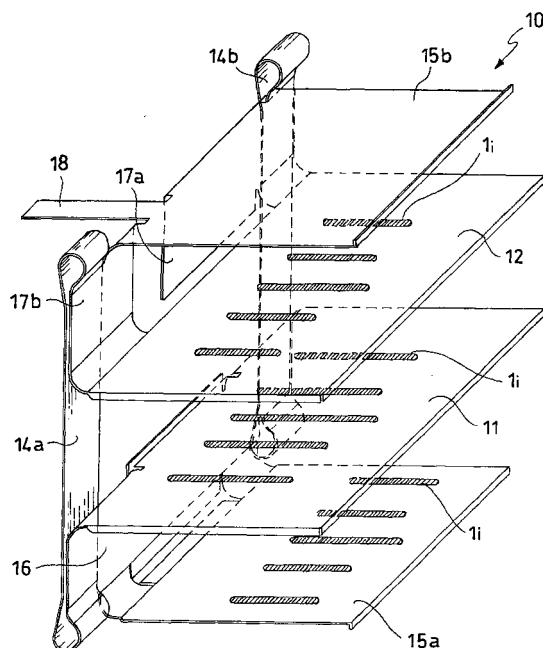


FIG. 3

Description

[0001] The present invention relates to a shelf-type heat exchanger (evaporator).

[0002] More specifically, the present invention relates to a shelf-type heat exchanger for refrigerators, upright freezers and similar apparatuses.

[0003] It is known that an upright freezer of the traditional type provides for the presence of a plastic cabinet containing within it the heat exchanger (evaporator) formed by metal shelves on which the foodstuffs to be preserved are stored. Such shelves are connected to one another via the same piping which runs through the shelf itself by one or more welds.

[0004] The temperature of the cabinet is kept low by virtue of the passage of a refrigerant substance which runs through the piping of the heat exchanger.

[0005] It is also known that, in order to increase the refrigerant efficiency within the freezer cabinet, the shelves of the heat exchanger are also provided with a tubular coil through which the refrigerant substance runs. The presence of the coil along the shelves, in fact, makes it possible to obtain uniform refrigeration of the shelf itself.

[0006] The tube of the coil is at present applied on the surface of the shelves and of the back of the cabinet by means of welding or crimping, or the said tubular coil may be premoulded inside the shelves and the back by means of the technology known as roll bonding.

[0007] The latter provides for the roll bonding of two plates of which one bears a screen-printed channel line shaped in accordance with the desired path of the coil. This bonding results in the welding of the entire surface of the two metal plates except along the screen-printed line, which is subsequently inflated with air forming the channel of the entire area enclosed by the said line.

[0008] The abovementioned heat exchangers, positioned within the cabinet of a freezer of the traditional type, nevertheless have the drawback that, over time, the weld points between the shelves and the back of the heat exchanger may wear, resulting in leakage of the refrigerant substance contained in the tubular coil.

[0009] The result, therefore, is that the said refrigerant substance may come into contact with the foodstuffs stored on the shelves, contaminating them.

[0010] The above drawback is even more felt in freezers of modern design which use C.F. gases (chlorofluorides) as the refrigerant substance. There is in fact new environmental protection legislation which issues a directive to the effect that such freezers must be replaced by freezers that use substances causing no environmental pollution.

[0011] An example of a non-polluting refrigerant substance is cyclopentane. This, however, becomes dangerous when it comes into contact with heat or energy sources. In such cases, the leakage of the said substance from the heat exchanger coil, in addition to contaminating the foodstuffs, could, once the refrigeration

cabinet has become saturated, come into contact with some electrical component and result in the explosion of the said freezer.

[0012] The problem on which the present invention is based is therefore that of providing a shelf-type heat exchanger which overcomes the above drawbacks.

[0013] The problems stated above are solved by a shelf-type heat exchanger as described in the appended claims.

[0014] A further object of the present invention is a method of manufacturing the heat exchanger according to the invention, as described in the appended method claims.

[0015] Further features and advantages of the shelf-type heat exchanger to which the present invention relates will become more clearly apparent from the description of various preferred embodiments given below, by way of indication and without implying any limitation, with reference to the drawings that follow.

[0016] Figure 1 shows a view from above of the heat exchanger according to the present invention in folded-out form.

[0017] Figure 1a shows a view in lateral section of a detail of Figure 1.

[0018] Figure 2 shows a view from above, in section, of the heat exchanger of Figure 1.

[0019] Figure 3 shows a perspective view of an embodiment of the heat exchanger according to the present invention.

[0020] Figure 4 shows a perspective view of a second embodiment of the heat exchanger according to the present invention.

[0021] Figure 5 shows a perspective view of a third embodiment of the heat exchanger according to the present invention.

