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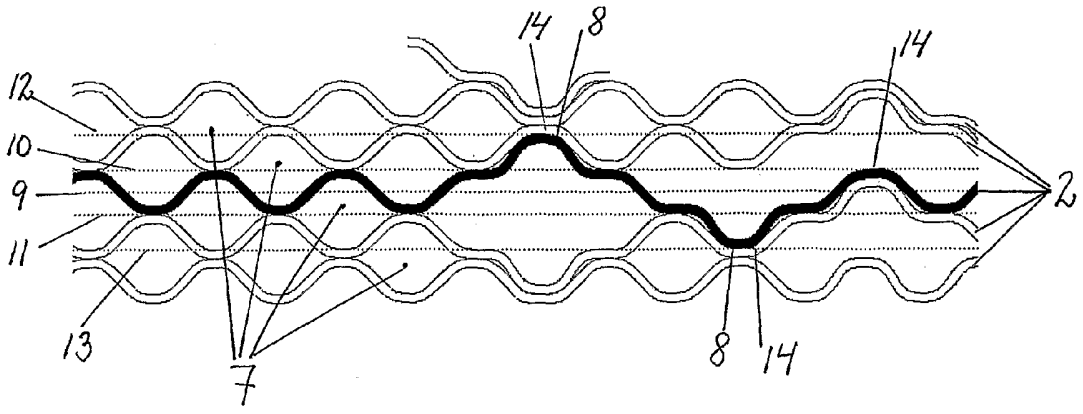
(54) **Title:** HEAT EXCHANGER



(57) **Abstract:** Heat transfer plate (2) with locating means (8) and adapted to being stacked in a plate stack, and a heat exchanger comprising said plates (2). The plate (2) comprises a patterned heat transfer surface, an edge portion, ports, locating means (8) and accommodating means (14). Locating means (8) in the form of nibs (8) is situated on the heat transfer surface of the plate. The nibs (8) are between two planes (10 and 12) situated above the heat transfer surface pattern. In the plate stack, between two mutually adjacent plates (2), the nibs (8) fit into accommodating means (14) on an adjacent plate (2), which accommodating means (14) are disposed in the latter's heat transfer surface. Two mutually adjacent plates (2) in the plate stack together comprise two nibs (8) and two accommodating means (14) which fit into one another and thereby fix the plates (2) relative to one another so that the plates cannot shear or rotate relative to one another. This means that plates (2) need not have any so-called locating flanges for positioning them in a plate stack.

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HEAT EXCHANGER

FIELD OF THE INVENTION

The present invention relates to a heat exchanger according to the preamble of claim 1.

Permanently connected heat exchangers are traditionally made up of a number of heat transfer plates forming a plate stack. The soldering process involves the plate stack being placed in a furnace whereby the solder connects the plates to one another. During the handling operations relating to the soldering it may easily happen that unflanged plates lying on one another become mutually displaced. To prevent this, it is usual for fixtures to be used during heat exchanger manufacture. A usual such means is that the plates are placed within so-called support pins which therefore prevent the plates from shifting sideways.

BACKGROUND TO THE INVENTION

Japanese patent specification JP 09-113170 refers to a heat transfer plate with locating means in the form of pressed ridges situated in its edge portion. During plate stacking, the locating means engages mechanically with the locating means of an adjacent plate, thereby preventing mutual displacement between the plates. The disadvantage of having locating means situated in edge portions is that the edges will be relatively large. As the edges constitute so-called dead surface (because no heat transfer takes place in the edge portion), it is desirable from the material point of view to be able to minimise the edges as much as possible. What determines the size of edges is their width, measured from the outer edge of the plate to the heat transfer surface. As the edge portion has to be soldered to the corresponding edge of an adjacent plate, the edge portion needs to be wide enough to be able to fulfil the tightness and

pressure requirements for the heat exchanger. With today's manufacturing and assembly technology, the edge width needs to be at least about 2 mm from the outer edge to the heat transfer surface.

