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Description

The invention relates to a plate heat exchanger functioning as an evaporator and/or condenser according to the preamble of claim 1.

Plate heat exchangers of this type are stacked to form a packet, so that the product or the heating/cooling medium flows alternately in the spaces between the plates. The plates are known in a great variety of designs and profiles and are characterised by a high heat transfer output due to the split flow.

Usually, the openings are arranged in the four corners of the plate, such that two diagonally opposite openings serve as the inlet opening and outlet opening for one medium, while the two other diagonally opposite openings are separated by seals from the first medium and are used for the flow of the second medium to the next space between the plates.

However, other positions for the openings in the plate are also already known. German Patent DE 32 20 774 from the same applicant, for instance, describes a plate evaporator or condenser in which the plates have laterally protruding projections in which openings are arranged such that continuous channels are produced. Said channels are used particularly for supplying heating steam. In addition, WO 01/90671 discloses a heat transfer plate which has two inlet openings closely adjacent to one another in the lower, middle area from which the medium first enters an intermediate chamber, such that the partial flows coming from the two inlet openings intermix. The medium then flows along the heat transfer area to the other plate edge into a common centrally arranged outlet opening.

A plate heat exchanger for pasteurising milk is known from US Patent US-A-2248933, which has a heat transfer area and peripheral sealing gaskets. The gaskets are positioned such that openings are assigned to the respective medium and the respective side of the plate. Channels for the heating or cooling medium are arranged on the longitudinal sides of the plate heat exchanger on the upper and lower edge.

A plate heat exchanger is known from FR 834 829 A, which comprises a substantially rectangular heat transfer area with seals. Moreover, several inlet and outlet openings are arranged on the transverse sides of the plates.

Based on this known prior art, the object of the present invention is to produce a more uniform flow of the inlet medium into the plate gap and thus achieve more homogeneous conditions for heat transfer and for the product temperature. As a result, the new plate is characterised by more cost-effective production and greater operational reliability.

This object is achieved according to the invention in a heat transfer plate according to the preamble of claim 1 through the features of the characterising portion of claim 1.

The plates of the heat transfer plate according to the invention each have a plurality of steam channels arranged adjacent to one another in a longitudinal direction of the plate and a condensate channel for the heating or cooling medium on the longitudinal edges. Said steam channels and the condensate channel are no longer formed as before by so-called 'projecting ears,' but are within the almost rectangular plate contour, wherein preferably the entire longitudinal edge, on one side or both sides of the plate, is formed by steam and condensate channels. The essential advantage of providing several steam channels integrated in the plate is that steam channels can be interconnected internally, i.e. within the plate stack. The previously required reversing lines and connections mounted on the outside are thus no longer required. Instead, it is only necessary to omit the seal between adjacent steam channels on some plates until a transitional area having a sufficient cross section is available. Of course, the aforementioned internal connection possibility is also feasible for the condensate channels.

The inlet openings can extend over almost the entire width of the heat transfer area and thus produce a considerably more uniform admission to the plate gap over its width. Differences in temperature in the transverse direction of the plate gap are thereby virtually eliminated, and the heat treatment of the product can be more easily and more precisely reproduced than previously. Secondly, the direct alignment of the inflowing medium into the heat transfer area leads to a lower loss in pressure, while omitting an intermediate chamber in which mixing effects are bound to result.

Theoretically, the inlet openings could also be arranged cornerwise. However, it is especially useful if they are arranged only along a narrow side of the plate and extend over almost the entire width of the heat transfer area. In particular, therefore, the inlet openings should be adjacent to one another on the same side of the plate and without sealed flow-through openings between them for the other medium.

In a further embodiment of the invention, it is recommended that the seals arranged on the outside of the inlet openings each extend into the space between adjacent inlet openings. As a result, transverse flows and mixtures are prevented between the arriving partial flows, which would produce a loss in pressure. This is true in particular if the aforementioned seal extends further into the space between adjacent inlet openings than corresponds to the diameter of the inlet openings. Advantageously, the seal should thus extend about the inlet openings, such that it offers a flow cross section expanding in the direction of the heat transfer area at each inlet opening. Thus, the seal should only extend over the outer peripheral area of the inlet opening and expand towards the space between the plates, such that it forms guide edges there which run diagonally into the space along the lines of a fanning of the flow cross section from the smaller flow width in the inlet opening to a larger flow width in the plate gap. The individual flows thus achieve an optimal alignment towards the heat transfer area.

