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(54) Glued heat exchanger

(57) The invention relates to plate heat exchangers. These consist of a plurality of heat exchanger plates (7), which are joined two by two alternately at two opposite edges (8), thus producing a primary flow duct system (A) and a secondary flow duct system (B), of end faces (2) equipped with edge flanges (12) parallel to the heat exchanger plates and of corner mouldings (3) equipped with edge folds (13a, 13b) extending between the end faces on top of the corner stack formed by the mutually

transverse joint edges (8) of the heat exchanger plates. Each of these corner mouldings (3) is fixed at its ends to the respective end face with an L-shaped corner block (4; 14), whose first branch (15a) is parallel to the end face and whose second branch (15b) is parallel to the corner moulding. The corner block is fixed both to the end face and to the corner moulding with adhesive layers.

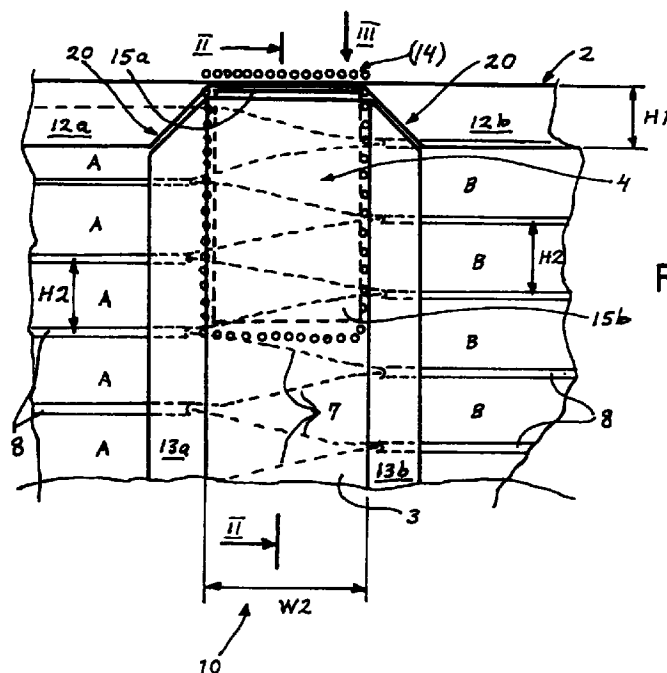


Fig. 1

Description

[0001] The invention relates to a plate heat exchanger comprising: a plurality of essentially parallel heat exchanger plates, which are joined two by two alternately at two opposite edges, thus producing a primary flow duct system and a secondary flow duct system, the flowing directions being transverse to each other; end faces equipped with edge flanges parallel to the heat exchanger plates; and corner mouldings equipped with longitudinal edge folds extending between the end faces on top of the corner stack formed by the mutually transverse joint edges of the heat exchanger plates.

[0002] Plate heat exchangers of the type described above are commonly used for heat transfer from a first typically gaseous stream to a second typically gaseous stream, these streams being transverse and usually perpendicular to each other. Such a plate heat exchanger is formed by joining two parallel plates at two opposite edges so as to form a stream duct parallel to the joint edges between the plates. The third parallel plate on top of this is connected to the uppermost of the two plates just mentioned, however, at two other opposite edges of these, which are perpendicular to the edges first mentioned. The heat exchanger plates are further joined in this manner, two by two alternately at edges typically perpendicular to each other. In this manner, a plurality of flow ducts is produced, in which every second is parallel and perpendicular to every second interposed flow duct. The description above merely concerns the principle of the heat exchanger, whereas in practice, the apparatus may be assembled in any manner. Such heat exchangers have been depicted in CH patent specification 588 672, CH patent specification 598 559, US patent specification 4 140 177 and EP patent specification 0 443 299.

In such a plate heat exchanger the corner stacks perpendicular to the heat exchanger plates, i.e. the edges, must be sealed, and the entire stack of heat exchanger plates must be retained in a direction perpendicular to the plates. Usually the corner stacks or edges are sealed with corner mouldings parallel to them, and the heat exchanger is kept together by providing end faces almost parallel to the heat exchanger plates and bolts between the end faces extending through the entire thickness of the heat exchanger plates. Such a structure requires support blocks at the bolts between the heat exchanger plates, as described in US patent specification 4 140 177 and EP patent specification 0 443 299. Such a design is expensive, due both to material costs incurred by the great number of necessary components and to the vast proportion of assembling work.