A further disadvantage of the invention according to Japanese patent specification JP 09-113170 is that the locating means only prevents movement of the plates transversely to the direction of the edge portion. Two plates placed against one another are not prevented from moving in the direction of the plate longitudinally with the edge portions. The result during soldering of the plates is that the plates might shift in a longitudinal direction relative to one another, rendering the heat exchanger impossible to use.

SUMMARY OF THE INVENTION

A heat transfer plate with locating means comprises an edge portion which extends round the periphery of the plate, and a heat transfer surface which is surrounded by the edge portion. The heat transfer surface normally exhibits a pattern of crests and valleys. The crests and valleys are situated within a first (upper) plane and a second (lower) plane. The lateral mid-portion of the heat transfer surface is in a normal plane situated between the first and second planes. The heat transfer plate is stacked on top of a plate which is similar but oriented differently in a plate stack in a heat exchanger. Flow channels which accommodate different media are formed between the plates in the plate stack. During operation there is temperature exchange between the media in mutually adjacent channels.

An object of the present invention is to provide a heat transfer plate for a permanently connected heat exchanger comprising a unflanged plate stack which can be set up during manufacture without the plate stack having to be supported externally by walls or guiding elements to prevent mutual displacement of the stacked plates during handling relating to the soldering process.

An object of the present invention is to provide a heat transfer plate for a permanently connected heat exchanger comprising a unflanged plate stack whereby the plates in the plate stack cannot rotate relative to one another during the manufacturing process.

An object of the present invention is to provide a heat exchanger which is made up of heat transfer plates stacked on, and permanently connected to, one another.

A further object of the present invention is to provide a design which makes it possible to reduce the time required for making heat exchanger plate stacks so that the manufacturing process will be quick and cost-effective.

The aforesaid and other objects are achieved according to the invention by the heat transfer plate described in the introduction being provided with the characteristics indicated in claim 1.

An advantage afforded by a unflanged heat transfer plate with locating means according to the characterising part of claim 1 is that a number of plates can be stacked on top of one another to form a plate stack which does not need to be supported in lateral or longitudinal directions during soldering.

Another advantage is that since the edges comprise no locating means, the width and thickness of the edges can be minimised, with the result that less material need be used in manufacturing the plates.

A further advantage is that reduced width of the edges results in less solder consumption for joining together the edges of the plates than the case, for example, of traditional plates, since part of the width of the latter's edges is used to form an angled locating flange.

A further advantage is that there is no need for a locating flange round the periphery of a plate, since the function performed by the locating means on the unflanged plate corresponds to that of such a locating flange as regards the positioning of plates in a plate stack.

Preferred embodiments of a heat transfer plate according to the invention have the further characteristics indicated by subclaims 2 – 11.

According to an embodiment of a heat transfer plate according to the invention, a second locating means is disposed between the second plane of the heat transfer surface and a fourth plane placed laterally parallel below the second plane. The fact that a second locating means is disposed on the heat transfer surface makes the plate rotationally fixed so that mutual rotation between the plates is prevented. In contrast, with only one locating means between two plates, the plates might rotate about the locating means.

According to a further embodiment of a heat transfer plate according to the invention, a locating means is disposed on the heat transfer surface. With advantage, the locating means is placed on regions which are not subject to high pressure. The fact that the number of contact points is reduced locally in a region where the locating means is situated results in local weakening between mutually adjacent plates. With advantage, the locating means is therefore not situated in port regions where contact and solder points of mutually adjacent plates are subject to high pressure in the heat exchanger. Instead, the locating means is situated at a distance from the port regions on the heat transfer surface so that the total pressure resistance of the heat exchanger is not affected.

According to a further embodiment of a heat transfer plate according to the invention, the locating means on a first plate is adapted to fitting into a first accommodating device intended for the locating means and disposed on an adjacent second plate. At the same time, the second locating means on an

adjacent second plate is adapted to fitting into a second accommodating device intended for the locating means and disposed on the adjacent first plate in the plate stack, thereby fixing the plates relative to one another in their lateral directions. The fact that the locating means on each plate fits into accommodating devices of the adjacent plates results in the plates being firmly locked to one another, thereby countering both shear and rotation between the plates.