In a further advantageous embodiment of the invention, the heat transfer area is profiled at least in the plate half allocated to the inlet openings, in such a way that a plurality of almost straight individual channels, which extend in a longitudinal direction of the plate, are produced in combination with the profiling of the adjacent plate. Thus, in this case, the attachment of diagonal ribs, projections distributed in a grid-like fashion, and a deviation of the flow produced thereby are intentionally omitted in order to make do with as low a loss of pressure as possible. Thus, this design is especially suitable for evaporating the product in a vacuum.

The adjoining remaining heat transfer area, which is allocated to the inlet openings for the heating medium on the other plate side, preferably has a different profiling, i.e. one that allows both longitudinal and diagonal flows on the heating medium side. As a result,

the possible transfer flow on the rear side of the plate facilitates the distribution of the heating medium coming from the outside over the entire plate width. Two relatively large outlet openings are provided in the plate for the vapour outlet.

In a further advantageous embodiment of the invention, the condensate channel is surrounded by a seal which comprises an area which is at least 50%, preferably at least 75%, of the area which is surrounded by the seal of the steam channel furthest removed from the condensate channel. As a result, the condensate channel can be cut out of the plate substantially larger than what would actually be required for the pure condensate discharge; in particular, the condensate channel can be made with a cross section that is similar in size to a steam channel. This results in the advantage that the condensate channel can also be selectively used as a steam channel. This means that the same plate can be selectively used as a rising film or falling film evaporator. To this end, it must only be turned by 180° about its transverse axis.

Moreover, the described oversizing of the area surrounded by the seal of the condensate channel offers the possibility of providing a further channel for the condensate exhaust within this area and above the condensate channel. As a result, an air separator on the outside of the plate heat exchanger can be omitted.

Not least, the steam channels arranged adjacent to one another enable the use of unused steam channels for drawing in clamping means for pressing the plate packet together.

Of course, it is also within the scope of the invention that the plate has, in a known manner, a central seal passing in a longitudinal direction on at least one side, such that two separate, adjacent flow cross sections are produced. This separation may also be realised by dividing the plate in the central longitudinal direction into two separate plate halves, which fit together in the composite construction with divided or undivided plates. The advantage of plates divided in this way is that, due to the smaller plate area, only smaller pressure forces are required, and the layout of plates as a whole can be adapted in a more individual manner to the requirements of the user, for example, such that two evaporating steps are carried out with only one apparatus.

Plate halves separated in this way also offer the possibility of placing clamps in the intermediate space for pressing the plate packet together.

Further features and advantages of the invention are discussed in the description below using example embodiments and the appended drawings.

Figure 1 shows a view of the product side of a plate with a rising film evaporation;

Figure 2 shows a view of the rear side of the plate according to Figure 1;

Figure 3 shows a view of the product side of a plate during falling film evaporation;

Figure 4 shows a view of the rear side of the plate according to Figure 3;

Figure 5 shows a perspective view of a section of profiling in the inlet area of the heating medium;

Figure 6 shows a perspective view of a section of profiling in the central heat transfer area.

As the drawings show, the plate has a substantially rectangular outer contour. In Figure 1, the product is supplied via four inlet openings 1a to 1d arranged on the lower narrow side of the plate and distributed uniformly over said narrow side, while the steam product is discharged via two outlet openings 2a, 2b, which are arranged on the upper narrow side of the plate, and each extends over almost half of the plate width.

Four almost rectangular channels are each arranged within the rectangular plate contour on both longitudinal sides of the plate, the channels being used in this embodiment for supplying and discharging a heating medium. In this case, the three upper channels 3a, 3b, 3c of each side function as steam channels, whereas the lower channel 3d on each side serves as a condensate channel. The channels are arranged directly above one another.

The heat transfer area 4 is situated between the aforementioned inlet and outlet openings on the narrow sides of the plates and the aforementioned channels on the

longitudinal sides of the plates. The heat transfer area 4 first has a knob-like profiling on the lower end, in the region of the inlet openings 1a to 1d, and then passes into a profiling 4a which is shown in greater detail in Figure 5. In association with the corresponding profiling of the adjacent plate, it forms a plurality of small, straight flow channels in the longitudinal direction of the plates through which the product flows upwards. However, on the side facing away from the product, the undulating surfaces of the channels have a plurality of successive indentations 4a' spaced from one another. In this way, the profiling enables the heating or cooling medium to flow not only in a longitudinal direction but also in a transverse direction.

