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

(11) EP 0 843 138 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.05.1998 Bulletin 1998/21

(51) Int. Cl.[6]: **F25B 39/00**, F25D 3/00, B21D 53/04

(21) Application number: **96830582.1**

(22) Date of filing: **14.11.1996**

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

(71) Applicant: **OCEAN S.p.A.**
25028 Verolanuova (Brescia) (IT)

(72) Inventor: **Nocivelli, Gianfranco**
25028 Verolanuova (Brescia) (IT)

(74) Representative:
De Nova, Roberto et al
c/o JACOBACCI & PERANI S.p.A.
Via Visconti di Modrone 7
20122 Milano (IT)

(54) A heat exchanger such as a condenser and/or an evaporator for a refrigerator, a freezer, a combination of the two and the like

(57) A heat exchanger (1, 20, 30 40), such as a condenser and/or an evaporator for a refrigerator, a freezer, a combination of the two, and the like, which has the advantage of reducing energy consumption and, at the same time, of being light, strong, reliable and economical to manufacture, includes a serpentine coil (2) formed by inflation between a first sheet (5) and a second sheet (6) roll bonded together, and a chamber (9), containing a substance (5) of high thermal capacity, formed by inflation between a third sheet (10) roll bonded to the first sheet (5).

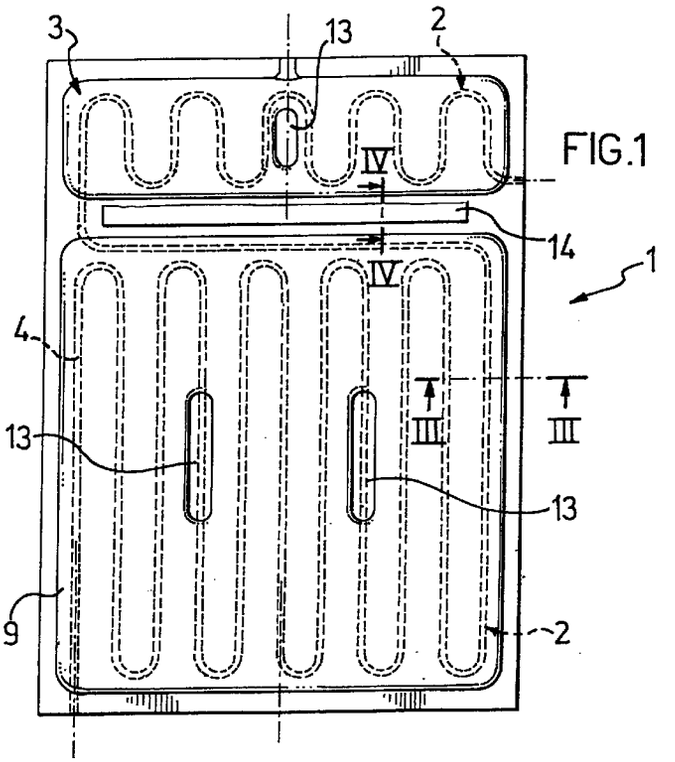

FIG.1

EP 0 843 138 A1

Description

The present invention generally concerns a heat exchanger and a method for its manufacture. More particularly, it concerns a heat exchanger in the form of a condenser and/or an evaporator intended for a refrigerator, a freezer, a combination of the two and the like.

A heat exchanger of this type includes a serpentine coil for a refrigerant, and a body having a high thermal capacity arranged in heat-exchange relationship with the refrigerant.

It is known that in refrigerators, freezers, combinations of the two and the like, energy consumption is reduced if the thermal capacity of the heat exchangers, in particular, the condenser and evaporator, is increased.

In fact, if the thermal capacity of the heat exchangers is increased, this has the effect that they continue to exchange heat even during the phase in which the compressor does not operate; the period of the operating cycle is thus lengthened and the difference between the evaporation and condensation temperatures is reduced; this, as is known, gives rise to an increase in efficiency.

The requirement to be met is therefore that of providing a heat exchanger having a high thermal capacity.

In order to satisfy this requirement, heat exchangers have been proposed in which the fluid flows along a pathway between thick metal walls.

Although satisfying the aim, heat exchangers made in accordance with this proposed solution are heavy and expensive to manufacture.

The problem upon which the present invention is based is that of devising a heat exchanger of the type specified, having structural and functional characteristics which overcome the aforesaid disadvantages described with reference to the prior art.

This problem is resolved by a heat exchanger of the specified type, characterised in that it includes a first sheet roll bonded to a second sheet, and a third sheet roll bonded to the first sheet, a fluid pathway constituting the serpentine coil formed between the first sheet and the second sheet by inflation, a chamber formed between the first sheet and the third sheet by inflation, and a substance having a high thermal capacity located within the said chamber in heat-exchange relationship with the refrigerant through the first sheet and constituting the said body.