[0003] CH patent specification 598 559 describes a more straightforward design of a plate heat exchanger, in which the end faces are equipped with edge flanges facing away from each other and corner mouldings extending between the end faces. The longitudinal edges of these corner mouldings are bent outwards

from the heat exchanger to form a triangular outer cross-sectional surface and the ends of the corner mouldings are bent to form triangular ends perpendicular to the moulding length, these ends being fixed to the end plates of the heat exchanger by rivets or screws. Such a design is appreciably more straightforward and requires less components than other known ways of assembling plate heat exchangers. Yet this design also involves obvious drawbacks. First, the sealing provided by the corner mouldings at the corner stack formed by the different edges of the heat exchanger plates in their intersecting area is doubtful, because the corner moulding extends to cover the bevel alone between the joint edges of the heat exchanger plates. Similarly, the reliability of the separation of the mutually transverse flow ducts near the end faces is doubtful, because in this construction, the gap between the end plate and the consecutive heat exchanger plate is connected both with the primary flow and the secondary flow. A third drawback is the mechanical working required by the rivet or screw joint and the price-raising effect of the high proportion of labour.

[0004] Thus, the purpose of the invention is to provide a plate heat exchanger whose assembly can be accomplished with a minimum of labour and which does not require any, or a minimum, of mechanical working. The intention is to provide a way of assembling the apparatus which is suitable for serial production and can be automated. The second goal of the invention is such a plate heat exchanger whose primary flow duct system and secondary flow duct system can be separated at all points by simple means in a satisfactory and reliable manner.

[0005] The drawbacks described above are eliminated and the purposes defined above are accomplished with a heat exchanger in accordance with the invention, which is characterised by the features defined in the characterising clause of claim 1.

[0006] The chief advantage of the invention is that using its design, the assembly of the heat exchanger will be rapid and simple, thus reducing production costs. Also, the components used have a straightforward design, further ensuring low production costs. What is more, the design of the invention enables cross gas flows to be kept apart in a reliable and simple manner.

[0007] The invention will be described in greater detail below with reference to the accompanying drawings.

Figure 1 shows the corner joint used in the heat exchanger assembly of the invention, viewed in the direction of the plane of the heat exchanger plates and perpendicular to the length of the corner stack formed by these, i.e. the edge, from direction I in figures 2 and 3. The first embodiment of the corner block in accordance with the invention is shown with a full line and the second alternative embodiment with a dotted line.

Figure 2 shows a longitudinal section of the joint of figure 1 along plane II-II in figures 1 and 3, which is parallel to the corner stack, i.e. the edge.

Figure 3 shows the joint of figures 1 and 2 from direction III, which is perpendicular to the plane of the heat exchanger plates.

[0008] The actual heat exchanger portion consists of a plurality of principally parallel heat exchanger plates 7 known *per se* as described above, the opposite edges 8 of two adjacent plates respectively being interconnected such that in consecutive pairs of plates interconnected edges 8 are typically perpendicular to each other, as understood from figure 1. In this manner, a primary flow duct system A and a secondary flow duct system B are produced, in which the individual ducts are alternately positioned and are separated by one heat exchanger plate 7 respectively. In these primary flow duct systems and secondary flow duct systems, flow directions Fa and Fb are transverse and generally perpendicular to each other, as indicated in figure 3. The edges 8 of heat exchanger plates 7 can be joined in any adequate manner, for instance by bending or welding.

[0009] In addition, the plate heat exchanger comprises end faces 2 substantially parallel to the heat exchanger plates 7 at either end of the stack of heat exchanger plates and flow duct systems A, B, only one of the end faces being illustrated in the figures, however, it is understood that an exactly corresponding end face 2 is provided mirror-like symmetrically at the other end of the heat exchanger. These end faces 2 are equipped with edge flanges 12a-12d typically perpendicular to the end plane, the outer shape of the end face then matching the outer shape of the heat exchanger plates in the situation where the edges of the heat exchanger plates are joined. The edge flanges 12a-d stiffen the end faces among other things.

[0010] Corner mouldings 3 fixed to end faces 2 extend between these end faces 2, i.e. from one end to the other. A typical plate heat exchanger includes four such corner mouldings 3, which are placed at the edges of the heat exchanger plates, i.e. at the corner stacks 10, where the different joined edges of the heat exchanger plates are reversed, as is understood from figures 1 and 3. At these corner stacks 10 there is usually a bevelled portion 16, which forms an angle with both the edges 8 of the heat exchanger plates extending from here. The central normal of this bevelled portion 16 typically bisects the angle formed between the mutually transverse edges 8 of the heat exchanger plates. This bevelled portion 16 provides the necessary bending of the heat exchanger plates, e.g. from the plane formed by one edge of primary flow duct A to the plane formed by one edge of secondary flow duct B, and each consecutive heat exchanger plate from this point to the plane forming the other side of the primary flow duct. This is for instance indicated in figure 1 with width W2. Conse-

quently, a corner stack perpendicular to the plane of the heat exchanger plates is formed, with a bevel portion 16 parallel to the heat exchanger plates, which is covered with corner mouldings 3 interconnecting opposite end faces 2.