This is followed by an undulated profiling 4b which is shown in Figure 6. It is configured and oriented in association with the corresponding profiling of the adjacent plate, such that a plurality of small, straight partial flows is produced in the longitudinal direction of the plates by which the product flows upwards. In this case, a transverse flow is not provided either for the product or for the heating or cooling medium. However, this can be allowed by indentations as in Figure 5. The undulated profiling 4b extends over about two-thirds of the height of the heat transfer area.

The remaining upper area is formed by a profiling 4c which allows longitudinal and transverse flow of the product and also of the heating or cooling medium. This area is situated at the level of the upper steam channels 3a.

On the product side of the plate, shown in Figure 1, the seal 5 is placed such that the heat transfer area 4 is connected to the inlet openings 1a to 1d and to the outlet openings 2a and 2b for the product, whereas the steam and condensate channels 3a to 3d are sealed off with respect to the heat transfer area. In this case, each of the seals 5 extends in a funnel-shaped manner about the inlet openings 1a to 1d, such that the flow width increases continuously from the inlet opening to the heat transfer area 4 until the seal bends sharply, in order to travel about the next inlet opening in a funnel-like manner. In this way, the flows coming from the inlet openings 1a to 1d are uniformly distributed over the full width of the heat transfer area 4.

Figure 2 shows the rear side of the plate according to Figure 1. It can be seen that the seal 5 is placed here in such a way that the inlet channels 1a to 1d and the outlet channels 2a,

2b for the product are sealed off with respect to the heat transfer surface 4 and that the upper steam channels 3a and the lower channels 3d, which act as condensate channels, are instead connected to the heat transfer area 4. Moreover, it becomes clear in Figure 2 that the upper heat transfer area 4c, which allows transverse flows, is important for distributing the steam flowing in on both sides from the channels 3a over the width of the plates. The same applies to the lower heat transfer area 4a, because there the condensate must be conveyed outwards again into the condensate channels 3d.

The seal 5 not only seals off the steam channels 3b and 3c with respect to the heat transfer area 4, but also between them and towards the outside, so that these channels may be optionally used for a second heating or cooling medium circulation. To interconnect the steam channels internally, only the one sealing strip situated between them need be removed on several plates.

An advantageous alternative in the form of a vertical sealing strip 5a is indicated, moreover, in Figure 2 on the right condensate channel 3d. Said sealing strip seals the upper part 3d' of the condensate channel 3d from the heat transfer area 4, whereas the shorter lower part remains free for the condensate inlet. As a result, the upper part 3d' may function as an air collector for the condensate channel.

Figures 3 and 4 show the use of a plate according to the invention as a falling film evaporator. That is, the product-side inlet openings 1a to 1d are now situated on the upper narrow side of the plates and the product-side outlet openings 2a and 2b on the lower narrow side of the plates. The important point in this case is that the indentations for the seal 5 are identical to the ones described with respect to the application for the rising film evaporator according to Figures 1 and 2. Therefore, one can work with almost the same plates in both cases, and it is only necessary to turn them by 180° about their transverse axis.

The only difference is in the partition of the heat transfer area 4 which does not make this shift. Rather, the heat transfer area 4c remains in this case. Said heat transfer area 4c in the upper plate area, namely at the level of the steam supply channels 3a (see Figure 4) advantageously has the profiling shown in Figure 5, i.e. only flows in longitudinal direction of the plates are allowed on the product side, while on the back they are allowed both in

the longitudinal direction and in the transverse direction. The lower heat transfer area 4a substantially retains its position. However, it now opens to the product-side outlet openings 2a, 2b or the condensate channels 3d respectively, and allows both longitudinal flows and transverse flows on both sides.

As a result, the same embossing die can be used for the outer area of the plates and, in particular, the sealing profiles for rising film and falling film evaporators. It is only necessary to shift the die for the heat transfer area 4 relative hereto.

Usually, the plates have upper and lower recesses for hanging in racks. These recesses (not shown in the drawings) advantageously have the same contour, so that it is possible to turn the plates about their transverse axis in the prescribed manner.

To form a plate stack, every second plate is turned about its longitudinal axis by 180°, so that the plates adjoin back-to-back. If the sealing groove lies in the central plane of each plate, a seal with the same height can be used for product and steam side. If, on the other hand, the sealing plane lies in a zero plane, then the seal of the steam plate may be replaced by a weld seam, soldered joint or the like.

