(12) UK Patent Application (19) GB (11) 2 184 826 (13) A

(43) Application published 1 Jul 1987

(21) Application No 8630222

(22) Date of filing 18 Dec 1986

(30) Priority data
(31) 285323 (32) 24 Dec 1985 (33) DD

(51) INT CL⁴
F28F 3/04

(52) Domestic classification (Edition I):
F4S 4B 4G

(56) Documents cited
GB 1229733

(58) Field of search
F4S
Selected US specifications from IPC sub-class F28F

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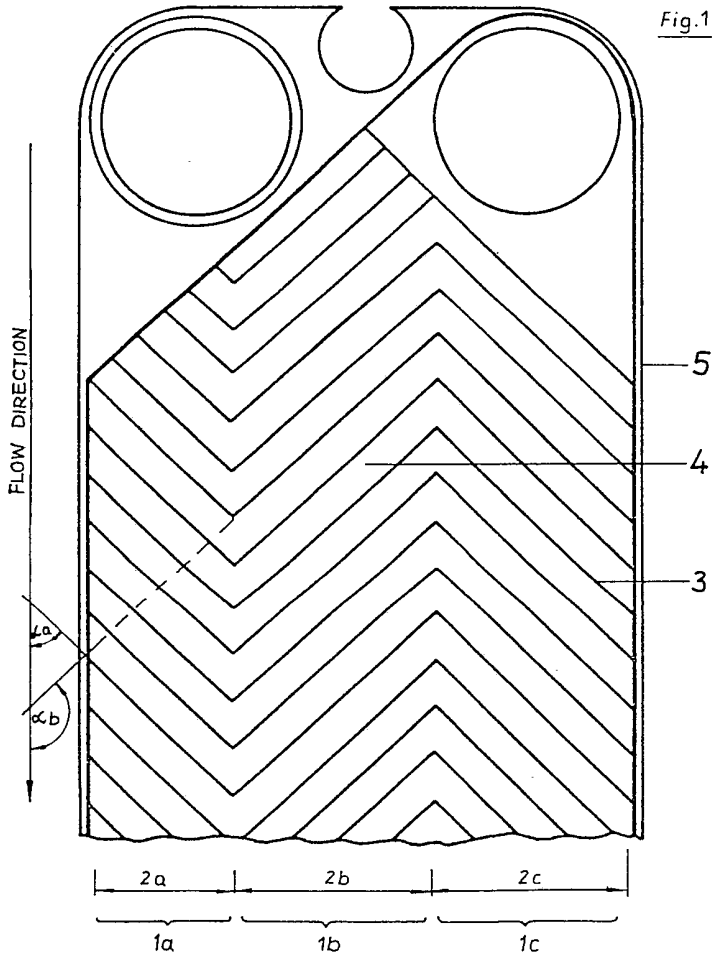
(54) Plate heat exchanger

(57) A plate heat exchanger comprises heat exchanger plates (5) each with a heat exchanger surface (4) having a sinuous profile, the plates being assembled with neighbouring plates being turned through 180° about an axis perpendicular to the flow direction. An uneven number, which is greater than one, of segments (1a, 1b, 1c) is arranged transversely to the flow direction over the width of the heat exchanger surface (4) and the width of the segments arranged at both sides of the plate is different. The angles (α_a, α_b), which the sinuous profile elements (3) of the individual segments form with the flow direction are substantially equal in the case of the mutually opposite segments of adjacent plates in the exchanger.

