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D E C I S I O N
of 5 February 2003

Case Number: T 0782/02 - 3.2.3

Application Number: 96932904.4

Publication Number: 0852693

IPC: F28D 9/00, F28F 3/08, 9/02

Language of the proceedings: EN

Title of invention:
Plate heat exchanger

Patentee:
ALFA LAVAL AB

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - after amendment (yes)"

Decisions cited:
-

Catchword:
-



Case Number: T 0782/02 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 5 February 2003

Appellant: ALFA LAVAL AB
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Representative: Stefan Berglund
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 13 June 2001
refusing European patent application
No. 96 932 904.4 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: C. T. Wilson
Members: U. Krause
J. P. B. Seitz

Summary of Facts and Submissions

I. The appeal contests the decision of the examination division, dated 21 May 2001 and posted on 13 June 2001, to refuse European patent application Nr. 96 932 904.4, filed as International application Nr. PCT/SE96/01 192 and published as WO 97/12 189, for lack of inventive step in view of the following documents:

D1: JP-A-62 062 187

D3: SE-B-343 383

D4: SU-A-1 035 399

II. The Appellant (Applicant) filed the notice of appeal on 10 August 2001 and paid the appeal fee on the same day. The statement of the grounds of appeal, including an amended set of claims 1 to 17, was submitted on 12 October 2001.

The amended independent claim 1 has the following wording:

"1. A plate heat exchanger (1) comprising a stack of heat transfer plates (2) provided between two end pieces (3,4) and each having an essentially plane extension, each end piece (3,4) having an inner surface facing said heat transfer plates (2) and an outer surface (10,14,22) facing away from said heat transfer plates (2) and extending from one side to another of the end piece (3,4), the plate heat exchanger (1) being compressed by means of at least one member (11,18,24) extending around the end pieces and the heat transfer plates in such a

manner that said member abuts said outer surface (10,14,22) of each end piece (3,4) in order to prevent the retreat of the end pieces from each other, characterized in that said outer surface (10,14,22) of each end piece (3,4) is continuously curved from said one side to another in such a manner that the end piece has a convex shape in a cross-section along a first plane (Y,Z) crossing said sides and being perpendicular to the essentially plane extension of the heat transfer plates (2), and that the curved outer surface (10,14,22) in the proximity of an edge between said inner surface (9) and said outer surface (10,14,22) is shaped in such a manner that a tangential plane (X,Y) of said outer surface is essentially perpendicular to the essentially plane extension of the heat transfer plate (2)."

III. With communication of 24 September 2002 the Board informed the Appellant that the amended claims were considered to meet the requirement of inventive step but that further defects in the application required clarification.

On 21 January 2003 the Appellant filed amended claims 11 to 17 and amended description pages 3 and 4.

IV. Consequently, the request of the Appellant to set aside the decision under appeal and to grant a patent is based on the following documents:

Claims: 1 to 10 filed on 12 October 2001 and
 11 to 17 filed on 21 January 2003;

Description: pages 1,2, 5 to 7 and 9 to 12 as

published, pages 3,4 filed on 21 January 2003 and page 8 filed on 18 October 2000;

Figures: sheets 1/5 to 5/5 as published.

V. The arguments of the Appellant can be summarized as follows:

The aim of reducing the stresses in the end pieces and in the compressing members was achieved by the continuous curvature of the outer surface of the end pieces from the edge between the inner and outer surface, as defined in amended claim 1, which provided a continuous contact between the end pieces and the compressing members and avoided any sharp bend in the compressing members which are, therefore, subject to uniformly distributed pulling forces only.

In D1, the sharp bends at the side edges of the end pieces and at the ribs resulted in significant bending stresses in the compressing member. D3 was concerned with the problem of achieving a uniform distribution of the compressing forces across the plates by providing convex outer end pieces for uniformly supporting the end plates. The compressing forces were taken up by tie bolts and the end pieces, having flanges for receiving the tie bolts, were neither designed nor intended to receive any external forces applied by a compressing member wound there around. D4 showed a convex shape of one of the pressing plates only for increasing the rigidity and was entirely silent about the type of compressing member to be used.

Reasons for the Decision

1. The appeal meets the provisions mentioned in Rule 65(1) EPC and is, therefore, admissible.
2. The amended claim 1 on file is, in substance, a combination of claims 1 and 2 underlying the decision under appeal, corresponding to a combination of original claims 1 to 3. The dependent claims 2 to 17 correspond to original claims 4 to 19, with minor clarifications in claims 11 and 15. The description pages 3 and 4 were amended to conform to the invention defined in amended claim 1. Thus, the application as on file meets the requirements of Article 123(2) EPC.
3. Novelty of the claimed subject-matter was acknowledged in the decision under appeal. Considering the amended claim 1 in the light of the available documents the Board is satisfied that the invention defined in claim 1 does not form part of the state of the art, thereby meeting the requirement of novelty.
4. The precharacterising portion of claim 1 is based on a plate heat exchanger as disclosed in document D1. The compressing member employed in this prior art for holding the plate heat exchanger together is formed by a "belt-type thin sheet" (10) tightly wound around the outer periphery of end pieces (4,14) formed of flat plates (4) extending parallel to the heat transfer plates (2) and upstanding ribs (14) of different heights extending in a direction perpendicular to the plates (4) on the side opposite to the heat transfer plates. The tightened sheet (10) bends not only at the side edges of the plates (4) but also at the points of contact with the ribs, exerting a force through the

ribs onto the plates (4) to thereby obtain a more uniform distribution of the load on the plates, as compared with an end piece having no ribs or being clamped by lateral tie bars.

