(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 178 268 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.02.2002 Bulletin 2002/06

(51) Int Cl.[7]: **F25B 39/02**, B21D 53/04

(21) Application number: **01118491.8**

(22) Date of filing: **01.08.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **04.08.2000 IT UD000150**

(71) Applicant: **C.G.A. COMPAGNIA GENERALE ALLUMINIO S.p.A.**
I-33043 Cividale del Friuli (IT)

(72) Inventors:
- **Gilli, Roberto**
  33043 Cividale del friuli (UD) (IT)
- **Colugnati, Giorgio**
  33043 Cividale del friuli (UD) (IT)

(74) Representative: **D'Agostini, Giovanni, Dr.**
D'AGOSTINI ORGANIZZAZIONE SRL, Via G. Giusti 17
33100 Udine (IT)

(54) High-efficiency improved evaporator for refrigerators and deep-freezers

(57) An evaporator made using the Roll-Bond technique, that is:

- by joining two sheets of aluminium (1A, 1B) with a channel system pattern traced between them by means of a detachment layer (D), so that the welding between the two sheets is only carried out on those surfaces where the said detachment layer (S) is not applied;
- the said channel system is created by injecting a fluid under pressure in the areas where the detachment layer (D) is applied, in order to separate the sheets and create a gap between them in the said areas in order to form the channel system (C) according to the size and shape determined by the mould and die;

characterised by the fact that;

- the surfaces of the mould and/or die which correspond to the said channel system are corrugated so that, during the expansion phase in order to create the said channel system,
- the final layout of the said channel system takes up a similarly corrugated form (N).

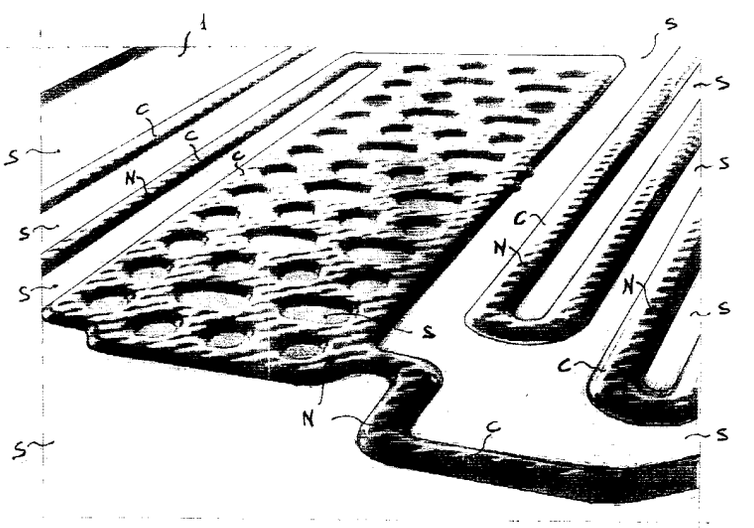

FIG. 1

EP 1 178 268 A2

Description

[0001] The object of the patent contained herein is an improved, high-efficiency evaporator, used particularly for, but not limited to, refrigerators, deep-freezers and freezers.

Area of Use

[0002] The patent is preferably, but not necessarily exclusively, used in the sector of refrigerators and deep-freezers in which there is a closed-circuit frigorific cooling system, with a condenser and compressor located externally with respect to the freezing unit and an evaporator located inside the freezing unit.

State of the Art

[0003] Evaporators for refrigerators, deep-freezers or freezers are widely used, and their purpose is to extract heat from the area around the freezing unit where they are housed, by means of evaporation of the fluid in the frigorific circuit which is located inside.

[0004] The evaporators are usually made by welding two sheets of aluminium together, in order to leave a channel system which has a gradually increasing section so that, on the basis of the fluid dynamics law for gases PV=RT (pressure x volume = constant x temperature, where the temperature indicates the absolute temperature), in a condition of an increase in volume and a drop in pressure, there is a lowering of the temperature.

[0005] The lowering of the temperature inside the channel system of the evaporator leads to a cooling down of the area around it (refrigerator or freezer unit) due to the heat exchange through conduction and convection between the air outside of the channel system.

[0006] In order to improve the efficiency of the heat exchange, the channel system may be formed in various sections and paths in order to achieve the best performance possible.

[0007] The system most commonly used to make the evaporators is the widely known Roll-Bond process, which foresees the application, by means of silkscreen printing for example, of a detachment pattern according to the predetermined layout of the channel system required on one of the internal surfaces of the two aluminium sheets that are to be welded together, joining the two sheets together and hot-rolling them in order to weld them together in the areas that do not have the detachment pattern, followed by an annealing cycle and the injection under pressure of a fluid between the two sheets which are clamped in position between two expansion-limiting plates, in order to form the final channel system.