Fig.1



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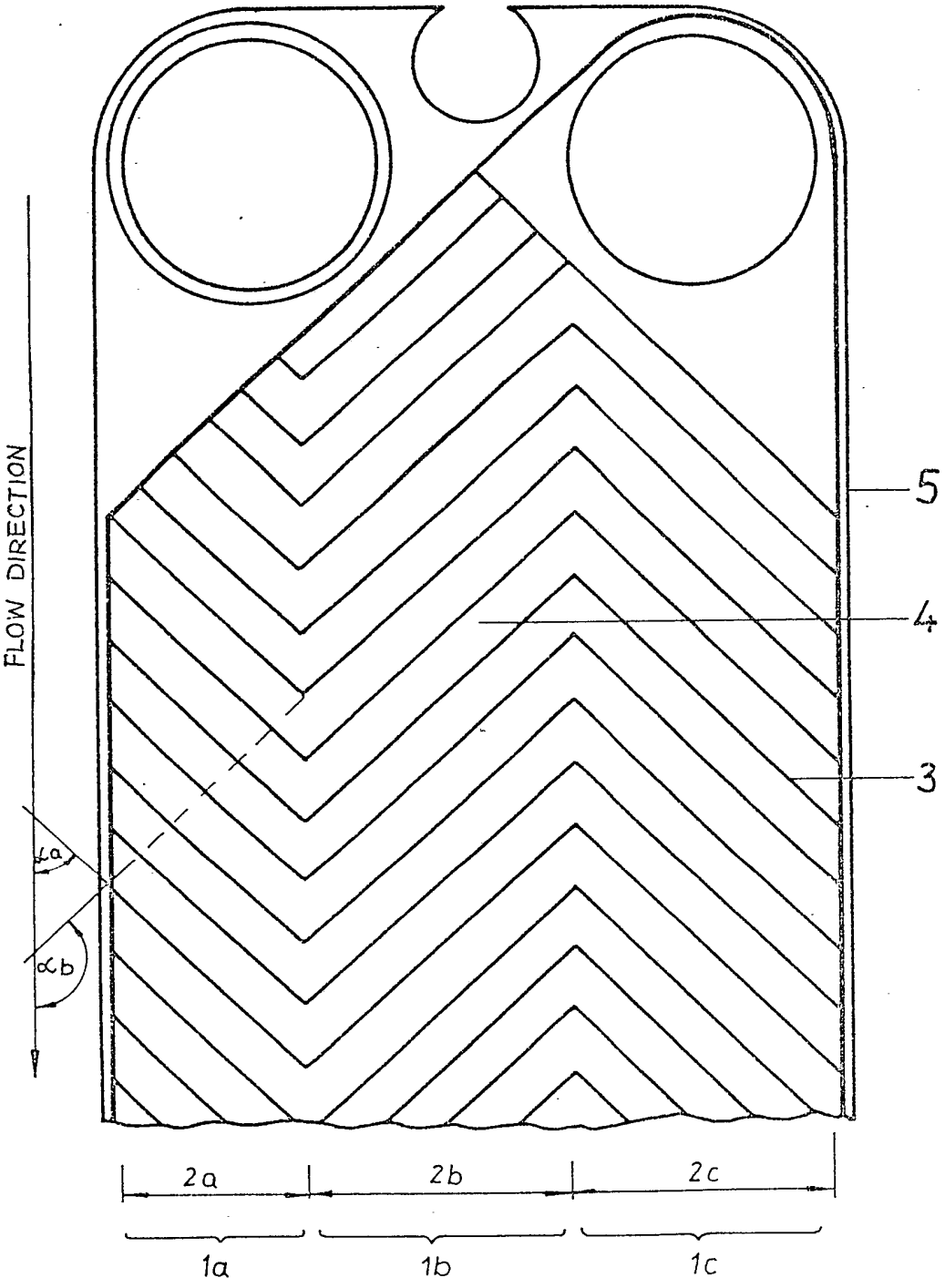