Further characteristics and advantages of the heat exchanger according to the present invention will become clearer from the following description of a preferred embodiment, given by way of non-limitative example and with reference to the accompanying drawings, in which;

- Figure 1 is an elevational view of a heat exchanger, more precisely a condenser, according to the invention;
- Figure 2 is a view from below of the heat exchanger of Figure 1;
- Figure 3 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 1, taken on the line III-III;
- Figure 4 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 1, taken on the line IV-IV;
- Figure 5 is a view of another embodiment of a heat exchanger, more precisely a condenser, according to the invention;
- Figure 6 is a view from below of the heat exchanger of Figure 5;
- Figure 7 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 5, taken on the line VII-VII;
- Figure 8 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 5, taken on the line VIII-VIII;
- Figure 9 is an elevational view of a heat exchanger, more precisely an evaporator, according to the invention;
- Figure 10 is a side view of the heat exchanger of Figure 9;
- Figure 11 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 9, taken on the line XI-XI;
- Figure 12 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 9, taken on the line XII-XII;
- Figure 13 is a plan view of a further embodiment of a heat exchanger, more precisely an evaporator, according to the invention;
- Figure 14 is a sectional view on an enlarged scale of a detail of the heat exchanger of Figure 13, taken on the line XIV-XIV; and
- Figure 15 is a schematic view of an evaporation tower incorporating the heat exchanger of Figure 13.

With reference to the accompanying drawings, a heat exchanger, more precisely a condenser, for a refrigerator, a freezer, a combination of the two or the like, is generally indicated 1. The heat exchanger 1, which is generally flat, has a shape of a rectangle with a predetermined surface and includes a serpentine coil 2 for a refrigerant and a body 3 having a high thermal capacity arranged in heat-exchange relationship with the refrigerant in the coil.

The coil 2 comprises a fluid pathway 4 formed between a first sheet 5 and a second sheet 6 by inflation. The first sheet 5 has a face 7 which is printed with a track 8 defining the fluid pathway 4 and which is roll bonded to the second sheet 6, except along the track 8.

The first sheet 5 and the second sheet 6 are preferably made from aluminium and/or its alloys, and are thin, for example, 0.75 mm thick.

The body 3 comprises a chamber 9 which is formed between a third sheet 10 and the first sheet 5 by infla-

tion.

The third sheet 10 is roll bonded to an opposing face 11 of the first sheet 5 except at a printed zone 12 having a shape corresponding to that of the chamber 9.

The third sheet 10 is preferably made from aluminium and/or its alloys, and is thin, for example, 0.5 mm thick.

In other words, the opposite faces 7 and 11 of the first sheet 5 which are screen-printed, the first with the track 8 defining the fluid pathway 4 and the other with the zone 12 corresponding to the chamber 9, are roll bonded to the second sheet 6 and the third sheet 10 respectively, the fluid pathway 4 and the chamber 9 then being formed by inflation, the one between the first sheet 5 and the second sheet 6, and the other between the first sheet 5 and the third sheet 10.

The body 3 is completed by a substance S having a high thermal capacity, located within the chamber 9 in heat-exchange relationship with the refrigerant in the serpentine coil through the thickness of the first sheet 5.

The substance S is a fluid, a solid, a mixture, a composite or a suspension; its physical state remains the same or changes either gradually or at a predetermined temperature within the temperature range. In the example, the substance S is a solution of ethyl alcohol in water.

The chamber 9 has a surface which extends over most of the surface of the heat exchanger and is thick, for example, 13 mm.

The third sheet 10 and the first sheet 5 are welded together at weld points, each indicated 13, distributed over the surface of the chamber to interrupt the volume of the chamber itself and to strengthen the heat exchanger.

A fin 14 extending parallel to, and substantially along the entire length of the short side of the rectangle and formed by blanking and bending, permits a flow of air and improves the heat exchange between the heat exchanger and the environment.

A heat exchanger 20, more precisely a condenser, according to another embodiment of the invention is illustrated in Figures 5, 6, 7 and 8 in which parts structurally and functionally equivalent to those of the heat exchanger of Figure 1 are indicated by the same reference numerals and are not described below.

The heat exchanger 20 includes a plurality of short fins 21, five in the example, extending parallel to the short side of the rectangle and distributed at regular intervals parallel to the long side of the rectangle.

A heat exchanger 30, more precisely an evaporator according to another embodiment of the invention, is illustrated in Figures 9, 10, 11 and 12 in which parts structurally and functionally equivalent to those of the heat exchanger of Figure 1 are indicated by the same reference numerals and are not described below.

The heat exchanger 30 has a serpentine coil 31 with an initial portion 32, a generally sinusoidal portion 33, a honeycomb portion 34, and a final portion 35.