According to a further embodiment of a heat transfer plate according to the invention, the heat transfer plate is adjacent to a second heat transfer plate, with the result that they together comprise at least two locating means, thereby effectively counteracting rotation between two mutually adjacent plates through the fact that the two points fix the plates to one another.

According to a further embodiment of a heat transfer plate according to the invention, the locating means takes the form of nibs. In the preferred embodiment, nibs are used as locating means. Pressing the heat transfer surface results in the creation in it of small elevations and depressions to form nibs. The nibs are situated in the region between the first and third planes and in the region between the second and fourth planes. Using nibs as locating means minimises the amount of heat transfer surface which needs to be used for them. This is because it is desirable to have as large a heat transfer surface (with maximum heat transfer) as possible.

According to a further embodiment of a heat transfer plate according to the invention, the locating means takes the form of grooves. Providing locating means in the form of grooves makes it possible for a heat exchanger with such plates to be subject to high pressure. This is because the locating means also serves as stiffening elements of the heat exchanger. The heat exchanger will therefore be strong and can be subject to high pressure stresses.

According to a further embodiment of a heat transfer plate according to the invention, the locating means is situated on or in the immediate vicinity of the edge portion. Enlarging the edge locally in various portions of the edge region makes it possible for locating means to be situated on or in the immediate vicinity of the edge portion. Local enlargement of the region for the locating means is achieved by the edge in the region being widened so that a locating means can be situated there.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the device according to the invention are described in more detail below with reference to the attached schematic drawings, which depict only the items which are necessary for understanding the invention.

Fig. 1 depicts a plate stack for a heat exchanger.

Fig. 2 depicts a view of a heat transfer plate according to the invention.

Fig. 3 depicts from the side in cutaway view a number of heat transfer plates according to the invention in a plate stack.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION

Fig. 1 depicts a heat exchanger with a plate stack (1) comprising unflanged heat transfer plates stacked on top of one another. In the ensuing text, the expression "heat transfer plate" is synonymous with "plate". Fig. 2 depicts a plate (2). The plate comprises an edge portion (3) which extends round the periphery of the plate (2). A heat transfer surface (4) is situated within the edge portion (3). At each corner of the plate, a port (5a-d) is provided for inflow and outflow of medium. In the preferred embodiment, the heat transfer plate has a pattern (6) for optimising the heat transfer in the heat exchanger. The pattern (6) comprises crests and valleys, which on mutually adjacent plates abut against one another locally so as to constitute contact points which in a known manner are used for connecting the plates to one another during the soldering together of the heat exchanger. Flow channels (7, see Fig. 3) are formed between mutually adjacent plates (2) in a plate stack (1) comprising a number of plates (2) stacked on one another. Mutually adjacent flow channels (7) accommodate different media between which there is temperature exchange through the heat transfer surfaces (4) of the plates.

The plate according to Fig. 2 has on the heat transfer surface a number of nibs (8a-d). The function of the nibs (8a-d) is to fit into accommodating means of an adjacent plate (2) in order thereby to prevent the plates (2) from being able to move laterally relative to one another. Plates bearing accommodating means have the latter in positions on the plate which correspond to the nibs (8a-d). This is not depicted in the drawing.

Fig. 3 shows how the plates (2) with nibs (8) are fixed to one another in a plate stack (1). The heat transfer surface of a first plate (2a) comprises a normal plane (9) situated in the lateral "mid-plane" of the plate. Above the normal plane (9) there is a first plane (10). Below the normal plane (9) there is a second plane (11). The heat transfer surface (4) with its crests and valleys is

disposed between the first plane (10) and the second plane (11). Above the first plane (10) there is a third plane (12). Below the second plane (11) there is a fourth plane (13). All the planes (9-13) are parallel to one another. In order to make it clear in the drawing how the planes relate to a plate, the plate with the relating planes described is drawn black in the diagram. Nibs (8) are disposed in the region between the first plane (10) and the third plane (12). Nibs (8) are disposed correspondingly in the region between the second plane (11) and the fourth plane (13). Accommodating means (14) are disposed in the region between the first and second planes (10 and 11). The accommodating means (14) are adapted to accommodating the nibs (8) on an adjacent plate (2) and thereby positively fixing the plates (2) in a lateral plane relative to one another.