[0011] In accordance with the invention, each corner moulding 3 is fixed at either end to the corresponding end face 2 with an L-shaped corner block 4 or 14, whose first branch 15a is placed parallel to the respective end face 2 and second branch 15b parallel to the respective corner moulding. This corner block is fixed with adhesive layers 5a and 5b both to end face 2 and 3, thus providing a very solid heat exchanger. The first branch 15a of this L-shaped corner block 4 may be placed against the inner surface of end face 2 and the second branch 15b against the inner surface of corner moulding 3, as indicated with a full line in figures 1 to 3. In this way, adhesive layers 5a and 5b will be located between the outer surface of such a corner block 4 and the end face and the inner surface of the corner moulding respectively. Alternatively, both the first branch 15a and the second branch 15b of this L-shaped corner block 14 may be placed against the outer surface of end face 2 and corner mouldings 3 against the outer surface respectively, as indicated with a dotted line in figures 1 and 2. In this case, adhesive layers 5a, 5b are located between the inner side of such a corner block 14 and the outer surface of the end face and the outer surface of the corner moulding, as is understood. However, there are no obstacles to disposing the first branch either against the inner or the outer surface of the end face and the second branch 15b similarly against the inner or outer surface of the corner moulding, which are embodiments not illustrated in the figures.

[0012] In the heat exchanger in accordance with the invention, edge flanges 12a-12d of end faces 2 are relatively narrow, so that their width H1 in a direction perpendicular to the plane of heat exchanger plates 7 typically at the most equals the thickness H2 of the parallel thickness H2 of one flow duct A or B, as can be seen in figures 1 and 2. In addition, in accordance with the invention, edge flanges 12a-12d of opposite end faces in the heat exchanger are directed towards each other and extend on top of the edges 8 of heat exchanger plates 7 that are next to them, i.e. the outmost edges, so as to cover them. By these means, the flows in the different flow duct systems A, B are effectively prevented from admixing, while the flow resistance of the heat exchanger still does not increase significantly.

[0013] In accordance with the invention, the cross-section of corner moulding 3, i.e. a section almost parallel to the plane of the heat exchanger plates, has the shape of a truncated V, the width W2 of the truncated portion equalling the width of the bevelled portion 16. The width W1 of the L-shaped corner block 4 mounted inside corner moulding 3 is disposed to equal or be smaller than the width of the bevelled portion 16, and

thus to equal or be smaller than the width W2 of the truncated portion of the V-shape of the corner moulding. The width of the L-shaped corner block 14 mounted outside corner moulding 3 preferably equals the width W2 of the truncated portion of the V-shape, however, it may be smaller or greater than this. The widths of the branches 15a and 15b of the corner block 4, 14 can obviously be mutually equal or different. This allows corner block 4, 14 to be manufactured by means of one single rectangular fold from a strip or sheet material having an appropriate width W1. Edge folds 13a and 13b of corner moulding 3, which thus project from the edges of the truncated portion W2 of the V-shape and away from each other, thus generating said V-shape, form an angle with each other, which equals the angle between adjacent joint edges 8 of the heat exchanger plates. When these corner mouldings 3 in the shape of a truncated V are positioned on top of bevelled portions 16 and parallel to corner stack 10 such that the V-shape opens up inside the heat exchanger, edge folds 13a, 13b will slightly overlap joint edges 8, thus ensuring that there will be no leakage between flow duct system A and flow duct system B in the corner area of bevelled portions 16 and joint edges 8.

[0014] At corner stacks 10 fragments of edge flanges 12a-12d of end faces 2 facing each other have been cut off over a distance equalling bevelled portion 16, so that the ends of corner mouldings 3 extend all the way to the end face planes. On each side of the heat exchanger perpendicular to flow direction Fa and Fb edge flanges 12a-12d and edge folds 13a, 13b of the corner mouldings have been disposed substantially in the same plane by means of bevels 20 shown in the figures, so that the heat exchanger can be readily fitted into sealing position. Most preferably, corner mouldings 3 have been sealed to the not joined edges of heat exchanger plates 7 at bevelled portions 16 by means of an elastic tape 6, whose width equals the width W2 of the truncated portion of the V-shape of the corner moulding, and which has been applied on this truncated portion over its entire length. This eliminates any problems of dosing the sealing compound.