Fig.1

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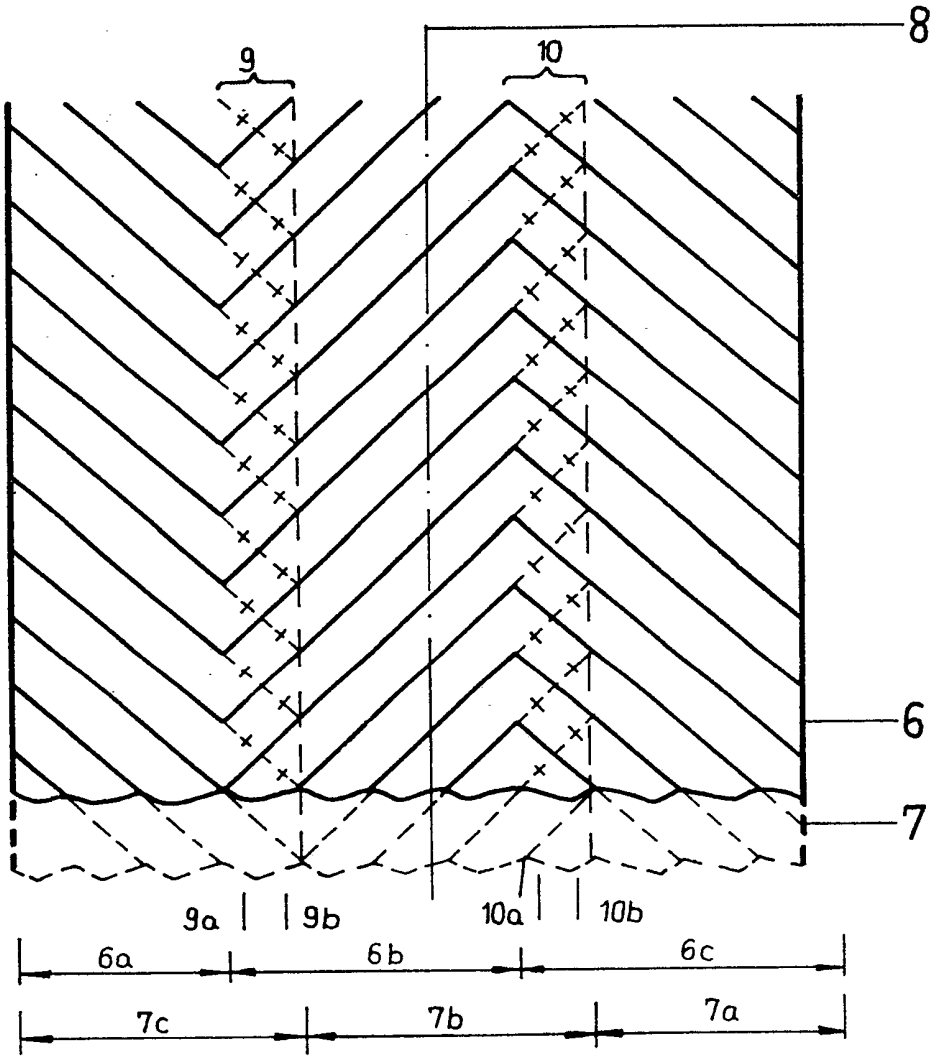

Fig. 2

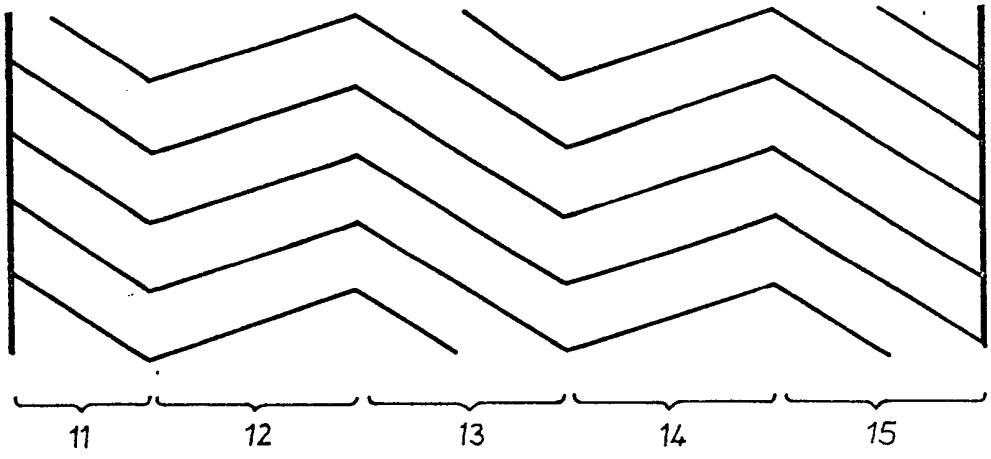

Fig. 3

SPECIFICATION

Heat exchanger

The present invention relates to heat exchangers.

Heat exchanger plates are known which, subject to the maintenance of a certain spacing, are so assembled into plate heat exchangers in suitable devices that flow channels arise between them and each plate is turned relative to the neighbouring one through 180° about an axis lying perpendicular thereto. The heat exchanger surface of this plate is provided with sinuous profiles. The individual sinuous profile elements are arranged either parallelly to each other over the entire width of the surface and at an angle of 90° or at a substantially constant angle different from 90° relative to the flow direction in the flow channels between the plates or else the surface is divided into segments in which the profile elements are arranged parallel to each other but at a substantially constant angle differing from 90° relative to the flow direction, this angle being different in the respectively adjacent segments.