The plates (2) in the plate stack (1, see Fig. 1) are stacked on one another by every second plate being turned 180°. This means that the first plane (10) of each plate (2) abuts against the first plane (10) of an adjacent plate. The second plane (11) of each plate (2) correspondingly abuts against the second plane (11) of an adjacent plate (2).

In the preferred embodiment according to the invention, a first plate and a fourth plate (2a, d, see Fig. 1) have a nib (8) situated on the heat transfer surface (4, see Fig. 2) in the region between the second plane (11) and the fourth plane (13). Three accommodating means (14) are disposed in the region between the first plane (10) and the second plane (11). This is not depicted in the drawing. Two of the accommodating means (14) open towards the first plane (10) and the third opens towards the second plane (11).

In the preferred embodiment according to the invention, a second plate and a third plate (2b, c, see Fig. 1) have two nibs (8) situated in the region between the first plane (10) and the third plane (12). One nib (8) is situated in the region between the second plane (11) and the fourth plane (13). One accommodating means (14) is disposed between the first plane (10) and the second plane (11) and opens towards the second plane (11).

The second plate (2b, see Fig. 1) is placed on the first plate (2a, see Fig. 1) in such a way that the first planes (10) on the respective plates (2a, b) abut against one another. The two nibs (8) in the region of the second plate (2b) between the first and third planes (10, 12) fit into accommodating means (14) of the first plate (2a) which are situated between the first and second planes (10, 11) and open towards the first plane (10). This is not depicted in the drawing.

The third plate (2c, see Fig. 1) is placed on the second plate (2b, see Fig. 1) in such a way that the second planes (11) on the respective plates (2b, c) abut against one another. The nib (8) on the second plate (2b), situated in the region between the second and fourth planes (11, 13), fits into the accommodating means (14) on the third plate (2c), which opens towards the second plane. At the same time, the nib (8) on the third plate (2c), situated in the region between the second and fourth planes (11, 13), fits into the accommodating means (14) on the second plate (2b), which opens towards the second plane. This is not depicted in the drawing.

The fourth plate (2d, see Fig. 1) is placed on the third plate (2c, see Fig. 1) in such a way that the first planes (10) on the respective plates (2c, d) abut against one another. The two nibs (8) in the region of the third plate (2c) between the first and third planes (10, 12) fit into accommodating means (14) of the fourth plate (2d) which are situated between the first and second planes (10, 11) and open towards the first plane (10). This is not depicted in the drawing.

The first plate (2a, see Fig. 1) is placed on the fourth plate (2d, see Fig. 1) in such a way that the second planes (11) on the respective plates (2d, a) abut against one another. The nib (8) on the fourth plate (2d), situated in the region between the second and fourth planes (11, 13), fits into the accommodating means (14) on the first plate (2a), which opens towards the second plane. At the same time, the nib (8) on the first plate (2a), situated in the region between

the second and fourth planes (11, 13), fits into the accommodating means (14) on the fourth plate (2d), which opens towards the second plane.

When the nibs (8) and accommodating means (14) fit into one another, the plates (2) are fixed relative to one another in their lateral plane. Fixing by at least two points between adjacent plates (2) also prevents the plates (2) from rotating relative to one another.

With locating means according to the preferred embodiment, there is no need for any fixture to support the plate stack (1) during soldering in order to counteract shifting between the plates (2). This is because the plates (2) are prevented from moving laterally by locating means (8) and accommodating means (14) on the plates.

When the plates (2) are stacked and locating means (8) have fitted in accommodating means (14), it is advantageous if a weight is rested on the plate package (1) during the soldering (this is not depicted in the drawing). This is because intermediate solder might make the plate package (1) slightly unstable. As there is solder between the respective plates (2), a weight will counteract the occurrence of regions where the plates (2) are not soldered to one another, because of the plates (2) being, for example, slightly curved.

An alternative embodiment according to the invention is that the locating means, instead of nibs, takes the form of beams or they have the shape of an X, Y, Z or some other configuration which prevents movement in the lateral plane between two plates. The advantage of such alternative locating means is that only one locating means will be needed for fixing the plates relative to one another. The disadvantage is that such locating means needs to be made larger than a nib. The surface available for heat transfer will thus be smaller, resulting in inferior heat transfer capacity.