[0022] With reference to the appended figures, a description will now be given of the heat exchanger according to the present invention. Figures 1, 1a and 2 show the manufactured article 10 provided for the manufacture of the heat exchanger according to the present invention, formed by two plates 18a, 18b of metal material such as, for example, aluminium and alloys thereof, copper and ironaluminates having an overall thickness of between 0.4 and 2 mm, preferably 1.4 mm. This manufactured article 10 is obtained by roll bonding of the two plates 18a, 18b, one of which bears a printed line shaped according to the path of the coil 20 which will carry the refrigerant substance. This bonding results in the welding of the entire surface of the two plates 18a, 18b except along the printed line. The construction of the coil 20 thus takes place by the inflation of the area enclosed by the printed line.

[0023] The manufactured article 10 according to Figure 1 forms, in practice, the heat exchanger in the form that has not been folded into shelves. It is of substantially rectangular shape and comprises a first head portion 11 and a second head portion 12, connected to one another via a central portion 13 which in turn is substan-

tially rectangular and on the inner sides of which the first and second head portions 11, 12 are connected. The said central portion 13 has, in proximity of the outer sides, a first and a second notch 1a, 1b parallel to the longitudinal axis of the said manufactured article 10 and such as not to run along the entire length of the outer sides but to leave unnotched portions of equal length at both ends, lateral braces 14a, 14b being defined between the said first and second notches 1a, 1b and the outer side of the central portion 13. The said central portion 13 also has a notch 1c perpendicular to the longitudinal axis of the said manufactured article 10 which connects the median points of the said first and second notches 1a, 1b, the said transverse notch 1c together with the said first and second longitudinal notches 1a, 1b forming a first flat element 15a and a second flat element 15b.

[0024] In correspondence with the side of the said first flat element 15a opposite the said notch 1c is disposed a notch 1d which is transverse relative to the longitudinal axis of the manufactured article 10 and is such as not to join the two longitudinal notches 1a, 1b. The said notch 1d terminates at its ends in respective T-shaped notches. Similarly, in correspondence with the junction point between the said first head element 11 and the said central portion 13 is disposed a notch 1e which is transverse relative to the longitudinal axis of the manufactured article 10 and is such as not to join the two longitudinal notches 1a, 1b, this also terminating with T-shaped notches at the ends.

[0025] The said notches 1d, 1e enclose a first back portion 16 positioned between the first flat element 15a and the first head portion 11 and serve the function of facilitating the folding of the first head portion 11 and of the first flat element 15a to form two shelves of the heat exchanger.

[0026] In correspondence with the junction point between the said second head element 12 and the said central portion 13 is disposed a notch 1f ending in a T-shaped notch at its end, while its other end perpendicularly intersects two mutually parallel notches 1g, 1h which originate at the base of the second flat element 15b. The notch portion 1f' of the notch 1f which meets the two notches 1g, 1h perpendicularly defines there-with a tongue 18.

[0027] The said notch 1f serves the purpose of facilitating the folding of the second head portion 12 to form a shelf of the heat exchanger.

[0028] The said tongue 18 divides into two the region between the second head portion 12 and the second flat element 15b, defining on the one hand the back half-portion 17a and on the other a back half-portion 17b.

[0029] The said first and second head portions 11, 12 and the said first flat element 15a have a plurality of notches 1i parallel to the longitudinal axis of the said manufactured article 10 whose function is to improve the ventilation within the shelves of the heat exchanger.

[0030] As shown in Figure 2, the manufactured article

10 provides for the presence of a coil 20 through which the refrigerated substance passes. The coil 20 is made in the manner such as not to be interrupted by the notches 1a-1i, except in correspondence with the notch portion 1f'. The coil 20 thus represents a closed circuit having a T-shaped junction 21, and is produced in a single length without transverse welds joining different sections of coil.

[0031] The said coil 20 is of metal such as, for example, copper, aluminium and iron and has a diameter "a" (Figure 1a) of between 0.8 and 2.5 mm. This diameter must not in fact be less than 0.8 mm in order to prevent its falling below 0.4 mm following the foldings of the coil.

[0032] As shown in Figure 2, the coil 20 is provided along the whole of the manufactured article 10 according to the present invention, so that the refrigerant substance, entering via the capillary tube located in the tongue 18, enters directly into the second flat element 15b, proceeds into the back half-portion 17b as far as the second head portion 12, runs along the lateral brace 14a and passes from the first head portion 11 to the first flat element 15a, from where it enters the first back portion 16, then along the lateral brace 14b to the back half-portion 17a, intersecting within the tongue 18 the inlet capillary tube for the incoming refrigerant substance and then returning to the compressor.

[0033] As shown in Figure 3, the manufactured article 10 is folded in a manner such as to form a heat exchanger having four shelves in which the central shelves coincide with the first and second head portions 11, 12 of the manufactured article 10 while the outer shelves coincide with the first and second flat elements 15a, 15b of the manufactured article 10, and in which the first back portion 16 and the back half-portions 17a, 17b of the manufactured article 10 are folded onto the lateral braces 14a, 14b of the manufactured article 10. The tongue 18 of the manufactured article 10 is substantially coplanar with the second flat element 15b and protrudes in an opposite direction to the shelf and substantially perpendicularly to the plane in which the back of the exchanger lies.