[0008] The channel systems, as previously stated, have a progressively variable section and have various paths according to a wide variety of designs, in order to give the highest efficiency of heat exchange.

[0009] Other solutions foresee the use of sheets of copper instead of aluminium, but is widely known that pure aluminium (above 99.5%) has a high degree of conductivity and that it may be joined together by using the Roll-Bond technique. What is more, aluminium has good resistance-to-wear properties and better non-toxic properties compared with other metals, e.g. copper and copper alloys (e.g. brass).

Drawbacks

[0010] In spite of all the efforts made, it has not been possible to improve the efficiency of the heat exchange above the limits of the characteristics mentioned above.

Aim of the Invention

[0011] The aim of this invention is to overcome the aforementioned limitations, without having to revolutionise the production cycle of the said Roll-Bond technique, and in particular to guarantee a higher heat exchange with the same dimensions and masses compared with current evaporators.

Description of the Invention

[0012] The problem is solved as claimed by means of an evaporator made using the Roll-Bond technique, wherein:

- it is made by joining two sheets of aluminium with a channel system pattern traced between them by means of a detachment layer, so that the two sheets are joined only in those points where the said detachment layer is not applied;
- the said channel system is created by injecting a fluid under pressure in the areas where the detachment layer is applied, in order to separate the sheets and create a gap between them in the said areas in order to form the channel system inside the expansion limiting plates;

characterised by the fact that;

- the surfaces of either one or both of the said plates is corrugated so that, during the expansion phase in order to create the said channel system
- the final layout of the said channel system takes up a similarly corrugated form.

[0013] The advantages obtained by using this system lie in the formation of the said channel system in order to increase the surface area in contact with the refrigerating fluid compared with evaporators of the same size.

[0014] Furthermore, the corrugated profile of the surface which is obtained in the channel system which forms the evaporation coil, apart from greatly increasing

the surface area for the heat exchange, also provokes a turbulent movement in the refrigeration fluid which further increases the heat exchange.

[0015] The production process foresees, as previously stated, that the channel system, which is formed by the Roll-Bond process, is created by injecting high-pressure air inside the sandwich of an upper sheet of aluminium, a detachment, heatresistant ink pattern and a lower sheet of aluminium.

[0016] The two sheets are welded together by means of a pre-heating process and hot-rolling, followed by a cold rolling cycle.

[0017] Inside the sandwich, after a suitable annealing treatment, high-pressure air is injected which provokes the separation of the two sheets of aluminium in correspondence with the points where the detachment ink pattern is applied, thus forming the channel system.

[0018] The deformation in the designated zones, that is, where the welding process has not taken place, forms a corrugated pattern, that is, ribbed or wavy, thus leading to the required increase in the surface area and turbulent movement when the fluid passes through it.

[0019] When the enlargement during the air injection cycle is carried out, the external surfaces of the channel system are pressed against the corrugated surface of the limiting plate or plates which thus define the final corrugated surface.

[0020] The surface of the plate or plates also moulds its rough surface to the external surface of the channel system when they are pressed together, thus determining a corresponding roughness or corrugation also on the inside of the channel system because of the constant thickness of the deformed sheet of aluminium. The channel system therefore takes up the same corrugated effect as the expansion limiting plates against which it is pressed and deformed. The shapes that may be formed are of various types or sizes, depending on the shape of the surface against which the evaporator channel system is expanded.

[0021] An advantage is that the said corrugations are transversally inclined, in order to give the refrigeration fluid which passes through the system a turbulent, helicoidal or helical movement.

[0022] In this way, the molecules of the fluid are forced to carry out a path which is longer than the path of the channel system, with a better flow against the walls of the channels, leading to a considerable increase in heat exchange.

Description of an Application of the Invention

[0023] These and other advantages, with the aid of the attached drawings, will be outlined in the following description of a typical application of the system, the particulars of which are to be considered as an example and not a limit.

[0024] Fig.1 is a three-dimensional view of a portion of an evaporator created by means of the characteristics of this invention.

[0025] Fig.2 is a transversal sectional view of a channel in the channel system.

[0026] Fig.3 is a longitudinal view of the channel as shown in Fig.2

[0027] In the figures, 1 indicates the evaporator.

[0028] 1A and 1B indicate the upper and lower sheets of aluminium of the evaporator.