[0015] However, beside the gluing described above, there are no obstacles to joining the L-shaped corner block 4, 14 to end face 2 and/or corner moulding 3 for instance with pop rivets or screws if the heat exchanger structure has to withstand considerable forces. Also, the invention does not prevent the contact area between the corner moulding and the heat exchanger plates from being sealed with elastic paste instead of tape 6.

Claims

1. A plate heat exchanger comprising:

- a plurality of substantially parallel heat exchanger plates (7), which are joined two by two alternatingly at two opposite edges (8),

thus producing a primary flow duct system (A) and a secondary flow duct system (B), in which the flow directions (Fa) and (Fb) are transverse to each other;

- end faces (2) equipped with edge flanges (12a-12d) parallel to the heat exchanger plates; and
 - corner mouldings (3) equipped with longitudinal edge folds (13a, 13b) extending between the end faces on top of the corner stack (10) formed by the mutually transverse joint edges (8) of the heat exchanger plates,
- characterised** in that each corner moulding (3) is fixed at either end to the respective end face (2) by means of an L-shaped corner block (4; 14), whose first branch (15a) is parallel to the branch and whose second branch (15b) is parallel to the corner moulding, and that the corner block is fixed both to the end face (2) and the corner moulding (3) with adhesive layers (5a, 5b) in order to form a solid heat exchanger.

2. A heat exchanger as claimed in claim 1, **characterised** in that the cross-section of the corner moulding (3) has the shape of a truncated V, the width (W2) of its truncated portion (16) equalling the width of the bevelled portion between the mutually transverse joint edges (8), that the width (W1) of the L-shaped corner block (4; 14) equals or is smaller than the width (W2) of the truncated portion of the V-shape and that the edge folds (13a, 13b) of the corner moulding at least slightly overlap the mutually transverse joint edges (8).
3. A heat exchanger as claimed in claim 1, **characterised** in that the edge flanges (12a-12d) of the opposed end faces (2) of the heat exchanger face each other on top of the joint edges (8) of the outermost heat exchanger plates and that on each side of the heat exchanger perpendicular to the flow direction (Fa, Fb) the edge flanges and the edge folds of the corner mouldings are substantially in the same plane, thus joining each other in a buffer-like manner.
4. A heat exchanger as claimed in claim 1, **characterised** in that the first branch (15a) of the L-shaped corner block (4; 14) is positioned against the inner or outer surface of the end face (2) and the second branch (15b) is positioned against the inner or outer surface of the corner moulding (3) and that the inner surface of the corner moulding (3) and if necessary that of the second branch of the corner block (4) is sealed at least on the bevelled portion (16) by means of a tape (6) elastic relative to the not joined edges of the heat exchanger plates (7).

