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## EUROPEAN PATENT APPLICATION

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### (54) Process for producing roll-bonded pannels

(57) A roll-bonded panel 1 has a fluid circuit including a U-shaped shunt passage 2 which comprises first and second shunt passageways 4, 5 parallel to each other and branching from a main passage 3, and a curved passageway 6 interconnecting the forward ends of the shunt passageways 4, 5. A pattern of parting agent corresponding to the circuit is so printed that the width W2 of a nonbonded portion for forming the second shunt passageway 5 is slightly smaller than the width W1 of a non-

bonded portion for forming the first shunt passageway 4. When air of high pressure is introduced into the non-bonded portion, the main passage 3 is formed first by inflation, and the shunt passage 2 is then formed. The shunt passage is formed in the order of the first passageway 4, the curved passageway 6 and the second passageway 5. This obviates the likelihood of the portion of curved passageway 6 rupturing.

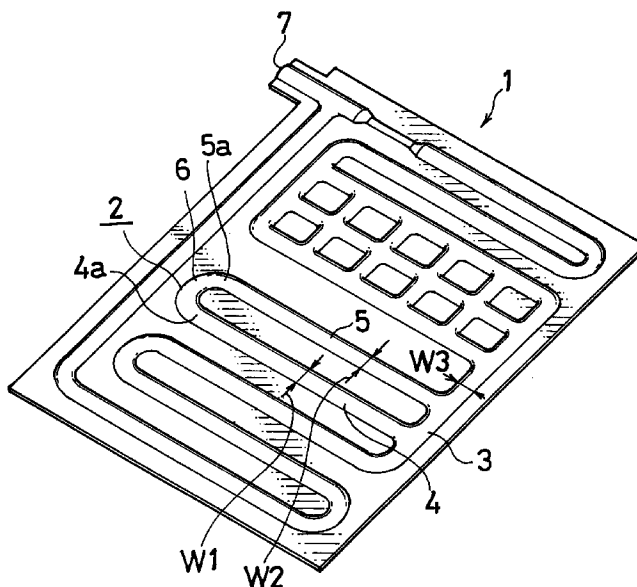


FIG.1

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## Description

### BACKGROUND OF THE INVENTION

The present invention relates to a process for producing roll-bonded panels for use in heat exchangers such as refrigerator evaporators.

It is already known to prepare a roll-bonded panel by printing a pattern corresponding to a fluid circuit on one surface of one of a pair of aluminum plates with a parting agent, superposing the other aluminum plate on the printed surface, roll-bonding the resulting assembly and thereafter inflating nonbonded portions to a tubular form with a fluid pressure. Roll-bonded panels of the type described are in use which differ variously in circuit arrangement or passage width. The circuit of known panels includes, for example, a main passage and a hairpin shunt passage having a smaller width than the main passage and comprising a straight first shunt passageway branching from one portion of the main passage, a straight second shunt passageway branching from another portion of the main passage and a curved passageway provided between the two shunt passageways.

When air of high pressure is applied to the nonbonded portion to produce a roll-bonded panel having such a hairpin shunt passage, the portion of main passage of large width is first inflated, and the portion of shunt passage is then inflated. In the shunt passage, the two straight shunt passageways are formed first, and the curved passageway is finally formed.

The air of high pressure forming one of the straight shunt passageways by inflation therefore collides with the high-pressure air forming the other straight shunt passageway at the portion of curved passageway which is lower than the portions of straight passageways in pressure-resistant strength. Accordingly, the conventional roll-bonded panel formed with the hairpin shunt passage has the problem that the portion of curved passageway with a small curvature is ruptured by the impact involved in inflation, or is not inflated as designed since this portion is inflated finally. This problem becomes pronounced in producing roll-bonded panels which have a shunt passage of small width and require air of increased pressure for forming the circuit by inflation.

### SUMMARY OF THE INVENTION

An object of the present invention is to provide a process for producing roll-bonded panels free of faults such as the rupture of the curved passageway portion or failure in inflating the passageway portion as designed.