The invention is not limited to the embodiment referred to but may be varied and modified within the scope of the ensuing claims, which have been partly described above.

CLAIMS

1. A heat transfer plate (2) with locating means (8) and adapted to being stacked in a permanently connected plate stack (1), which heat transfer plate (2) comprises an edge portion (3) extending round the periphery of the plate (2), and a heat transfer surface (4) situated within the periphery of the plate (2), which heat transfer surface (4) preferably exhibits a pattern (6) of crests and valleys, and the heat transfer surface (4) is within a first (upper) plane (10) and a second (lower) plane (11) which are laterally parallel with a normal plane (9) of the heat transfer plate (2),

   characterised

   in that the locating means (8) is disposed between the first plane (10) of the heat transfer surface (4) and a third plane (12) which is situated laterally parallel above the first plane (10).

2. A heat transfer plate (2) according to claim 1, ***characterised*** in that a second locating means (8) is disposed between the second plane (11) of the heat transfer surface (4) and a fourth plane (13) which is situated laterally parallel below the second plane (11).

3. A heat transfer plate (2) according to claim 1, ***characterised*** in that a locating means (8) is disposed on the heat transfer surface (4).

4. A heat transfer plate (2) according to claim 2, ***characterised*** in that the locating means (8) on a first plate (2a) is adapted to fitting into a first accommodating device (14) intended for the locating means (8) and disposed on an adjacent second plate (2b).

5. A heat transfer plate (2) according to claim 2, ***characterised*** in that the second locating means (8) on a second plate (2b) is adapted to fitting

into a second accommodating device (14) intended for the locating means (8) and disposed on an adjacent first plate (2a) in the plate stack (1), with the result that the plates (2) are fixed relative to one another in lateral directions.

6. A heat transfer plate (2) according to claim 1, ***characterised*** in that heat transfer plate 2 is adjacent to a second heat transfer plate (2b), with the result that they together comprise at least two locating means (8).

7. A heat transfer plate (2) according to claim 1, ***characterised*** in that the locating means (8) takes the form of nibs.

8. A heat transfer plate (2) according to claim 1, ***characterised*** in that the locating means (8) takes the form of grooves.

9. A heat transfer plate (2) according to claim 1, ***characterised*** in that the locating means (8) is situated in the immediate vicinity of the edge portion (3).

10. A heat transfer plate (2) according to claim 1, ***characterised*** in that the locating means (8) is situated on the edge portion (3).

11. A heat exchanger comprising a plate stack (1) composed of heat transfer plates (2) according to any one of the foregoing claims, which heat transfer plates (2) are permanently connected to one another.