[0029] "S" indicates the flat welded zone between sheets "1A" and "1B".

[0030] "D" indicates the inner surface of the channel system of which one or the other is covered by the detachment pattern.

[0031] "C" indicates the channel system.

[0032] "N" indicates the corrugated shape along the channel system according to this invention.

[0033] The said corrugations may be either knobbly or ribbed, more or less transversal or inclined in order to form a turbulence zone.

[0034] The best turbulence form is the one created by inclined corrugation and/or ribbing which give the fluid a basically helicoidal (helical), turbulent motion.
In this way, the heat exchange is further increased, not only because of the increase in the surface area, but also due to the turbulent, helicoidal motion given to the fluid while it passes inside the channel system.

[0035] In this way, the molecules of the fluid are forced to carry out a longer path compared with the centre line of the channel, and so the efficiency is undoubtedly superior.

[0036] As claimed, the invention concerns an evaporator made using the Roll-Bond (1) process, that is:

- by joining two sheets of aluminium (1A, 1B) with a channel pattern by means of the application of a detachment layer (D), so that when the two sheets are joined together by welding, the welding is only carried out on the surfaces where the detachment layer (S) has not been applied,
- in which they are joined together by autogenous welding by means of a preheating process and hot-rolling, followed by a cold rolling process and an annealing process,
- with the said channel system being formed by injecting fluid under pressure in the areas where the detachment layer (D) has been applied, in order to separate the two sheets and form a gap in the said areas to form the said channel system (C) according to a size and shape fixed by the expansion limiting plates.

[0037] In which:

- the surfaces of the said plates are corrugated so that, in order to form the said channel system by expansion phase in which
- the final form of the channel system takes up in a similarly corrugated shape (N).

[0038] The advantage is that the said corrugation (N) in the said channel system (C) is formed in order to create a turbulent movement to the refrigerating fluid which passes through the said channel system (C).

[0039] Another advantage is that the said corrugation also has ribbing or transversal undulations (N).

[0040] In an optimum solution, the said corrugation also has transversally inclined ribbing or undulations (N) in order to create a turbulent, more or less helicoidal, movement to the fluid which circulates in the said channel system (C) as it advances.

[0041] The said corrugation (N) may also have a rough appearance.

[0042] The said corrugation (N) may also be knobbly.

[0043] With these combinations, optimum results in terms of increased efficiency may be achieved, with the same size evaporator and the same energy consumed by the equipment. Alternatively, apparatus with the same heat exchange capacity may be obtained with a lower amount of electrical energy consumed.

[0044] The production process is as follows:

- use two sheets of aluminium with a purity of around 99.5% (1A, 1B);
- spread one of the two sheets, according to a predetermined pattern, with a detachment layer (D) which is resistant to the heat generated during the welding of the two sheets, in order to avoid welding taking place in the areas of the said detachment layer (D);
- position the two sheets together (1A, 1B) and subject them to a preheating cycle and a hot-rolling cycle in order to carry out autogenous welding of the areas and surfaces which are in contact and not covered by the detachment layer (D);
- carry out a cold rolling cycle of the sheets that are welded together;
- carry out an annealing cycle of the sheets;
- press the sheets treated as described above between two expansion limiting plates;
- in which the negative surfaces of the plate(s) are corrugated;
- the said channel system is then formed between the said limiting plates by injecting compressed air into the areas where the detachment layer (D) has been applied, in order to separate the said sheets and form a gap in the areas where the detachment layer (D) has been applied, thus forming the said channel system (C) so that;

the final shape formed by the channel system on the evaporator is similarly corrugated (N).

Claims

1. Evaporator, used particularly for refrigerators or deep freezers, of the type made using the Roll-Bond process, wherein:

- the evaporator is obtained by joining two sheets of aluminium (1A, 1B) with a channel pattern by means of the application of a detachment layer (D), so that the joining due to welding between the two sheets is only carried out on the surfaces where the detachment layer (S) has not been applied,
- the said channel system being formed by injecting fluid under pressure in the areas where the detachment layer (D) has been applied, in order to separate the two sheets and form a gap in the said areas to form the said channel system (C) according to a size and shape fixed by the expansion limiting plates
- **characterised by** the fact that the said plates are corrugated so that, during the expansion phase in order to form the said channel system,
- the final form of the channel system which has a similarly corrugated surface (N) is formed.

2. Evaporator according to claim 1, **characterised by** the fact that the said corrugation (N) in the said channel system (C) is formed in order to create a turbulent movement in the refrigerating fluid which passes through the said channel system (C).