[0034] In this manner, the back portion 16 forms the wall that connects the shelf comprising the first flat element 15a to the shelf comprising the first head portion 11 and the back half-portions 17a, 17b form the wall that connects the shelf comprising the second flat element 15b to the shelf comprising the second head portion 12.

[0035] The manufactured article 10 is obtained by first applying the technology described above, known as roll bonding, and then cutting the notches described above.

[0036] The heat exchanger having four shelves shown in Figure 3 is obtained by folding the manufactured article 10 in accordance with the following steps, performed in any order or simultaneously:

- a) folding through approximately 90°, relative to the plane in which the manufactured article 10 lies, the first flat element 15a along the notch 1d,

b) folding through approximately 90°, relative to the plane in which the manufactured article 10 lies, from the same part of the said first flat element 15a of step a), the first head portion 11 along the notch 1e, c) folding back on themselves the lateral braces 14a, 14b through approximately 180° in a manner such that the first flat element 15a and the first head portion 11 come to form two shelves of the heat exchanger that are substantially perpendicular to the lateral braces 14a, 14b and substantially parallel with one another and that the first flat element 15a comes to form the lower shelf of the heat exchanger, d) folding through approximately 90°, relative to the plane in which the manufactured article 10 lies, the second flat element 15b along the base of the said second flat element 15b, e) folding through approximately 90°, relative to the plane in which the manufactured article 10 lies, from the same part of the said second flat element 15b of step d), the second head portion 12 along the notch 1f, and f) folding back on themselves the lateral braces 14a, 14b through approximately 180° in a manner such that the second flat element 15b and the second head portion 12 come to form two shelves of the heat exchanger that are substantially perpendicular to the lateral braces 14a, 14b and substantially parallel with one another and that the second flat element 15b comes to form the upper shelf of the heat exchanger.

[0037] The abovementioned folding steps can be implemented in any order; for example, the fold through approximately 90° can be made first and the shelves obtained then rotated in a manner such that the first and second elements 15a, 15b, which in folded-out form were located at the centre, are the shelves at the end of the heat exchanger while the first and second head portions 11, 12, which in folded-out form were located at the end, are the shelves at the centre of the heat exchanger. Alternatively, the folding-back of the braces through approximately 180° can be implemented first and subsequently the first and second elements 15a, 15b and the first and second head portions 11, 12 can be folded back through approximately 90° towards the outside of the plane in which the manufactured article 10 lies.

[0038] In order to fill the coil 20 with the refrigerant substance, the tongue 18 of the manufactured article 10, which will come to be situated in a position outside the refrigerant cabinet, is connected to the compressor of the heat exchanger by means of a capillary tube. The said tongue 18 houses the inlet capillary tube for the refrigerant substance in a manner such that the tip of the capillary tube enters directly into the second flat element 15b, downstream of the T-shaped junction 21, so that the refrigerant substance leaving the coil 20, at the said T-shaped junction 21, is not mixed with the incom-

ing refrigerant substance.

[0039] Figure 4 shows a second embodiment of the heat exchanger according to the present invention, which differs from that in Figure 3 only in the fact that the first flat element 15a is of smaller size than the second flat element 15b of the manufactured article 10. The effect of this is that the central shelves (first and second head portions 11, 12) are also at a shorter distance, in other words their distance substantially coincides with the height of the said first flat element 15a.

[0040] Figure 5 shows a third embodiment of the heat exchanger according to the present invention, which differs from that in Figure 3 in that the lateral braces 14a, 14b are replaced with a single brace 14, substantially in a central position of the said central element 13 which, passing through the first and second flat elements 15a, 15b, results in the obtainment of outer shelves divided into two parts.

[0041] From what has been stated above, the advantages of the shelf-type heat exchanger according to the present invention are immediately apparent.

[0042] A first advantage is that the heat exchanger can be manufactured from a manufactured article in a single piece, avoiding the welds which, as stated above, may cause leakage of the refrigerant substance. In particular, the coil obtained according to the abovementioned roll bonding technology or affixed by welds will in any event be in a single length and not, as in the prior art, formed by different pieces of coil welded together.

[0043] A second advantage is that the heat exchanger is obtained by means of a method of simple folding which can even be performed manually.

[0044] A third advantage of the shelf-type heat exchanger according to the present invention is that it is adaptable to various needs. Specifically, the size, the number of shelves and their mutual distances can be adjusted by varying the size of the shelves and of the brace and the width of the back portions 16, 17a, 17b.

[0045] It is clear that what have been described are only a few specific embodiments of the shelf-type heat exchanger according to the present invention, to which the person skilled in the art will be able to add all the modifications necessary to adapt it to specific applications, without thereby departing from the scope of protection of the present invention.