Fig. 1

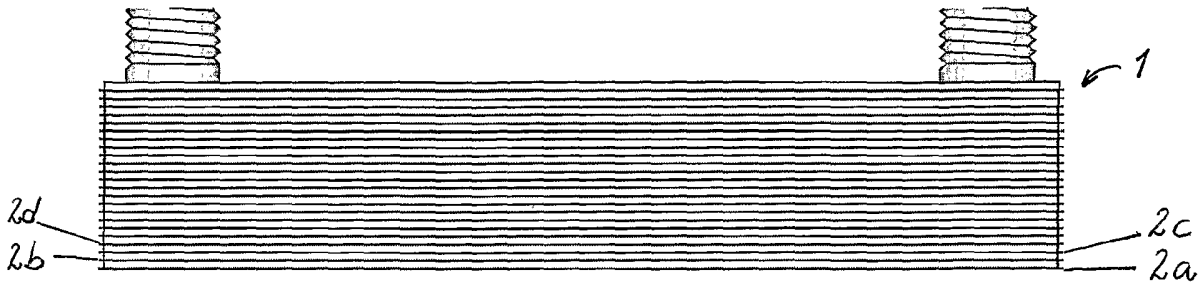


Fig. 2

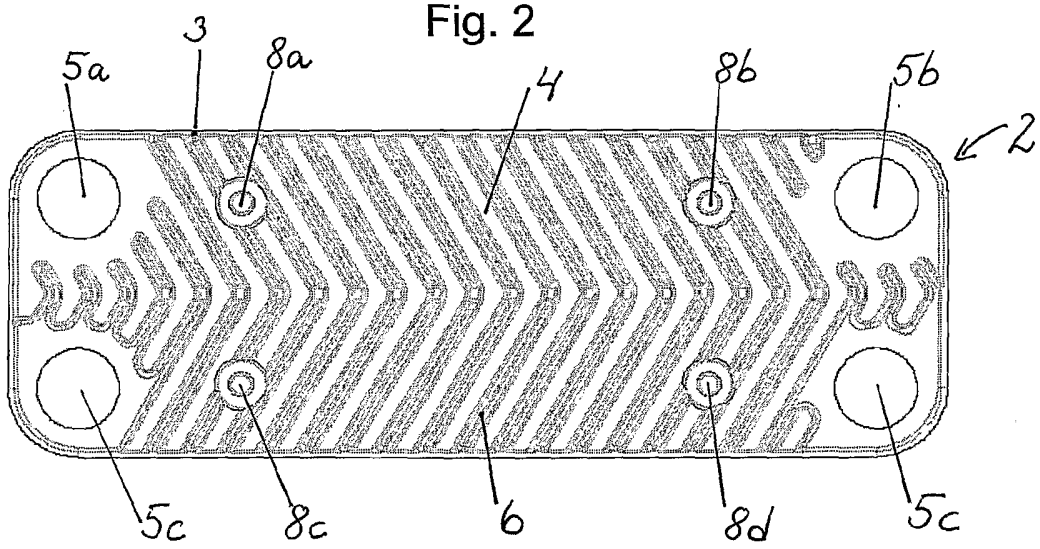
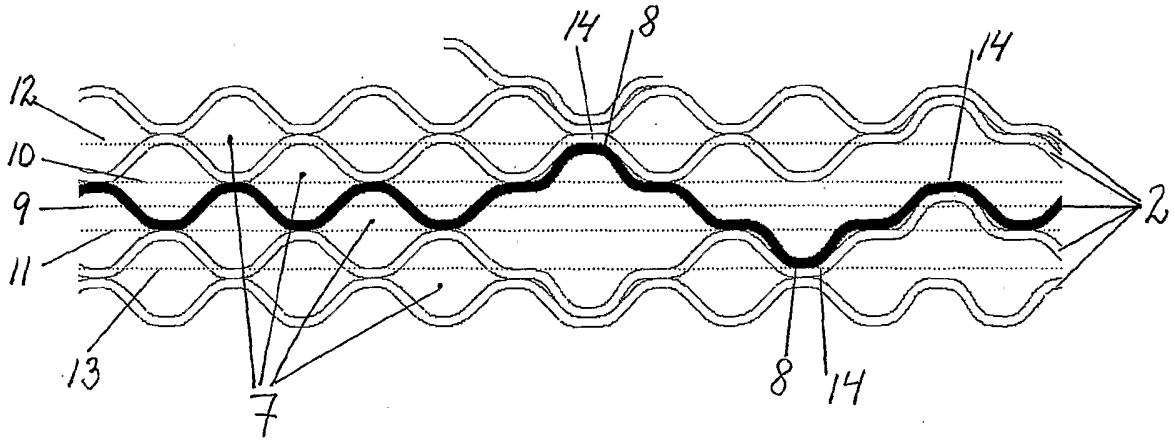


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/000160

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F28D, F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 1606643 A (N. KRAMER ET AL), 9 November 1926 (09.11.1926), figures --	1-3,6,7,11
A	DE 1003773 A (W. SCHMIDT), 28 April 1954 (28.04.1954), figure 3 --	5
X	US 5918664 A (EIICHI TORIGOE), 6 July 1999 (06.07.1999), detail (47a) --	1,11

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

International application No.
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International patent classification (IPC)

F28F 3/08 (2006.01)
F28D 9/00 (2006.01)

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Cited literature, if any, will be enclosed in paper form.

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