The present invention provides a process for producing a roll-bonded panel having a fluid circuit by printing a pattern corresponding to the fluid circuit on one surface of one of a pair of aluminum plates with a parting agent, roll-bonding the aluminum plates with the other aluminum plate superposed on the printed surface, and thereafter inflating nonbonded portions to a tubular form with a fluid pressure, the fluid circuit including a main

passage and at least one shunt passage smaller than the main passage in width, the shunt passage comprising a first shunt passageway branching from one portion of the main passage, a second shunt passageway branching from another portion of the main passage and a curved passageway provided between the two shunt passageways, the process being characterized in that the width of the nonbonded portion to be made into the first shunt passageway is different from the width of the nonbonded portion to be made into the second shunt passageway.

With the process of the invention for producing roll-bonded panels, air of high pressure is applied to a nonbonded portion to form a circuit in the panel, whereby a main passage of large width is formed first by inflation, and a shunt passage is subsequently formed similarly. In forming the shunt passage by inflation, one of first and second shunt passageways which is larger in width is formed first, a curved passageway is then formed, and the other shunt passageway which is the smaller in width is finally formed (see FIG. 2). Accordingly, the process is free of the problem that the curved passageway portion will be ruptured by impact involved in inflation, and is also free of the problem of failure in inflating the curved passageway portion as designed because this portion is inflated finally.

Preferably, the difference between the width of the nonbonded portion to be made into the first shunt passageway and the width of the nonbonded portion to be made into the second shunt passageway is not smaller than 0.2 mm.

The present process is very effective in the case where a U-shaped passage or V-shaped passage is formed by a portion of the first shunt passageway proximate to the curved passageway, the curved passageway and a portion of the second shunt passageway proximate to the curved passageway.

Preferably, air having a pressure not lower than 80 kg/cm<sup>2</sup> to not higher than 130 kg/cm<sup>2</sup> is introduced into the nonbonded portions for inflation.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing an embodiment of roll-bonded panel obtained by the production process of the invention;

FIG. 2 is a fragmentary plan view showing how a workpiece is inflated into the roll-bonded panel according to the invention;

FIG. 3 is a plan view corresponding to FIG. 2 and showing how a conventional roll-bonded panel is formed; and

FIG. 4 is a perspective view showing another embodiment of roll-bonded panel obtained by the production process of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described below with reference to the drawings.

FIG. 1 shows a roll-bonded panel obtained by the production process of the invention. The roll-bonded panel 1 is produced by printing a pattern corresponding to a fluid circuit on one surface of one of a pair of upper and lower aluminum plates with a parting agent (bonding preventing agent), roll-bonding the aluminum plates with the other aluminum plate superposed on the printed surface, and thereafter inflating nonbonded portions to a tubular form with air of high pressure introduced into these portions. This embodiment has an inflated tube on one side thereof over the entire area. The upper aluminum plate only is inflated, and the lower aluminum plate is flat.

The fluid channel of the roll-bonded panel 1 comprises a main passage 3 and a shunt passage 2 having a smaller width than the main passage 3. The shunt passage 3 comprises first and second shunt passageways 4, 5 branching from the main passage 3 and parallel to each other, and a curved passageway 6 interconnecting the forward ends of these shunt passageways 4, 5. A U-shaped passage is formed by the portion 4a of the first shunt passageway 4 proximate to the curved passageway 6, the curved passageway 6 and the portion 6a of the second shunt passageway 5 proximate to the curved passageway 6.

The pattern of parting agent is so printed on the aluminum plate that the width W1 of the non-bonded portion to be made into the first shunt passageway 4 is smaller than the width W3 of the nonbonded portion to be made into the straight passage 3, and that the width W2 of the nonbonded portion to be made into the second shunt passageway 5 is smaller than the width W1 of the non-bonded portion to be made into the first shunt passageway 4. The pattern portion for forming the curved passageway 6 is so printed that this portion gradually increases in width from the second passageway 5 toward the first passageway 4. The difference between the width W1 of the first straight shunt passageway 4 and the width W2 of the second straight shunt passageway 5 is 0.3 mm.

When air with a pressure not lower than 80 kg/cm<sup>2</sup> to not higher than 130 kg/cm<sup>2</sup> is introduced into an outlet 7 of the circuit to form the roll-bonded panel 1 by inflation, the circuit is inflated from portion to portion in the order of decreasing width. In the portion of the hairpin shunt passage 2, the main passage 3 is formed first, and the first shunt passageway 4 is then formed. The second shunt passageway 5 is slightly smaller than the first shunt passageway 4 in width and is therefore formed later than the first passageway 4. After the first passageway 4 has been formed, accordingly, the curved passageway 6 is formed first, and the second passageway 5 is formed finally (see FIG. 2).