[0046] In the event that it should be necessary to have a heat exchanger having more than four shelves, it will only be necessary to repeat the module of the central portion 13.

[0047] Furthermore, the notches 1i may also be present on the second flat element 15b or they may be entirely absent.

[0048] With regard to the notches 1d, 1e and 1f, these may be replaced by simple lines of weakness to facilitate folding or they may be simple theoretical fold lines. An example of a theoretical fold line 1m is that positioned between the base of the second flat element 15b and the back portion 17 used to facilitate the folding-back of

the shelf of the heat exchanger comprising the said second flat element 15b.

[0049] The coil 20, then, may also be applied by electrowelding to the surface of the manufactured article 10 and not merely obtained by inflation within the two plates that form the manufactured article as described above.

Claims

1. Manufactured article (10) for the manufacture of a heat exchanger having at least four shelves, the said manufactured article (10) being formed by at least one plate (18a, 18b) and a coil (20) and comprising a first and a second head portion (11, 12), foldable along fold lines (1e, 1f) to form respective shelves, and a central element (13), wherein the said central element (13) comprises at least two flat elements (15a, 15b), foldable along fold lines (1d, 1m) to form respective shelves, and at least one brace (14, 14a, 14b) providing connection between the said first and second head portions (11, 12), the said coil (20) defining a fluid path along the said first and second head portions (11, 12), along the said at least one brace (14, 14a, 14b) and along the said at least two flat elements (15a, 15b), the said coil (20) being produced in a single length.
2. Manufactured article (10) according to Claim 1, wherein the said at least two flat elements (15a, 15b) are defined by two notches (1a, 1b) parallel to the longitudinal axis of the said manufactured article (10) and by one notch (1c) perpendicular to the longitudinal axis of the said manufactured article (10), the said notch (1c) perpendicular to the longitudinal axis of the said manufactured article (10) connecting two points of the said notches (1a, 1b).
3. Manufactured article (10) according to Claim 1 or 2, wherein the said first and second head portions (11, 12) and the said at least two flat elements (15a, 15b) are foldable along fold lines (1d, 1e, 1f, 1m) which are transverse relative to the longitudinal axis of the manufactured article (10), the said fold lines (1d, 1e, 1f, 1m) enclosing at least one back portion (16, 17, 17a, 17b) positioned between a flat element (15a, 15b) and the respective head portion (11, 12).
4. Manufactured article (10) according to Claim 3, wherein one or more of the said fold lines (1, 1e, 1f, 1m) are notches or lines of weakness.
5. Manufactured article (10) according to any one of Claims 1 to 4, wherein the said coil (20) has a diameter of between 0.8 and 2.5 mm.
6. Manufactured article (10) according to any one of Claims 1 to 5, wherein the said manufactured article (10) has an overall thickness of between 0.4 and 2 mm.
7. Manufactured article (10) according to any one of Claims 1 to 6, wherein the said manufactured article (10) is obtained by roll bonding of the said two plates (18a, 18b), of which one of the two plates (18a, 18b) bears a screen-printed line shaped in accordance with the path of the said coil (20) and subsequent inflation of the area enclosed by the said line.
8. Manufactured article (10) according to any one of Claims 1 to 7, wherein at least one of the said at least four shelves of the heat exchanger has a different depth from the remainders.
9. Manufactured article (10) according to any one of Claims 1 to 8, wherein the said central element (13) comprises two flat elements (15a, 15b).
10. Manufactured article (10) according to any one of Claims 1 to 9, wherein the said two notches (1a, 1b) parallel to the longitudinal axis of the said manufactured article (10) in proximity of the outer sides of the said central portion (13) form two lateral braces (14a, 14b).
11. Manufactured article (10) according to any one of Claims 1 to 9, wherein the said two notches (1a, 1b) parallel to the longitudinal axis of the said manufactured article (10) form a single brace (14) substantially central to the said central portion (13).
12. Manufactured article (10) according to any one of Claims 1 to 11, wherein at least one of the said first and second head portions (11, 12) and at least one flat element (15a, 15b) have a plurality of ventilation notches (1i) parallel to the longitudinal axis of the said manufactured article (10).
13. Manufactured article (10) according to any one of Claims 1 to 12, in which a tongue (18) providing connection to a refrigerant fluid inlet/outlet capillary tube is defined by respective notches (1h, 1f, 1g) of the manufactured article (10), the said tongue (18) comprising the inlet/outlet end of the coil (20).
14. Manufactured article (10) according to Claim 13, wherein the said tongue (18) divides into two parts the region between the said head portion (11) and the said flat element (15b), defining two back half-portions (17a, 17b).
15. Method for the manufacture of a heat exchanger having at least four shelves by folding the manufactured article (10) described in the preceding Claims 1 to 14, the said method comprising, in any order or simultaneously, the steps of:

a) folding through approximately 90°, relative to the plane in which the manufactured article (10) lies, at least one flat element (15a, 15b) along a fold line (1d) or along the base of the said at least one flat element (15a, 15b), 5
b) folding through approximately 90°, relative to the plane in which the manufactured article (10) lies, from the same part of the said at least one flat element (15a, 15b) of step a) a head portion (11, 12) along a fold line (1e, 1f), 10
c) folding back on itself a brace (14a, 14b, 14) through approximately 180° in a manner such that the said at least one flat element (15a, 15b) and the said head portion (11, 12) come to form shelves of the said heat exchanger that are substantially perpendicular to the said brace (14a, 14b, 14) and substantially parallel with one another and that the said at least one flat element (15a, 15b) forms an end shelf of the said heat exchanger and that the said head portion (11, 12) forms an internal shelf of the said heat exchanger, and 15
d) folding through approximately 90°, relative to the plane in which the manufactured article (10) lies, the other head portion (11, 12) along a fold line (1e, 1f). 20 25

16. Method of folding according to Claim 15, in which the said step a) is repeated, simultaneously with the other steps or in any order, for each of the said at least one flat element (15a, 15b). 30
17. A heat exchanger having at least four shelves obtainable by folding the manufactured article (10) described in Claims 1 to 14 by means of the method according to Claim 15 or 16. 35
18. A heat exchanger having at least four shelves according to Claim 17, in which the said exchanger is obtained by the roll bonding method. 40
19. A heat exchanger according to Claim 17 or 18, in which the said heat exchanger has four shelves. 45

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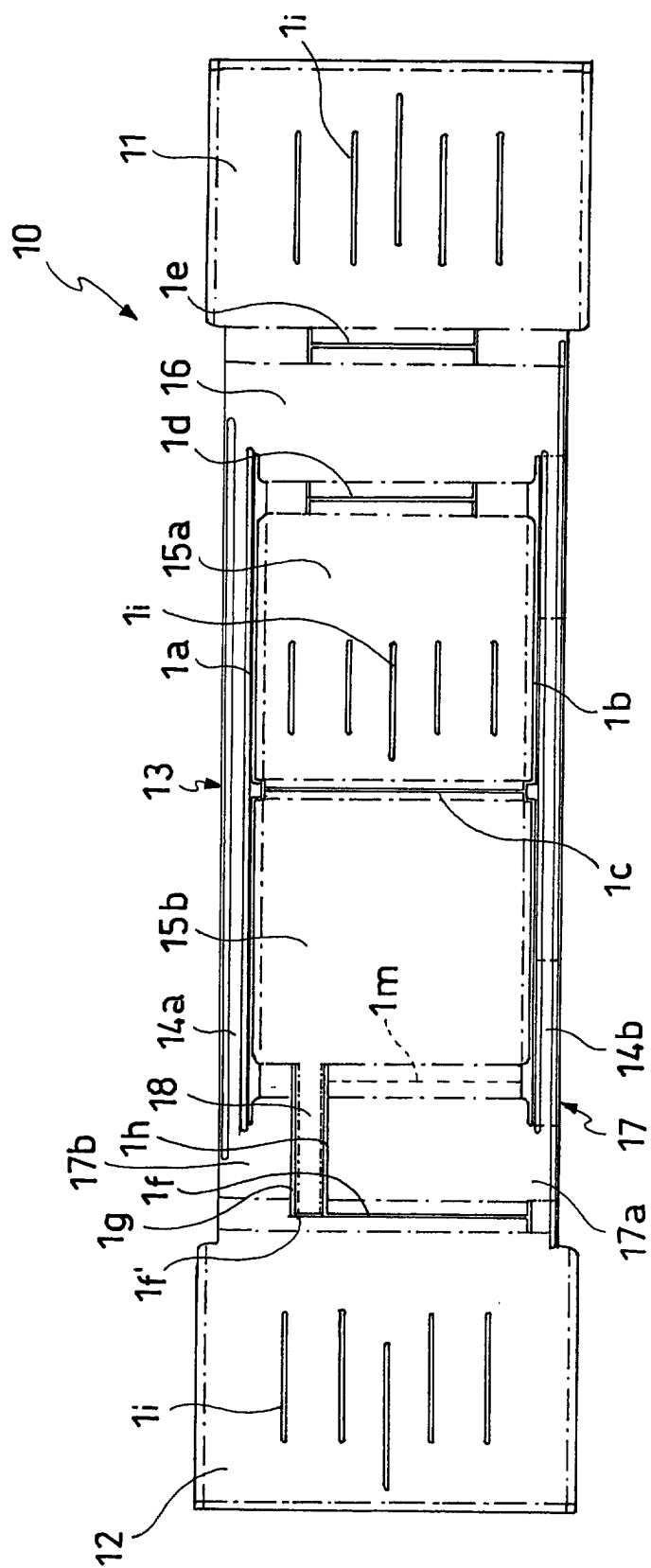