3. Evaporator according to the previous claims, **characterised by** the fact that the said corrugation also has ate least ribbing or transversal undulations (N).

4. Evaporator according to claim 1, **characterised by** the fact that the said corrugation also has ribbing or inclined transversal undulations (N) in order to create a turbulent, more or less helicoidal or helical, movement to the fluid which circulates in the said channel system (C) as it advances.

5. Evaporator according to any of the previous claims, **characterised by** the fact that the said corrugation (N) concretise a rough internal channel surface.

6. Evaporator according to claim 1, **characterised by** the fact that the said corrugation (N) concretise also knobbly-shape.

7. A method for making an evaporator according to any of the previous claims, **characterised by** the fact that it consists in basically the following phases:

- use two sheets of aluminium with a purity of at least 99.5% (1A, 1B);
- spread one of the two sheets, according to a predetermined pattern, with a detachment layer (D) which is resistant to the heat generated during the welding of the two sheets, in order to avoid welding taking place in the areas of the

said detachment layer (D);

- position the two sheets together (1A, 1B) and subject them to a preheating cycle and a hot-rolling cycle in order to carry out autogenous welding of the areas and surfaces which are in contact and not covered by the detachment layer (D);
- carry out a cold rolling cycle of the sheets that are welded together;
- carry out an annealing cycle of the sheets;
- press the sheets treated as described above between two expansion limiting plates;
- one or the other of the surfaces of the expansion limiting plates are corrugated;
- the said channel system is then formed between the said plates by injecting compressed air into the areas where the detachment layer (D) has been applied, in order to separate the said sheets and form a gap in the areas where the detachment layer (D) has been applied, thus forming the said channel system (C) so that;
- the final shape formed by the channel system formed on the evaporator is similarly corrugated (N).