In the cases where the profile elements extend over the entire width of the plate, they form an angle of 90° with the flow direction and the mutually opposite profile elements of the adjacent plates in the heat exchanger extend parallelly. The consequence is that, for the maintenance of the spacing between the adjacent plates, special spacer dogs must be pressed out of the plates. Moreover, plates of that kind have a relatively low inherent stiffness and thereby a low pressure stability. It is advantageous in these plates that the flow channels formed by them can be so structured that the flow speed components parallel to the heat exchanger surface can be largely suppressed and the number of the bearing points at which adjacent plates bear against each other can be fixed to the amount necessary for the required pressure stability of the heat exchanger. Thus, the flow build-up points in the flow channel, which increase the pressure loss, can be kept small in number. In the case of the other described kind of heat exchanger plates, the parallel profile elements extend over the entire width of the plate at a substantially constant angle differing from 90°, whereby mutually opposite profile elements of adjacent plates cross one another. This is also so in the case of plates having their surfaces divided into segments in which the profile elements are arranged at a substantially constant angle, differing from 90°, relative to the flow direction, this angle being different in the neighbouring segments.

The advantage of these constructions compared with the construction with profile elements extending parallelly over the entire plate width is that the elements of adjacent plates can bear directly one upon the other and the formation of special spacer dogs is thus not required. These plates also possess a relatively high inherent stiffness.

It is, however, disadvantageous that very large changes in flow cross-section arise locally and a speed component parallel to the heat exchanger surface is imposed on the flow. This leads to a high proportion of the conveying performance being unusable for the heat exchange. The number of the bearing points and thereby the number of the flow build-up points in the flow channel usually exceeds the number necessary for pressure stability of the heat exchanger.

It would thus be desirable to be able to combine the advantages of heat exchanger plates in which profile elements extend at an angle of 90° to the flow direction with those of plates, in which the elements extend at an angle differing from 90°.

According to the present invention there is provided a heat exchanger comprising a plurality of correspondingly structured sinuously profiled plates which are arranged adjacent to each other to define flow channels therebetween and which each comprise a plurality of profile elements so aligned in an uneven number of segments disposed side-by-side transversely to a given direction of flow along the channels that the elements in each segment extend parallelly to each other and at an angle relative to the flow direction which differs from 90° and from that of the elements in the or each adjacent segment of the same plate but which is substantially equal to that of the elements in the respectively facing segment of the or each adjacent plate, adjacent plates in the exchanger being turned through 180° relative to each other about an axis perpendicular to the flow direction and the width of those segments in each plate which are disposed at the edge regions of the plate or adjacent to the segments at the edge regions or either side of the middle one of the segments being different.

The heat exchanger plates, which are provided with a sinuous profile and subdivided into a number of segments, are thus arranged so that the mutually opposite profile elements of adjacent plates extend substantially parallelly in the assembled exchanger but form an angle differing from 90° with the flow direction.

In a preferred embodiment, the heat exchanger surface is provided with a sinuous profile and subdivided into a number of segments, which plates are assembled, subject to the maintenance of a certain spacing, into the exchanger in a suitable device in such a manner that each plate is turned relative to the adjacent plate through 180° about an axis perpendicular thereto, flow channels being formed between the plates. Each segment consists of a number of sinuous profile elements arranged

parallel to each other,but at a certain and substantially constant angle, which differs from 90°, relative to the flow direction in the flow channels, this angle being different between two neighbouring segments. An odd number, which is greater than one, of segments is arranged transversely to the flow direction over the width of the heat exchanger surface and the width of the segments respectively arranged at both sides of the plate is different. The angle which the profile elements of the individual segments form with the flow direction is so chosen that it is substantially equal in the case of the oppositely disposed segments of the respectively adjacent plates.

In that case, the profile elements of the segments neighbouring each segment transversely to the flow direction can have a substantially equal angle or, in the case of individual segments, form different angles with the flow direction. The difference in the width of the segments respectively arranged at both the sides of the plate can be so chosen that, on placing of the plates against one another, the elements of the adjacent plates bear against each other on one or more lines parallel to the flow direction.