For comparison, FIG. 3 shows how a conventional example is formed by inflation wherein first and second two shunt passageways 24, 25 are equal in width. With the conventional panel, a main passage 23 is formed first, and the two shunt passageways 24, 25 are thereafter formed at the same time. A curved passageway 26 is formed finally with a portion of high-pressure air from the first passageway 24 and with a portion of high-pressure air from the second passageway 25. Consequently, the air portions collide with each other in the portion of curved passageway 26, which is lower than the portions of shunt passageways 24, 25 in pressure-resistant strength and therefore ruptures. The problem of rupture of the curved portion becomes more pronounced when the circuit can not be formed by inflation unless the air pressure is at least 100 kg/cm<sup>2</sup>.

With the embodiment shown in FIG. 2, the second shunt passageway 5 is formed eventually by inflation, so that collision of high-pressure air portions produces an impact in the second passageway 5, whereas the portion of the second passageway 5 is unlikely to rupture since the portions of passageways 4, 5 are sufficiently greater than the portion of curved passageway 6 in pressure-resistant strength.

FIG. 4 shows another embodiment of roll-bonded panel 11 obtained by the production process of the present invention. With reference to this drawing, the roll-bonded panel 11 has a fluid circuit which comprises a main passage 13 and a shunt passage 12 with a smaller width than the main passage 13. The shunt passage 12 comprises first and second shunt passageways 14, 15 branching from the main passage 12, and a curved passageway 16 interconnecting the forward ends of these shunt passageways 14, 15.

The second embodiment differs from the first with respect to the following. The first and second shunt passageways 14, 15 are not parallel to each other. A V-shaped passage is formed by the portion of the first passageway 14 proximate to the curved passageway 16, the curved passageway 16 and the portion of the second passageway 15 proximate to the curved portion 16. The first shunt passageway 14 is not straight and is held in communication with the main passage 13 by a straight passageway 14b connected to the passageway 14 approximately perpendicular thereto. As in the first embodiment, a pattern of parting agent is so printed in this case that the width W4 of the nonbonded portion to be made into the first shunt passageway 14 is smaller than the width W6 of the nonbonded portion to be made into the main passage 13, and that the width W5 of the non-bonded portion to be made into the second shunt passageway 15 is smaller than the width W4 of the non-bonded portion to be made into the first passageway 14. This eliminates the faults that would otherwise occur in the portion of curved passageway 16.

With the foregoing two embodiments, the portion of curved passageway 6 (16) can be effectively rendered free from faults if the difference between the width W1 (W4) of the first shunt passageway 4 (14) and the width

W2 (W5) of the second shunt passageway 5 (15) is not smaller than 0.2 mm. Preferably, the main passage 3 (13) is usually not smaller than 8 mm to not larger than 12 mm in width, and the second shunt passageway 5 (15), which has the smallest width, is not smaller than 4 mm 5 in width.

## Claims

1. A process for producing a roll-bonded panel 1, 11 10 having a fluid circuit by printing a pattern corresponding to the fluid circuit on one surface of one of a pair of aluminum plates with a parting agent, roll-bonding the aluminum plates with the other aluminum plate superposed on the printed surface, and 15 thereafter inflating nonbonded portions to a tubular form with a fluid pressure, the fluid circuit including a main passage 3, 13 and at least one shunt passage 2, 12 smaller than the main passage 3, 13 in width, the shunt passage 2, 12 comprising a first 20 shunt passageway 4, 14 branching from one portion of the main passage 3, 13, a second shunt passageway 5, 15 branching from another portion of the main passage 3, 13 and a curved passageway 6, 16 provided between the two shunt passageways 4, 5 and 14, 15, the process being characterized in that the 25 width W1, W4 of the nonbonded portion to be made into the first shunt passageway 4, 14 is different from the width W2, W5 of the nonbonded portion to be made into the second shunt passageway 5, 15. 30
2. A production process as defined in claim 1 wherein the difference between the width W1, W4 of the nonbonded portion to be made into the first shunt passageway 4, 14 and the width W2, W5 of the 35 nonbonded portion to be made into the second shunt passageway 5, 15 is not smaller than 0.2 mm.
3. A production process as defined in claim 1 wherein a U-shaped passage is formed by a portion 4a of the 40 first shunt passageway 4 proximate to the curved passageway 6, the curved passageway 6 and a portion 5a of the second shunt passageway 5 proximate to the curved passageway 6. 45
4. A production process as defined in claim 1 wherein a V-shaped passage is formed by a portion 14a of the first shunt passageway 14 proximate to the curved passageway 16, the curved passageway 16 50 and a portion 15a of the second shunt passageway 15 proximate to the curved passageway 16.
5. A production process as defined in claim 1 wherein air having a pressure not lower than 80 kg/cm<sup>2</sup> to not higher than 130 kg/cm<sup>2</sup> is introduced into the 55 nonbonded portions for inflation.