It should be noted that in the heat exchanger 30, the coil 31, with its portions 32, 33, 34 and 35, defines a fluid pathway 4 between a first sheet 5 and a second sheet 6 obtained by inflation. The inflation causes the first sheet to be deformed while the second sheet remains flat: the fluid pathway 4 is thus formed within the chamber 9 such that the heat exchanger 30 lends itself to use in a refrigerator, the outer face of the second sheet 6 being visible when the refrigerator is open.

A heat exchanger 40, specifically an evaporator according to a further embodiment of the invention, is illustrated in Figures 13 and 14 in which parts structurally and functionally equivalent to those of the heat exchanger of Figure 1 are indicated by the same reference numerals and are not described below. This heat exchanger 40 lends itself to use in an evaporation tower of a freezer.

Figure 15 shows an evaporation tower 50 of a freezer having five refrigerating levels. More precisely, the evaporation tower 50 includes five refrigerating levels, three intermediate levels 51 and two end levels, these being an upper level 52 and a lower level 53. The levels 52 and 53 are substantially equivalent to the evaporator 40.

A method for manufacturing a heat exchanger 1 such as a condenser and/or an evaporator for a refrigerator, freezer, a combination of the two, or the like, of the type including a serpentine coil 2 for a refrigerant, and a body 3 having high thermal capacity arranged in heat-exchange relationship with the refrigerant, includes the steps of roll bonding a first sheet 5 that is printed on both of its surfaces, for example, by screen printing, to a second sheet 6, and a third sheet 10 to the first sheet 5, forming a fluid pathway 4 between the first sheet 5 and the second sheet 6 by inflation to obtain the serpentine coil 2, forming a chamber 9 between the first sheet 5 and the third sheet 10 by inflation, and filling this chamber 9 with a substance S having a high thermal capacity to obtain the body 3.

Preferably, the step of forming the pathway between the first sheet 5 and the second sheet 6 by inflation is preceded by a step of pre-inflating the chamber 9 at high pressure, for example 150 bar, in order to separate, in practice, detach, the first and third sheets from each other slightly in correspondence with the chamber.

As far as the roll bonding of the sheets and the inflating is concerned, no more detailed information is given, because such methods are well known per se and usually employed.

In accordance with the method of the invention, the first sheet 5, the second sheet 6 and the third sheet 10 are obtained from three continuous strips unwound from respective reels, the strip corresponding to the first sheet 5 being previously screen-printed on both of its faces, specifically, on one face with the track corresponding to the serpentine coil, and on the other face with the zone corresponding to the chamber.

According to another aspect of the method of the

invention, the first sheet 5, the second sheet 6 and the third sheet 10 are obtained from one continuous strips unwound from a reel, the said strip comprising five layers, specifically: an outer layer of aluminium and/or its alloys of a thickness of, for example, 0.75 mm; a layer of a material having a lower melting point than aluminium, for example, zinc, of a thickness of, for example 20 μm; a central layer of aluminium and/or its alloys, of a thickness of, for example, 0.75 mm; a layer of a material having a lower melting point than aluminium, for example, zinc, of a thickness of, for example, 20 μm; and an outer layer of aluminium and/or its alloys of a thickness of, for example 0.75 mm. The strip is then heated to the melting point of zinc and inflated under pressure in a mould, the mould bearing impressions reproducing the track corresponding to the serpentine coil and the zone corresponding to the chamber. In this case, the two layers of zinc interposed between the central and outer layers of aluminium act like the screen printing.

The principal advantage of the heat exchanger according to the present invention resides in its lightness which is exceptional for an exchanger of high thermal capacity.

A further advantage resides in its strength, which means that it is able to withstand a long period of use.

The method for the manufacture of the heat exchanger according to the present invention is extremely simple which is advantageous, not least in lending itself to large scale production.

Obviously, man skilled in the art, with the aim of satisfying contingent and specific requirements, may introduce numerous modifications and variants to the heat exchanger and the method for its manufacture as described above, all, however, being within the scope of protection of the invention as defined in the following claims.

Claims

1. A heat exchanger (1) such as a condenser and/or an evaporator for a refrigerator, a freezer, a combination of the two, and the like, of the type including a serpentine coil (2) for a refrigerant, and a body (3) having a high thermal capacity arranged in heat-exchange relationship with the refrigerant, characterised in that it includes a first sheet (5) roll bonded to a second sheet (6), and a third sheet (10) roll bonded to the first sheet (5), a fluid pathway (4) constituting the serpentine coil (2) formed between the first sheet (5) and the second sheet (6) by inflation, a chamber (9) formed between the first sheet (5) and the third sheet (10) by inflation, and a substance (S) having a high thermal capacity located within the said chamber (9) in heat-exchange relationship with the refrigerant through the first sheet and constituting the said body (3).

2. A heat exchanger (1) according to Claim 1, characterised in that the second sheet (6) is flat and the fluid pathway (4) is formed within the chamber (9).