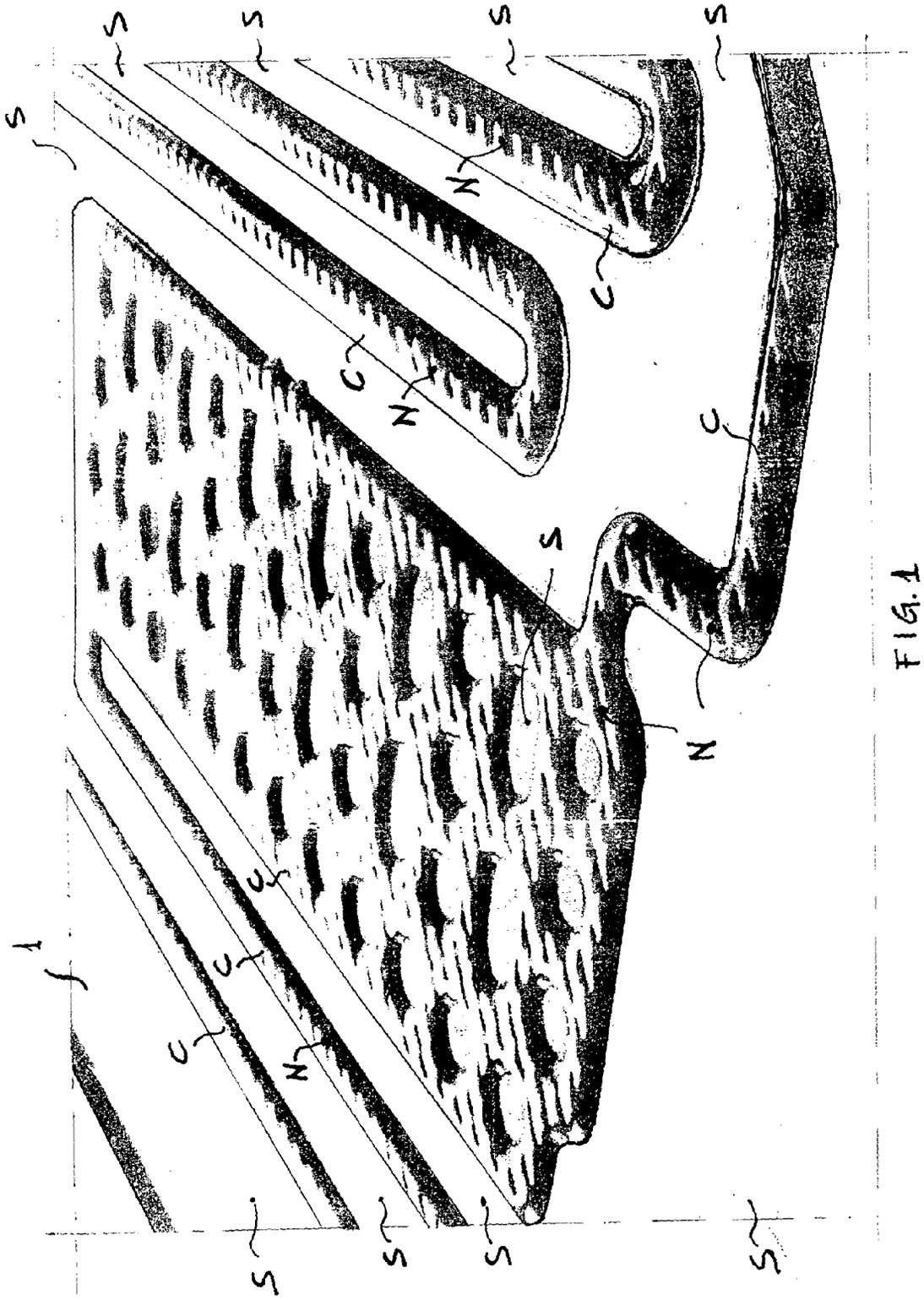

FIG. 1

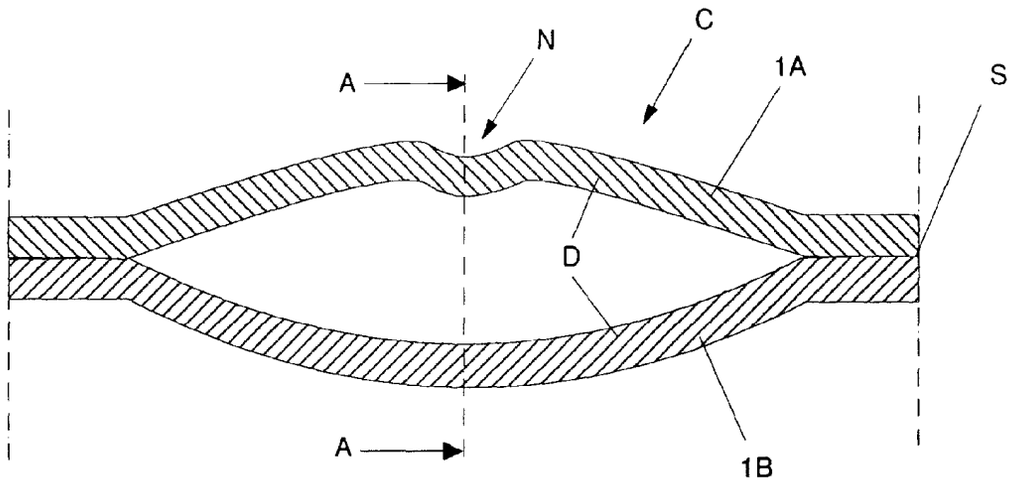

Fig. 2

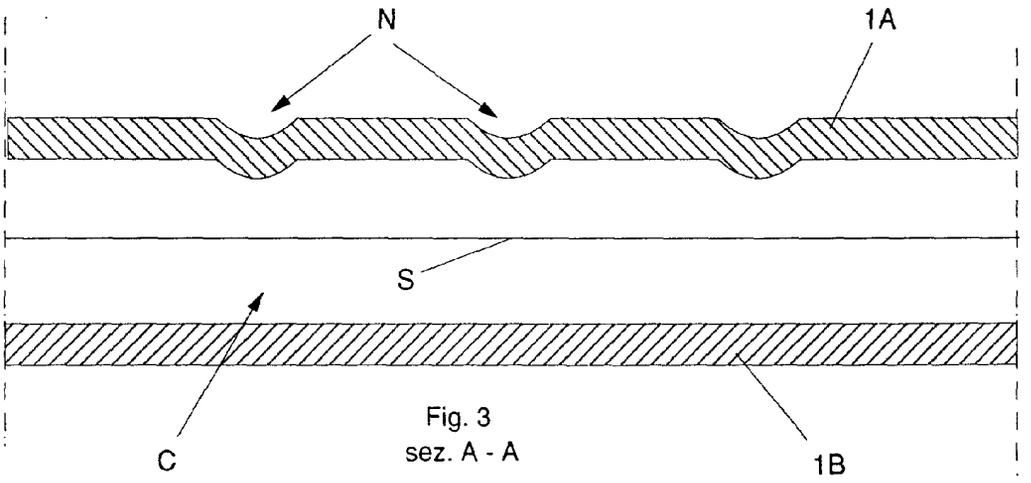

Fig. 3
sez. A - A