In the preferred embodiment, the mutually opposite profile elements of two adjacent plates extend parallelly as far as the support region and these elements are nevertheless supported one directly on the other so that special spacers are redundant. Through appropriate choice of the ratio of the widths of the segments at both sides of the heat exchanger surfaces, the number of the support lines can be matched to the necessary pressure stability of the heat exchanger, whereby it is possible to avoid support points which unnecessarily impair the flow in the flow channels. At the same time, through a suitable angle between the profile elements of the individual segments and the flow direction, a high inherent stiffness of the plates is secured even in the case of parallel guidance of the mutually opposite profile elements of adjacent plates.

Embodiments of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a heat exchanger plate, with heat exchanger surface subdivided into three segments transversely to the flow direction, in a first heat exchanger embodying the invention;

Figure 2 is a schematic view of the segments of two heat exchanger plates disposed one against the other in a plate heat exchanger embodying the invention; and

Figure 3 is a schematic view of a heat exchanger plate, in which the heat exchanger surface is subdivided into more than three segments transversely to the flow direction, in a second heat exchanger embodying the invention.

Referring now to the drawings, there is shown a heat exchanger plate 5 with its heat exchanger surface 4 divided transversely to a flow direction into an odd-numbered number of segments 1a, 1b and 1c. Within each segment, profile elements 3 each extend parallelly to each other and form a substantially constant angle(α_a, α_b, α_c), differing from 90°, with the flow direction. The angles of the neighbouring segments 1a and 1b or 1b and 1c are different, whereas the angles of the segments 1a and 1c are equal.

The width 2a, 2b of the segments 1a, 1c arranged at both the sides of the heat exchanger plate 5 is different. In the embodiment according to Fig. 1, the same width 2b, 2c is chosen for the segments 1b, 1c and the difference in the widths 2a, 2c for the segments 1a, 1c is chosen so that, on the assembly of such heat exchanger plates 5 into a heat exchanger, wherein each plate is turned relative to the adjacent plate through 180° about an axis perpendicular to the centre line 8, the profile elements 3 of adjacent plates 5 support themselves in such a manner that the support points, in the embodiment shown in Fig. 2, lie on two respective support lines 9a, 9b and 10a and 10b disposed one beside the other. It is evident from Fig. 2 that the number of such support lines 9, 10 is the number, reduced by one, of the segments 6a to 6c or 7a to 7c arranged over the width of the plate 6 or 7.

Fig. 3 shows another embodiment with five segments 11, 12, 13, 14 and 15 arranged one beside the other.

CLAIMS

1. A heat exchanger comprising a plurality of correspondingly structured sinuously profiled plates which are arranged adjacent to each other to define flow channels therebetween and which each comprise a plurality of profile elements so aligned in an uneven number of segments disposed side-by-side transversely to a given direction of flow along the channels that the elements in each segment extend parallelly to each other and at an angle relative to the flow direction which differs from 90° and from that of the elements in the or each adjacent segment of the same plate but which is substantially equal to that of the elements in the respectively facing segment of the or each adjacent plate, adjacent plates in the exchanger being turned through 180° relative to each other about an axis perpendicular to the flow direction and the width of those segments in each plate which are disposed at the edge regions of the plate or adjacent to the segments at the edge regions or either side of the middle one of the segments being different.

2. A heat exchanger as claimed in claim 1, wherein said difference between segment widths is such that the elements of adjacent

plates bear against each other at points disposed in lines parallel to the flow direction.

3. A heat exchanger as claimed in either claim 1 or claim 2, wherein the elements in alternate segments of each plate extend at the same angle to the flow direction.

4. A heat exchanger as claimed in either claim 1 or claim 2, wherein the elements in adjacent segments of each plate extend at different angles to the flow direction.

5. A heat exchanger substantially as hereinbefore described with reference to Fig. 1 of the accompanying drawings.

6. A heat exchanger substantially as hereinbefore described with reference to Fig. 2 of the accompanying drawings.

7. A heat exchanger substantially as hereinbefore described with reference to Fig. 3 of the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd, Dd 8991685, 1987.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.