3. A method for manufacturing a heat exchanger (1) such as a condenser and/or an evaporator for a refrigerator, a freezer, a combination of the two and the like, including a serpentine coil (2) for a refrigerant, and a body (3) having a high thermal capacity arranged in heat-exchange relationship with the refrigerant, characterised in that it includes the steps of roll bonding a first sheet (5) to a second sheet (6), and a third sheet (10) to the first sheet (5), forming a fluid pathway (4) between the first sheet (5) and the second sheet (6) by inflation to obtain the said serpentine coil (2), forming a chamber (9) between the first sheet (5) and the third sheet (10) by inflation, and filling the said chamber (9) with a substance (S) having high thermal capacity to obtain the said body (3).

4. A method according to Claim 3, characterised in that the first sheet (5), the second sheet (6) and the third sheet (10) are formed from three continuous strips unwound from respective reels, the strip corresponding to the first sheet previously being screen-printed on both faces.

5. A method according to Claim 3, characterised in that the first sheet (5), the second sheet (6) and the third sheet (10) are obtained from one continuous strip unwound from a reel, the said strip comprising a central layer and two outer layers of aluminium or its alloys, and a thin layer of a material having a lower melting point than aluminium interposed between the central layer and each of the outer layers.

6. A method according to Claim 3, characterised in that it includes a step of pre-inflating the chamber (9) at high pressure to separate the first sheet (5) from the third sheet (10) in correspondence with the chamber (9).

7. A method according to Claim 6, characterised in that the step of inflating the fluid pathway (4) is effected at high pressure.

8. A method according to Claim 7, characterised in that the step of inflating the chamber (9) is effected at low pressure.