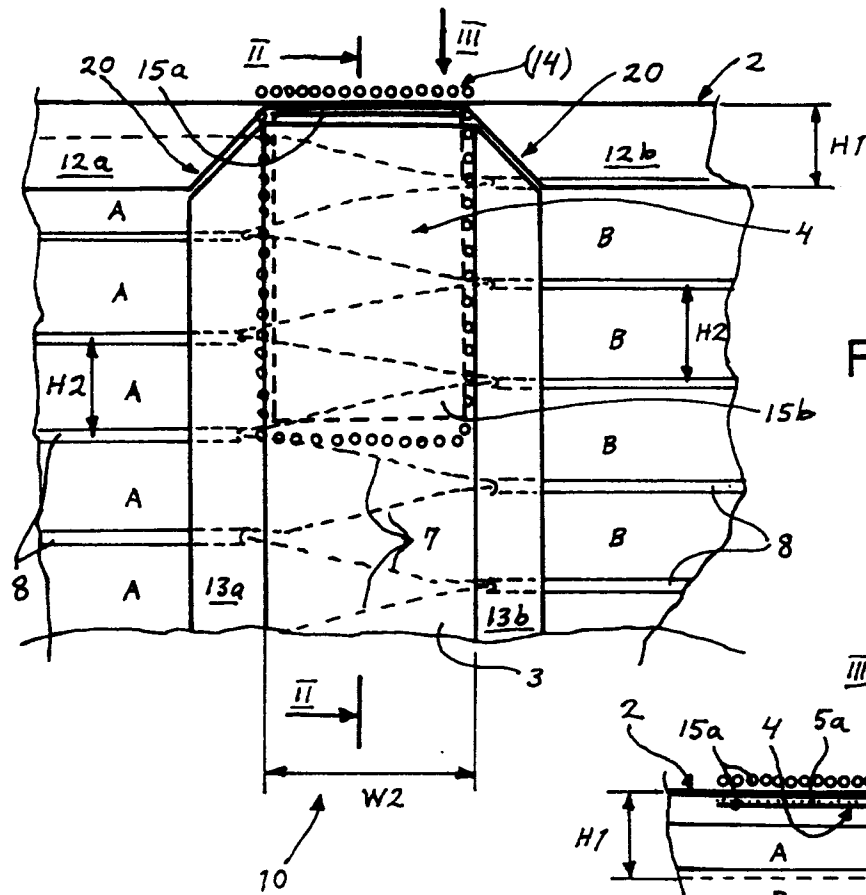


Fig. 1

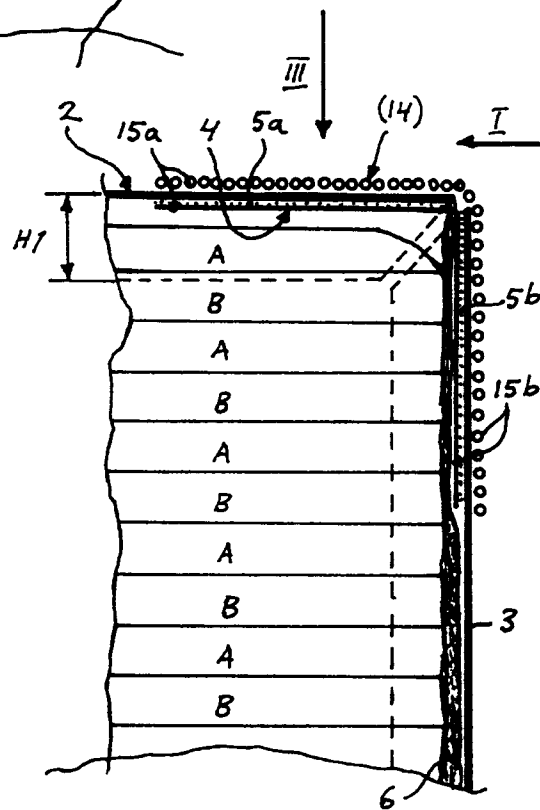


Fig. 2

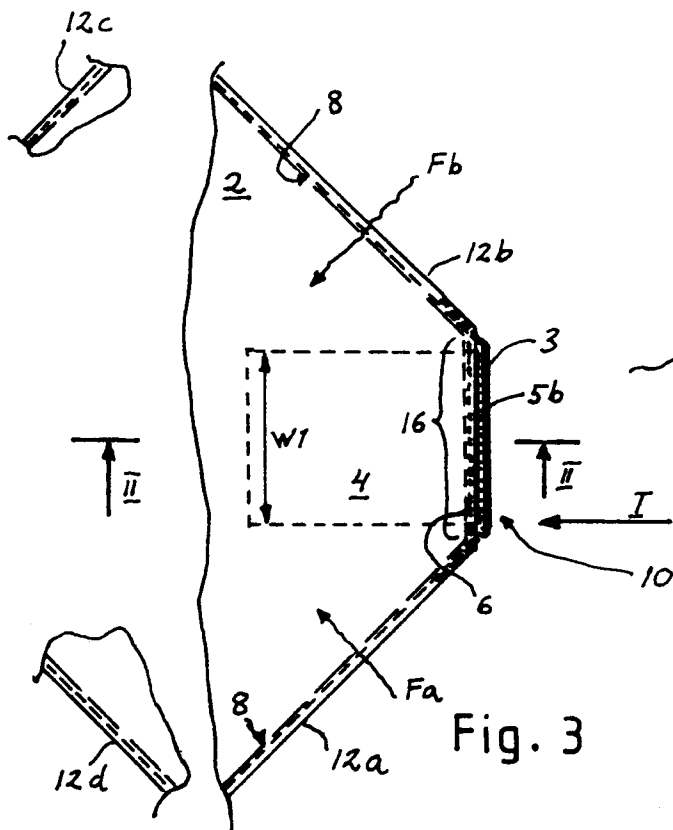


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 97 66 0103

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)
D,A	EP 0 443 299 A (RECUPERATOR S.R.L.) * the whole document *	1,2	F28D9/00 F28F9/00
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 034 (M-558), 31 January 1987 & JP 61 202096 A (SUMITOMO HEAVY IND LTD), 6 September 1986, * abstract; figures 1,2,8 *	1,2	
A	GB 1 384 460 A (KRUPP GMBH) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F28D F28F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		23 February 1998	Mootz, F
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