FIG. 1

FIG. 2

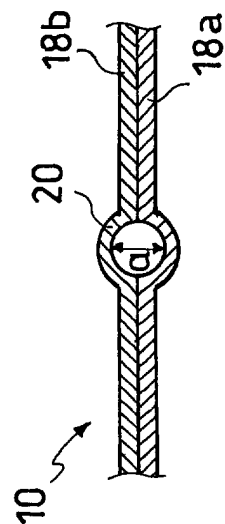
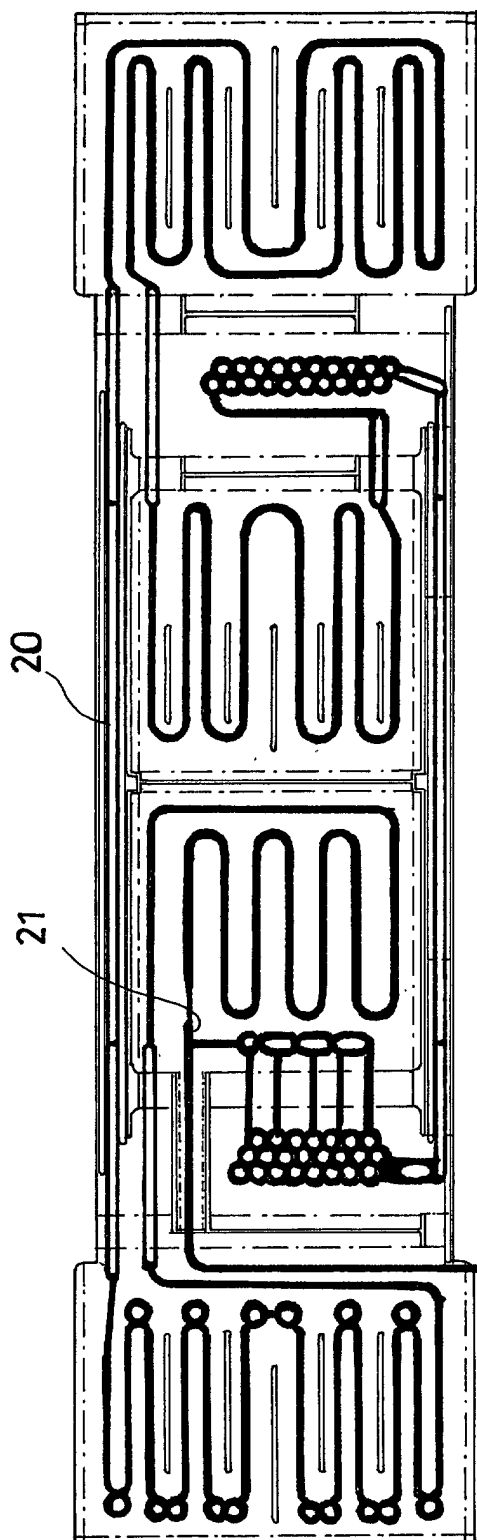