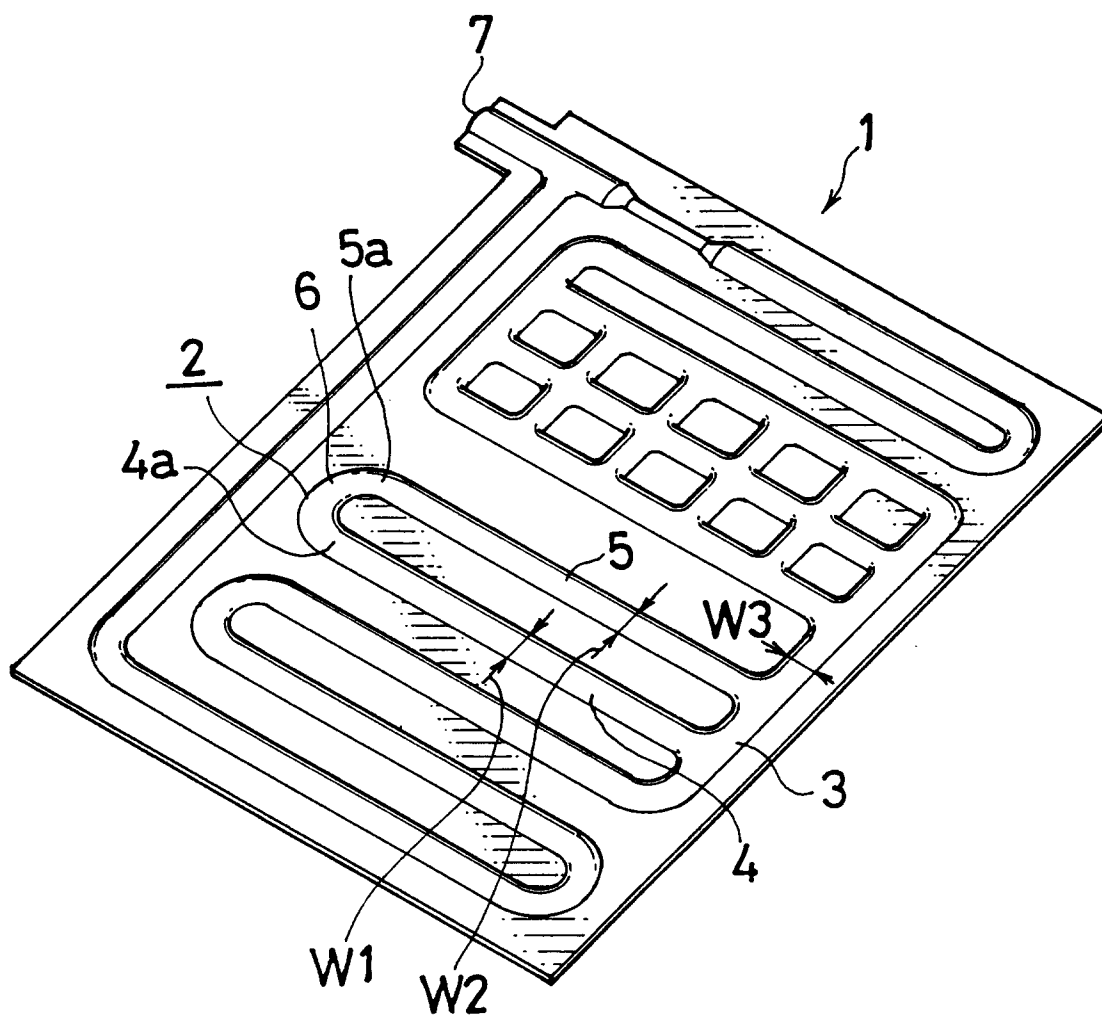


FIG. 1

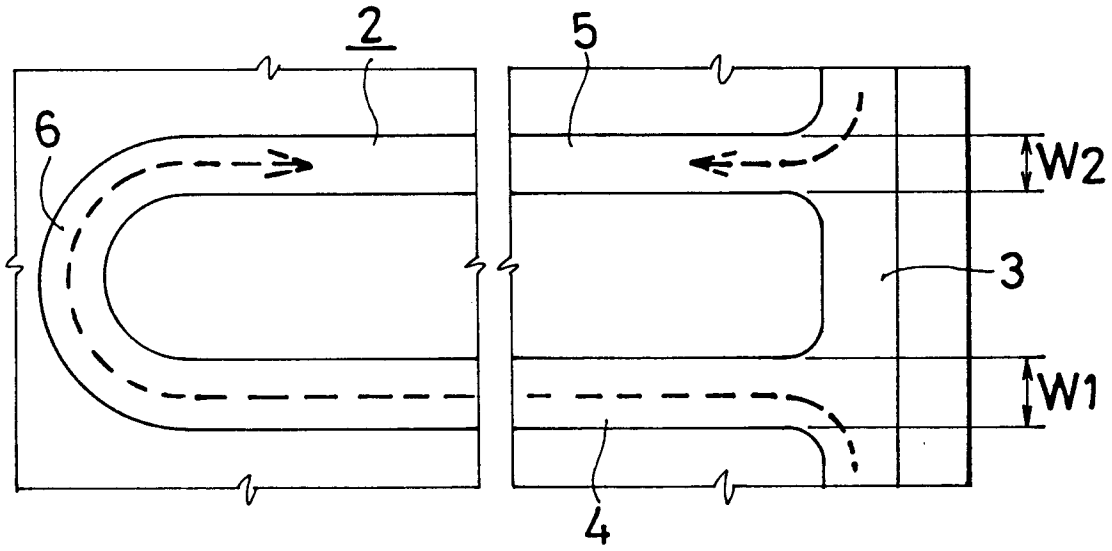


FIG. 2

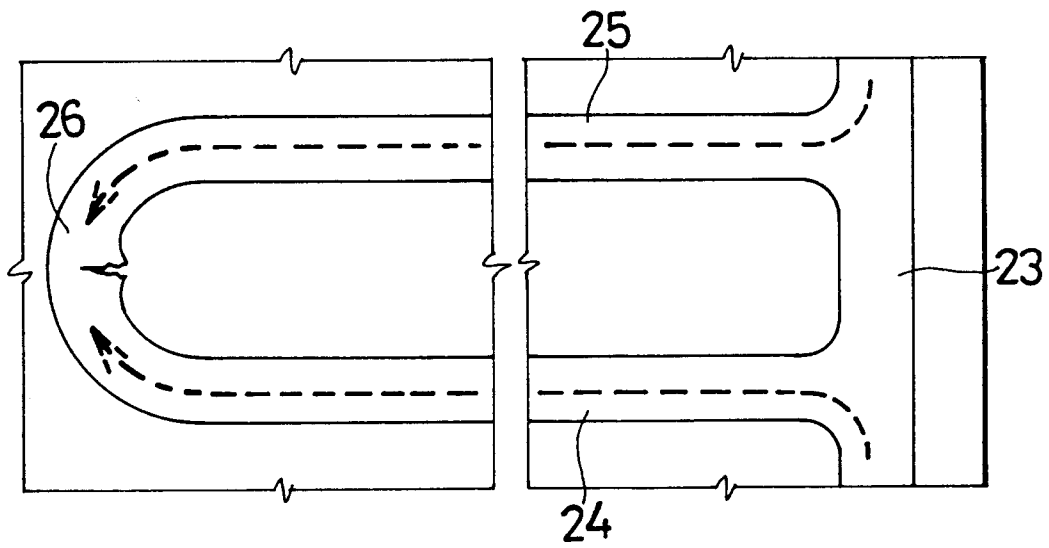


FIG. 3

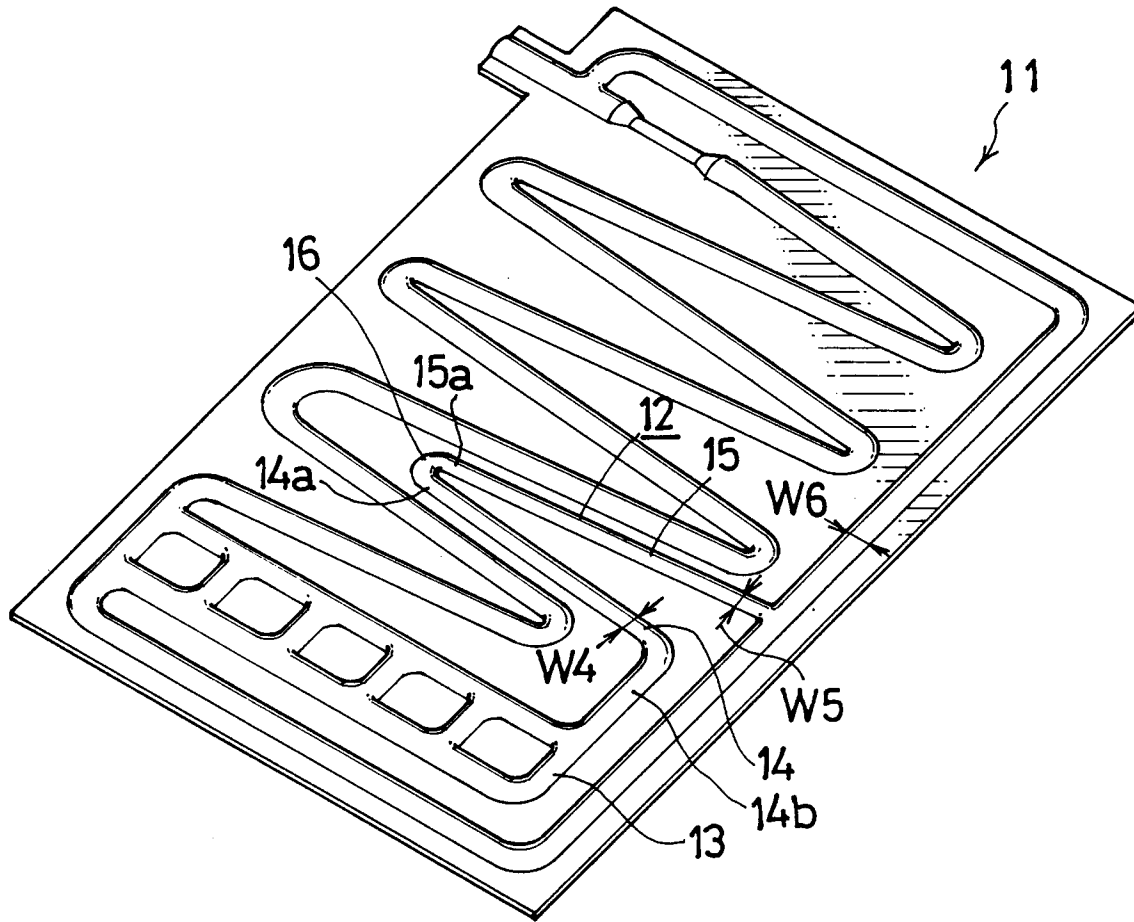


FIG. 4



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# EUROPEAN SEARCH REPORT

Application Number  
EP 94 11 4865

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | DE-A-34 43 797 (CEGEDUR)<br>* page 1, line 6 - page 5, line 19; figure 1 *                                                                | 1                                                    | F28F3/14<br>B21D53/04                        |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | US-A-2 874 942 (RIEPEL ET AL)<br>* column 3, line 6 - column 4, line 25; figures 1-7 *                                                    | 1                                                    |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | PATENT ABSTRACTS OF JAPAN<br>vol. 13, no. 305 (M-849) 13 July 1989<br>& JP-A-01 095 826 (SHOWA ALUM. CORP.) 13 April 1989<br>* abstract * | 1                                                    |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | US-A-3 334 398 (MIDDLETON)                                                                                                                |                                                      |                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                           |                                                      | TECHNICAL FIELDS SEARCHED (Int.Cl.6)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                           |                                                      | F28F<br>B21D<br>F24J                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                           |                                                      |                                              |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                           | Date of completion of the search<br>21 February 1995 | Examiner<br>Beltzung, F                      |
| <p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                           |                                                      |                                              |

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