5. The subject-matter of claim 1 is distinguished from this prior art by the features defined in the characterising portion. Instead of having multiple ribs as in D1, the outer surface of the end pieces is convex with a continuous curvature from one side to the other, the sides of the outer surface being perpendicular to the extension of the inner surface and of the heat transfer plates in the proximity of an edge between the inner surface and the outer surface. A compressing member abutting the outer surface of the end pieces will not have to undergo any sharp bending as at the side edges and ribs in D1, but will smoothly fit the continuously curved shape of the end pieces with a gradual change of direction from one perpendicular to the inner surface on one side of the end pieces around the end piece to a perpendicular orientation at the other side. Thus, the claimed shape of the end pieces reduces not only any bending stresses in the end pieces and, as a consequence, any non-uniformity of the compressing load on the heat exchange plates, but also the stresses in the compressing member by eliminating bending stresses therein and subjecting the compressing members solely to lengthwise acting pulling forces.

6. With regard to the issue of inventive step it will therefore have to be determined whether it was obvious to replace the arrangement of the plates and ribs disclosed in D1 by the continuously curved end pieces as claimed in claim 1 in order to reduce the stresses not only in the end pieces but also in the compressing

members.

7. In the decision under appeal it was held that the skilled person in the field of pressure vessels would use a curved outside surface to reduce bending stresses. This apparently applies to the bending stresses in dome-shaped end walls of pressure vessels having to resist a considerable internal pressure. The technical situation in a plate heat exchanger as shown in D1 is, however, different. Since, as in D1 and claim 1, the heat exchanger plates are typically flat, the end plates contacting the heat exchanger plates have to be flat as well and cannot be curved for better resistance to the compressing forces. Document D4 showing a partially convex end plate (2) on one side of the heat exchanger requires heat exchange plates having the same partially convex shape, which is incompatible with the heat exchanger of D1 and of claim 1 defining an essentially plane extension of the heat exchange plates and a continuous curvature of outer surface of the end plates. Stresses in the end plates can, therefore, be reduced essentially by improving the support of the end plates against the compressing forces. In D1, this support is provided by the surrounding belt or wire (10) through the ribs and it is, as far as this support is concerned, irrelevant whether the ribs abut the compressing member, i.e. the belt or wire, directly, as in D1, or through an additional convex or domed wall arranged between the ribs and the compressing member. The latter design is shown in Figure 1 of D3 where the compressing forces from the end plate (13) are transmitted through the shaded support blocks or a liquid filling to a dome-shaped end wall (10) having a continuously curved outer surface which corresponds, except for the flange on its

periphery, to that of the end piece defined in claim 1. In this case, however, the dome-shaped end wall (10) serves the purpose of receiving and further transmitting the compressing forces to the tie bolts (16) clamping the end pieces together. Such a transmission would not be required if, as in D1 and in the subject-matter of claim 1, the compressing member extended around the end pieces for directly taking up the compression forces. Thus, the skilled person who is aware of documents D3 and D4 and intends to reduce the stresses in the end pieces would not have any reason to modify the design shown in D1 by including a continuously curved convex portion of the end piece.

A reason for, nevertheless, incorporating an end piece having a continuously curved outer surface, as claimed in claim 1, in a heat exchanger comprising a compression member in the form of belt or wire extending around the end pieces, as in D1, could therefore be seen only in the positive effect of the resulting continuous curvature of the overlying compression member on the stresses in that member, rather than on the stresses in the end piece. Since an indication of this effect cannot be found in any of the available documents, the combination of end pieces with continuously curved outer surfaces and compression members extending around these end pieces would require further considerations of their own of a skilled person. The Board is convinced that such considerations are to be regarded as being beyond those normal or typical in the art.

8. Similar considerations apply when, as in the decision under appeal, starting from document D3 as closest prior art and asking the question of whether it is

obvious to replace the tie bolts by a compression member extending around the end pieces as an alternative means for clamping the end pieces together. Apart from the fact that this approach appears rather artificial and the replacement of the tie bolts would require further modifications such as removing the flange at the dome-shaped end piece (10) in D3, the presence and shape of this end piece is dictated, as set out above, by its function of transmitting the clamping force of the tie bolts (16) to the end plate (13), rendering this end piece meaningless if, as in the case of a compression member extending around the end pieces and directly engaging the outer surface thereof, there is no such transmission of forces.

9. Since the further prior art cited in the Search report is less relevant, the amended claim 1 and dependent claims 2 to 17 meet the requirement of inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of the following documents:

Claims: - 1 to 10 filed on 12 October 2001 with
 letter of 10 October 2001,
 - 11 to 17 filed on 21 January 2003 with
 letter of 21 January 2003;

Description:- pages 1,2, 5 to 7 and 9 to 12 as published,
- pages 3, 4 filed on 21 January 2003 with letter of 21 January 2003,
- page 8 filed on 18 October 2000 with letter of 17 October 2000;

Figures: sheets 1/5 to 5/5 as published.

The Registrar:

The Chairman:

A. Counillon

C. T. Wilson