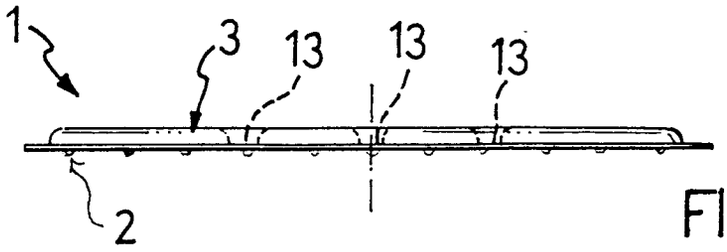

FIG.2

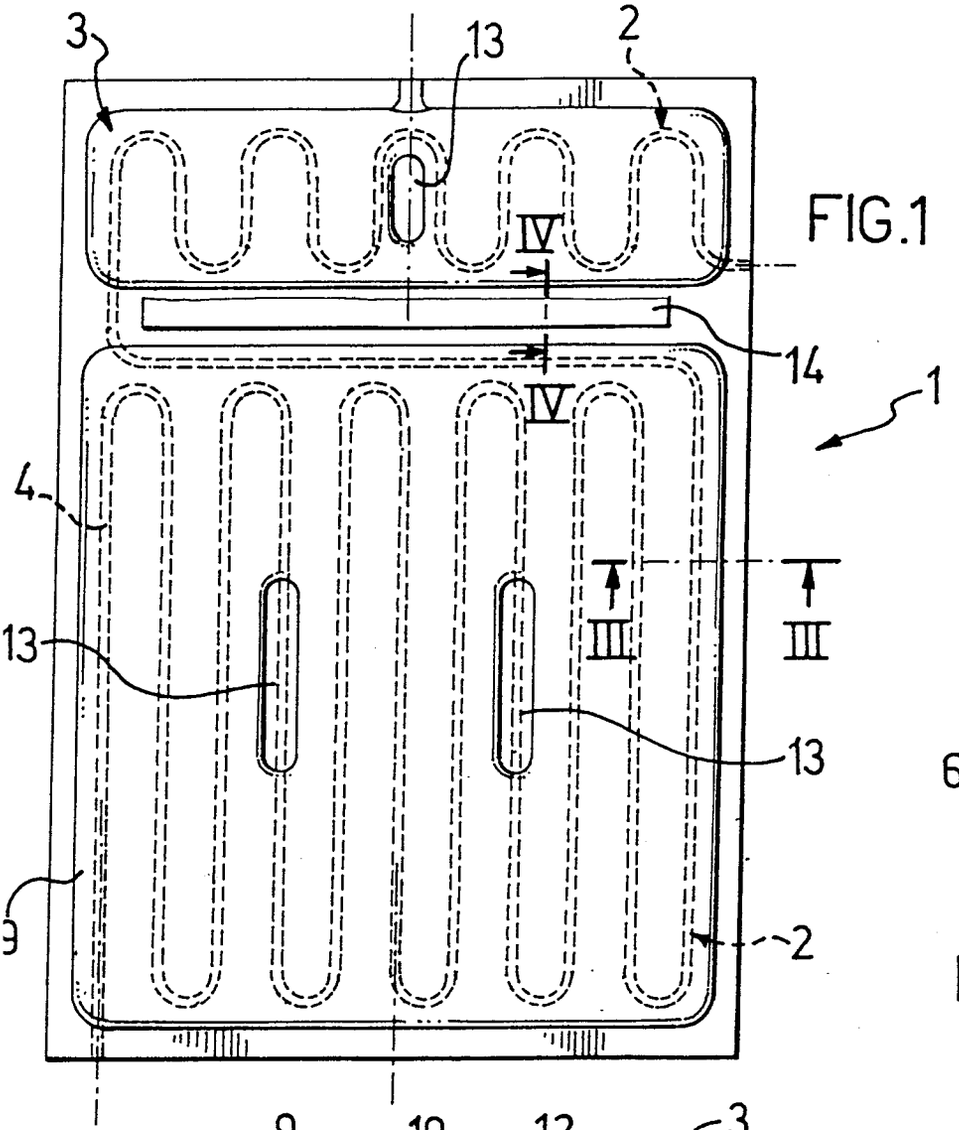

FIG.1

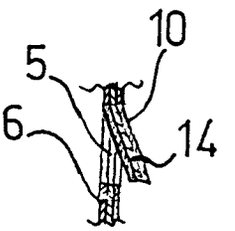

FIG.4

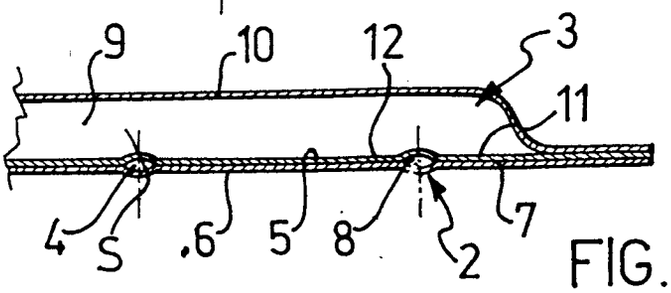

FIG.3

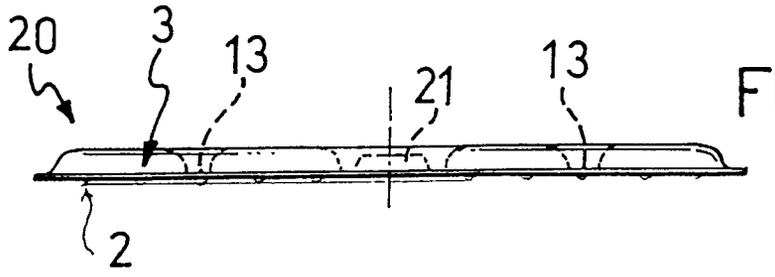

FIG.6

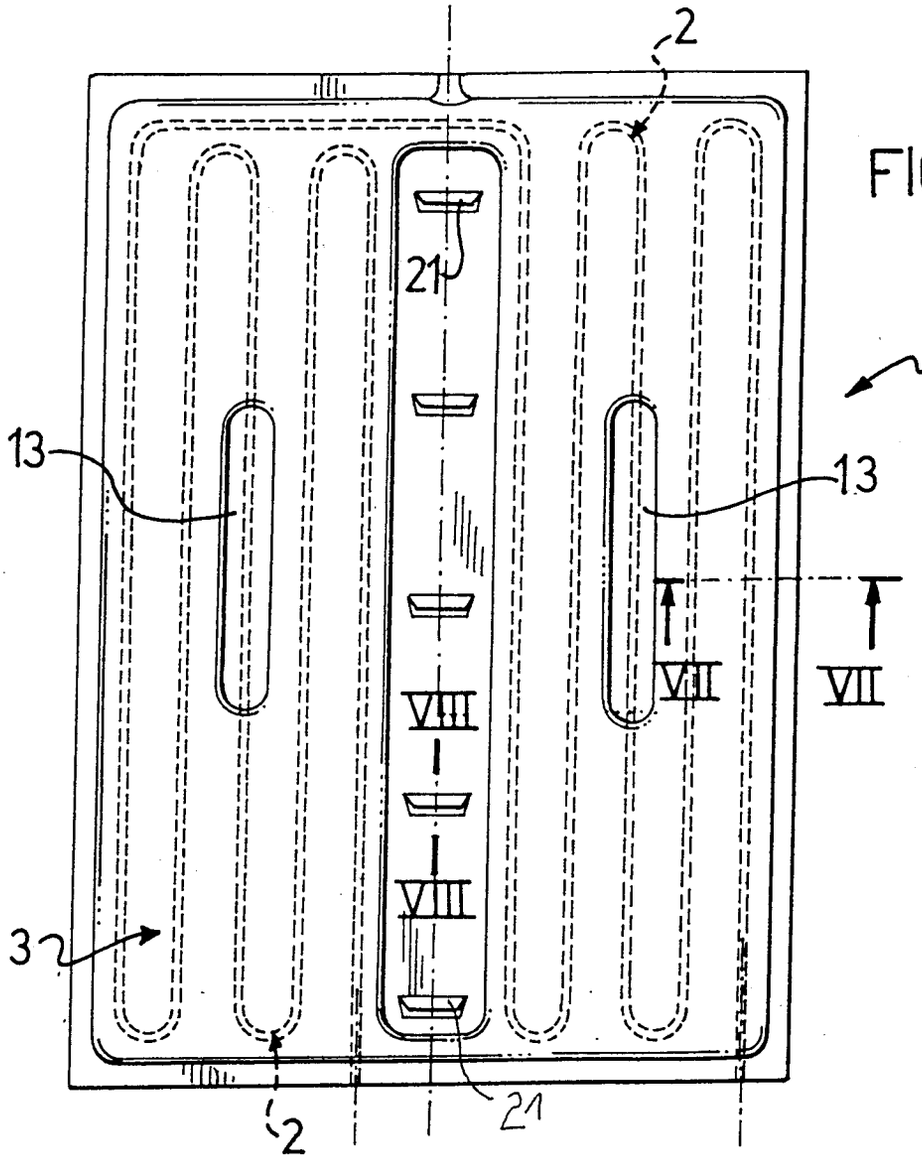

FIG.5

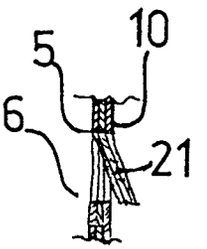

FIG.8

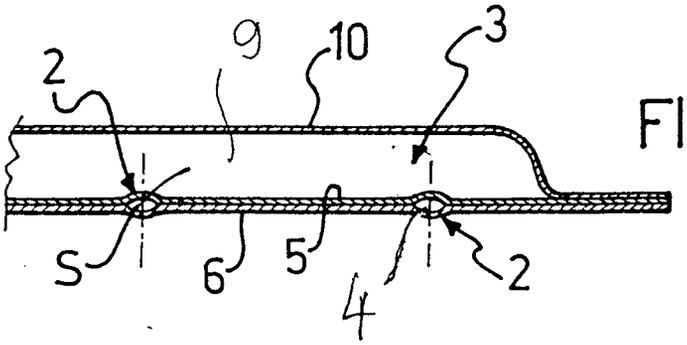

FIG.7

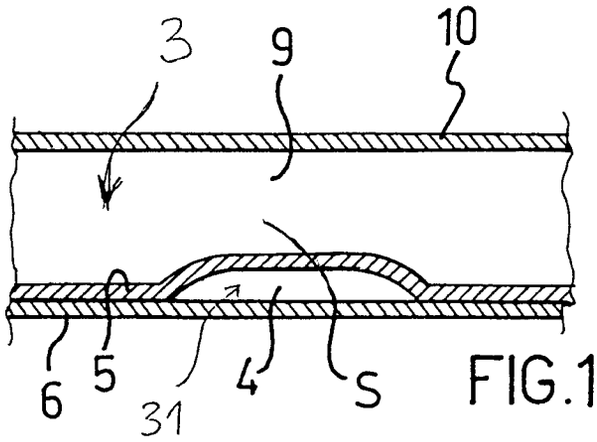

FIG.12

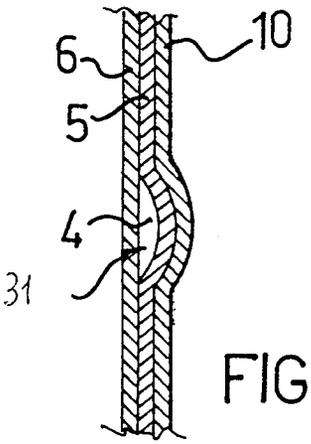

FIG.11

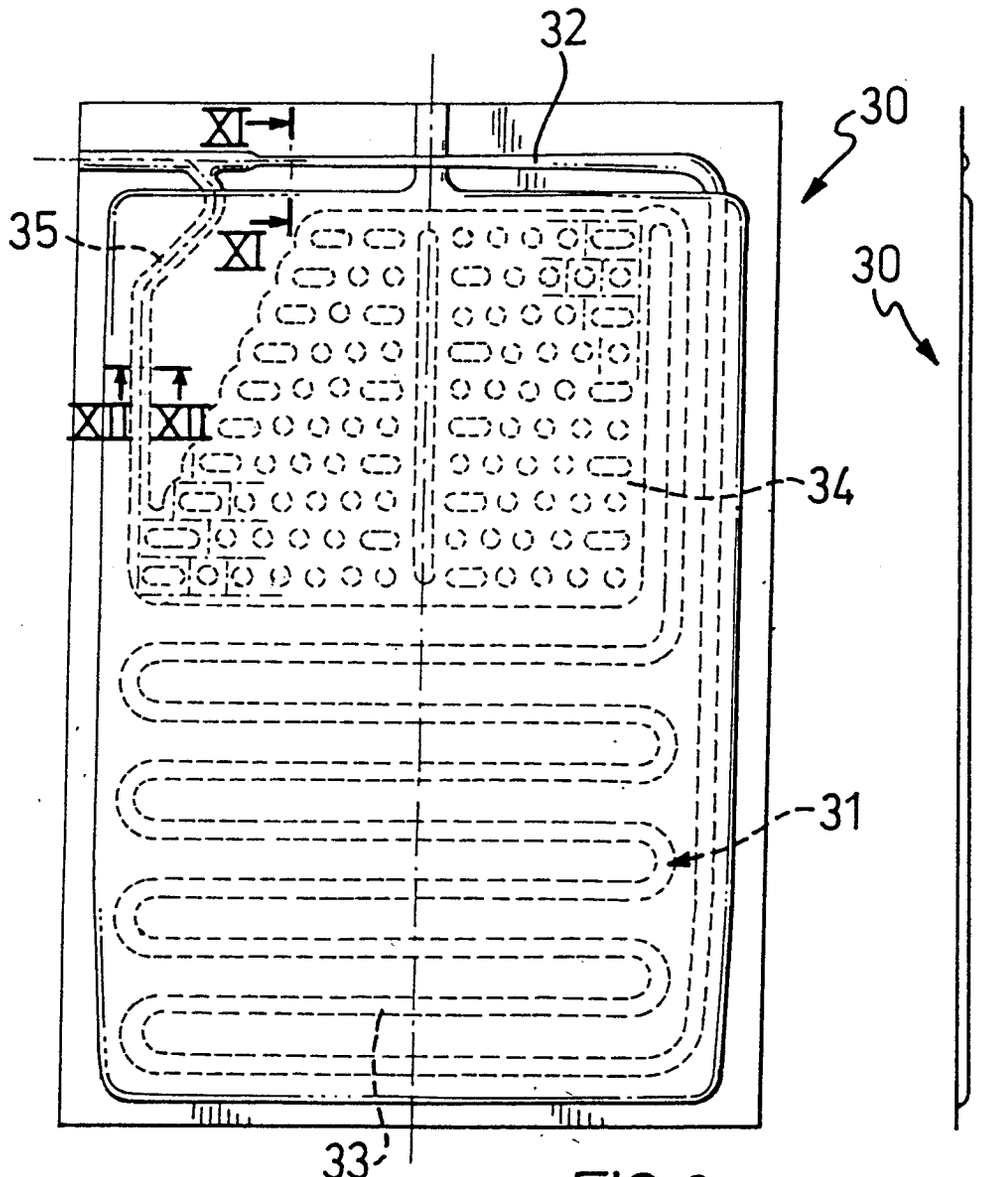