FIG. 1a

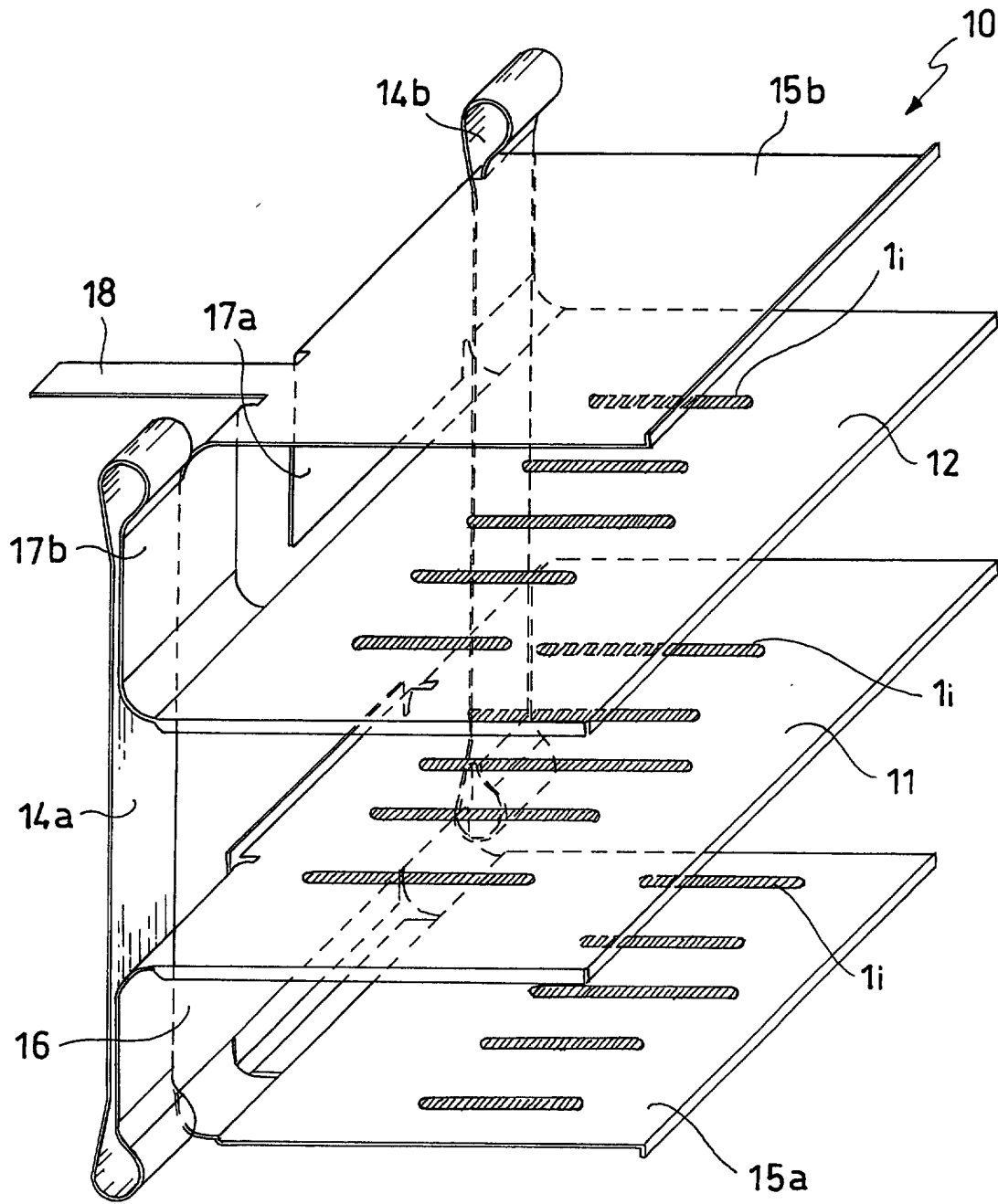


FIG. 3

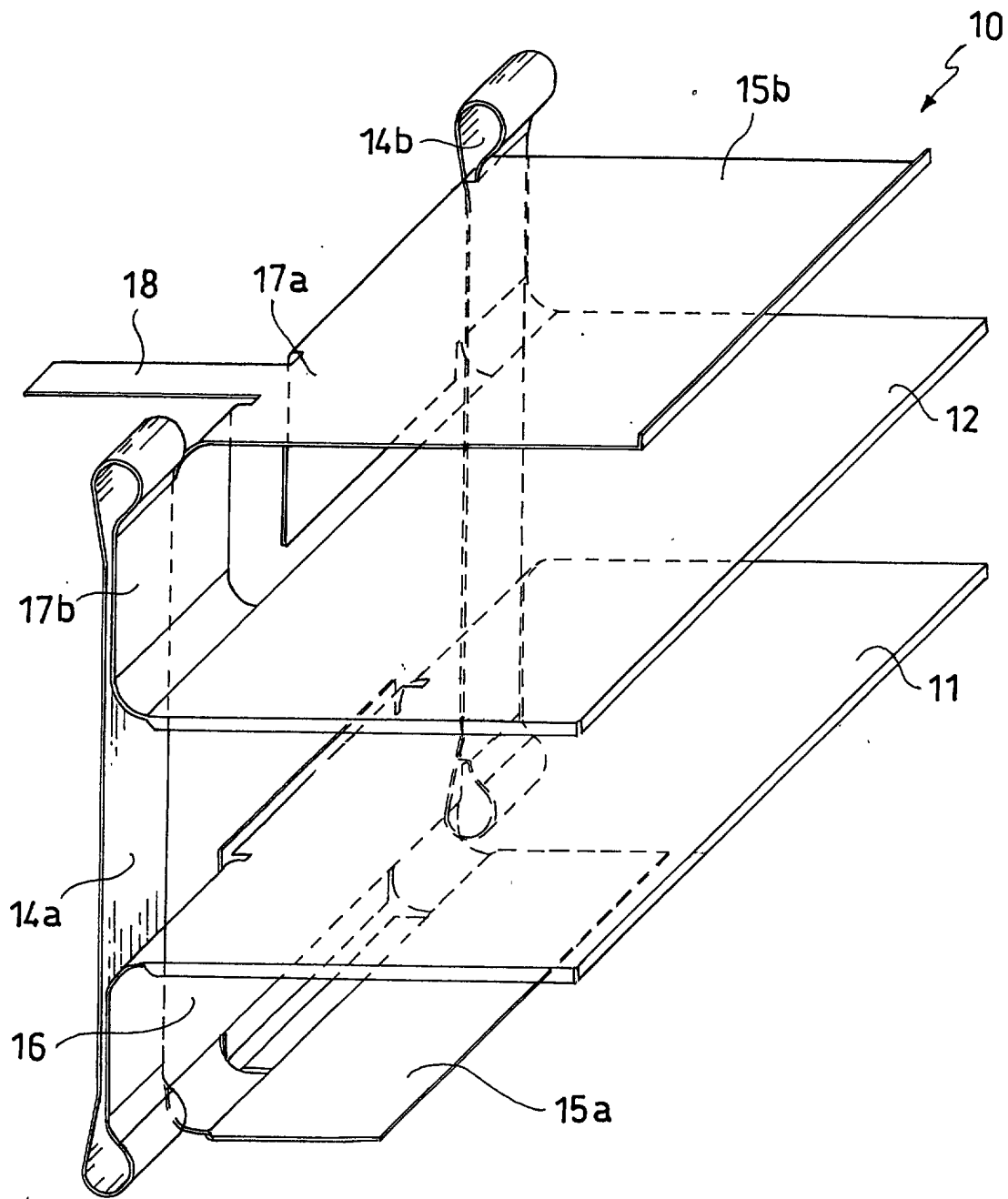


FIG. 4

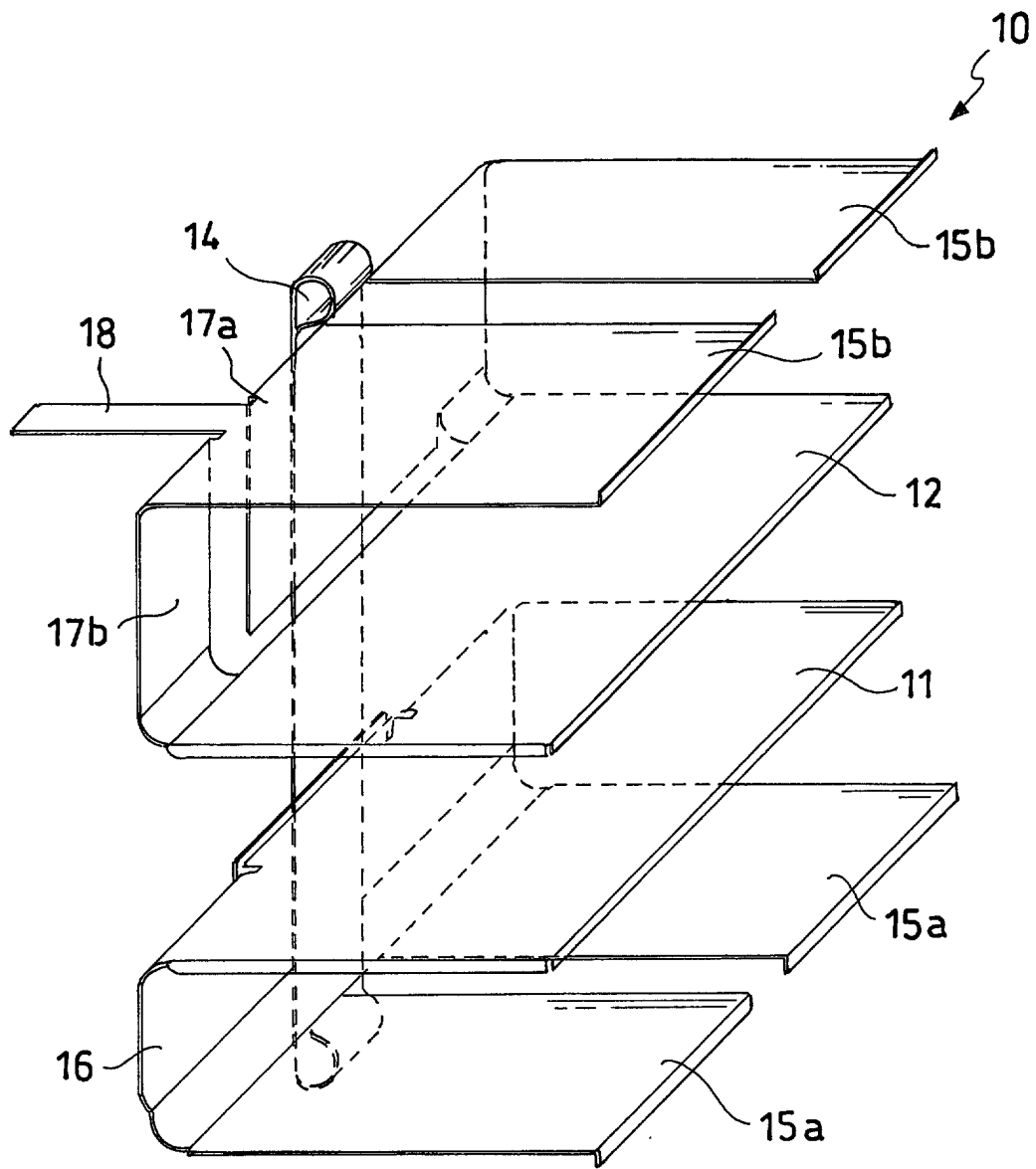


FIG. 5



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Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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