FIG.9

FIG.10

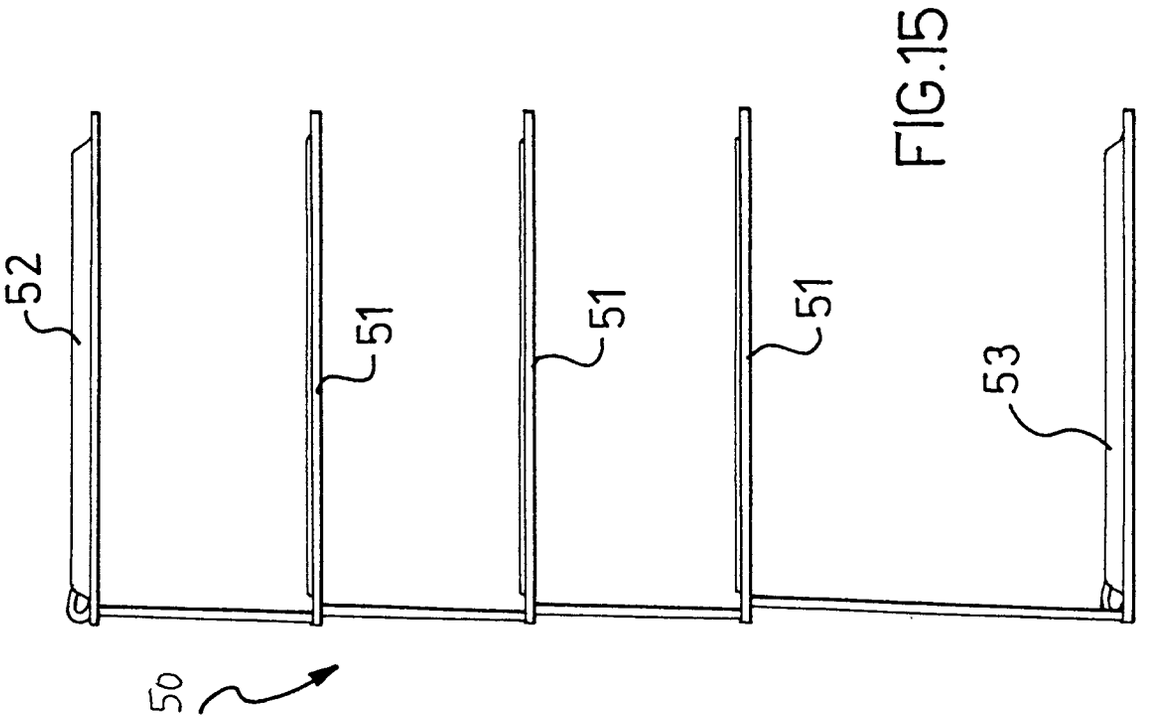

FIG.15

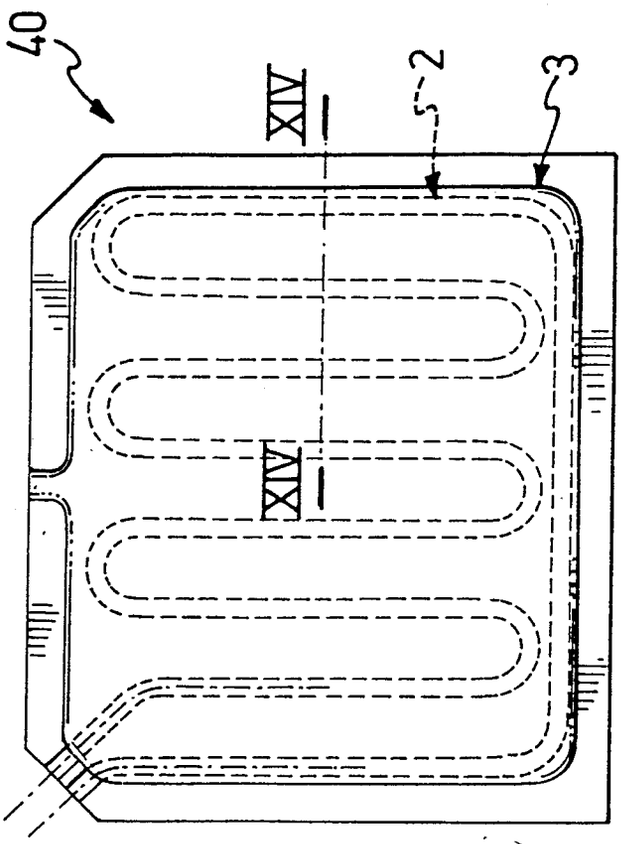

FIG.13

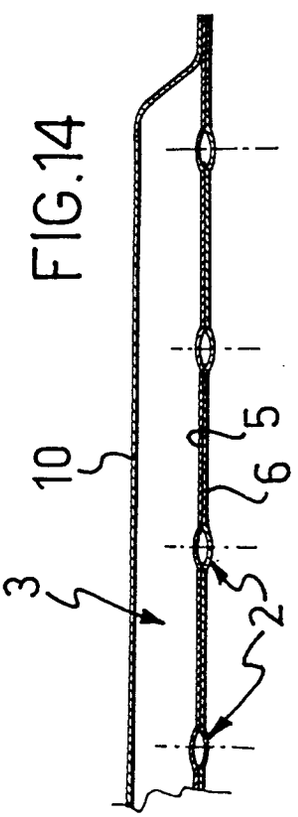

FIG.14

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 83 0582

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)
Y	US 2 073 123 A (SMITH) * page 1, right-hand column, line 31 - page 2, left-hand column, line 56; figures 1-3 *	1-3	F25B39/00 F25D3/00 B21D53/04
Y	US 3 216 093 A (TRANEL) * column 1, line 63 - column 5, line 4; figures 1-6 *	1-3	
A	US 2 690 653 A (KLEIST) * column 1, line 40 - column 4, line 23; figures 1-4 *	1,3	
A	US 2 191 198 A (GOULD) * page 2, right-hand column, line 25 - page 3, left-hand column, line 18; figures 1-4 *	1,3	
A	US 2 845 695 A (GRENELL) * column 1, line 60 - column 2, line 67; figures 1-7 *	3,4	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	US 3 297 082 A (TRANEL) * column 2, line 39 - column 7, line 56; figures 1-11 *	3,4	F25D F28F B21D
A	EP 0 117 710 A (ALCAN INTERNATIONAL) * page 4, line 6 - page 7, line 22; figures 1-4 *	3,4	
A	US 3 018 543 A (BECK) * column 4, line 46 - column 10, line 29; figures 1-13 *	3,5	
A	GB 989 836 A (LAVORAZIONE LEGHE LEGGERE)		
A	EP 0 568 188 A (BRITISH AEROSPACE)		

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 April 1997	Boets, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 83 0582

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	US 4 820 355 A (BAMPTON)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 April 1997	Boets, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)