Pladevarmeveksler

Patentkrav

1. Pladevarmeveksler der fungerer som en fordamper og/eller kondensator, omfattende en flerhed af stablede plader, hvor pladerne hver har et varmeoverførselsområde (4) og kantsidede gennemgangsåbninger (1, 2, 3) til det varmeoverførende medie, det vil sige, på den ene side, et produkt, som mindst delvist skal fordampes eller kondenseres og, på den anden side, et varme- eller kølemedie, og, ved hjælp af passende positionerede tætninger (5) en gruppe af gennemgangsåbninger er associeret med et medie og med en side af den pågældende plade, en anden gruppe af gennemgangsåbninger er associeret med det andet medie og med den anden side af den pågældende plade, hvor gruppen af gennemgangsåbninger som er associeret med produktet som skal fordampes på indstrømssiden af den pågældende plade består af en flerhed af indstrømsåbninger (1a til 1d) der er anbragt ved siden af hinanden og åbner direkte ind til varmeoverførselsområdet (4) af pladen i en retning praktisk talt vinkelret på den tilstødende kant af pladen, og hvor gruppen af gennemgangsåbninger (3) der er associeret med varme- eller kølemediet danner langs mindst en langsgående kant af den pågældende plade en flerhed af kanaler for varme- eller kølemediet som er anbragt ved siden af hinanden i den langsgående retning af pladen, hvor en af kanalerne er i form af en kondensatorkanal (3d) og yderligere kanaler er i form af dampkanaler (3a til 3c) og er anbragt langs de langsgående kanter af pladerne,

kendetegnet ved at

dampkanalerne (3a til 3c) og kondensatkanalen (3d) er anbragt umiddelbart ved siden af hinanden, og tætningen (5) er positioneret således at en af dampkanalerne (3a) og kondensatkanalen (3d) er forbundet til varmeoverførselsområdet og de yderligere dampkanaler (3b, 3c) er afspærret ikke kun fra varmeoverførselsområdet (4), men også fra hinanden og mod den udvendige side for at de kanaler eventuelt kan blive anvendt til et andet varme- eller kølemediekredsløb, og tilstødende dampkanaler (3a til 3c) på en flerhed af plader er forbindelige med hinanden internt ved udeladelse af deres mellemliggende tætning (5).

2. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
indstrømsåbningerne (1a til 1d) af produktet som skal fordampes er anbragt langs en plade-smalside.

3. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
indstrømsåbningerne (1 a til 1 d) af produktet som skal fordampes strækker sig over nærmest hele bredden af varmeoverførselsområdet.

4. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
tætningen (5) anbragt omkring ydersiden af indstrømsåbningerne i hvert tilfælde strækker sig til mellemrummet mellem tilstødende indstrømsåbninger (1a til 1d).

5. Pladevarmeveksler ifølge krav 4,
kendetegnet ved at
tætningen (5) strækker sig yderligere til mellemrummet som svarer til diameteren af indstrømsåbningerne.

6. Pladevarmeveksler ifølge krav 4 eller 5,
kendetegnet ved at
tætningen (5) strækker sig på sådan en måde for at danne strømningstværsnit som hver bliver bredere i retning mod varmeoverførselsområdet (4).

7. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
varmeoverførselsområdet (4), mindst i halvdelen af pladen associeret med indstrømsåbningerne, har profilering (4b) som i kombination med profileringen af den tilstødende plade genererer en flerhed af nærmest lige individuelle kanaler.

8. Pladevarmeveksler ifølge krav 7,
kendetegnet ved at
de individuelle kanaler løber i den langsgående retning af pladen.

9. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
varmeoverførselsområdet (4c) mod indstrømningsåbningerne (3a) af varmemediet har profilering der tillader både tværgående strømning og langsgående strømning.

10. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
mindst en af de to langsgående kanter af pladerne er dannet nærmest over hele længden af damp- og kondensatkanaler (3a til 3c).

11. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
kondensatkanalen (3d) er omgivet af en tætning (5) som omgiver en flade der er mindst 50 %, fortrinsvis mindst 75 %, af fladen omgivet af tætningen (5) af dampkanalen (3a) længst væk fra kondensatkanalen.

12. Pladevarmeveksler ifølge krav 11,
kendetegnet ved at
kondensatkanalen (3d) er dannet i den ønskede størrelse fra fladen omgivet af tætningen (5).

13. Pladevarmeveksler ifølge krav 11,
kendetegnet ved at
der inden i kondensatkanalen (3d) i det øvre område er dannet ved hjælp af et tætningsafsnit (5a) en kanal (3d') til afluftning af kondensatet, hvilken kanal er afskærmet fra varmeoverførselsområdet (4).

14. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
der inden i en ubrugt dampkanal (3a til 3c) er positioneret fastspændingsorgan til at presse en flerhed af plader sammen.

15. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
pladerne hver på mindst en side har en tætning som passerer cirka centralt igennem pladen i den langsgående retning for at danne to separate strømningstværsnit anbragt ved siden af hinanden.

16. Pladevarmeveksler ifølge krav 1,
kendetegnet ved at
pladerne hver er inddelt i den centrale langsgående retning for at danne to separate pladehalvdele der passer sammen i kombination med inddelte eller ikke inddelte plader.

17. Pladevarmeveksler ifølge krav 16,
kendetegnet ved at
der mellem pladehalvdelene er positioneret fastspændingsorgan til at presse de to tilstødende pladepakninger sammen.

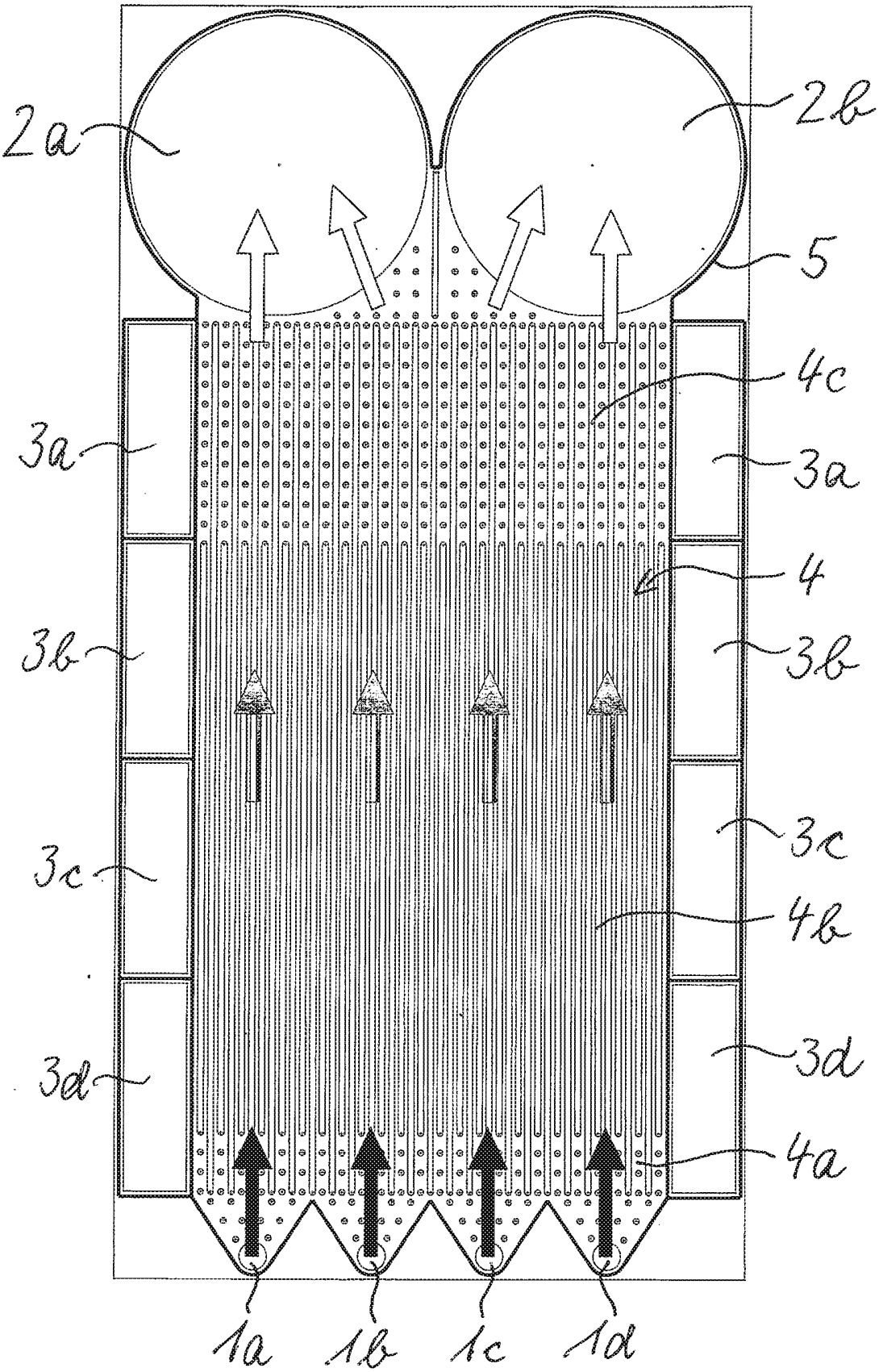

Fig. 1

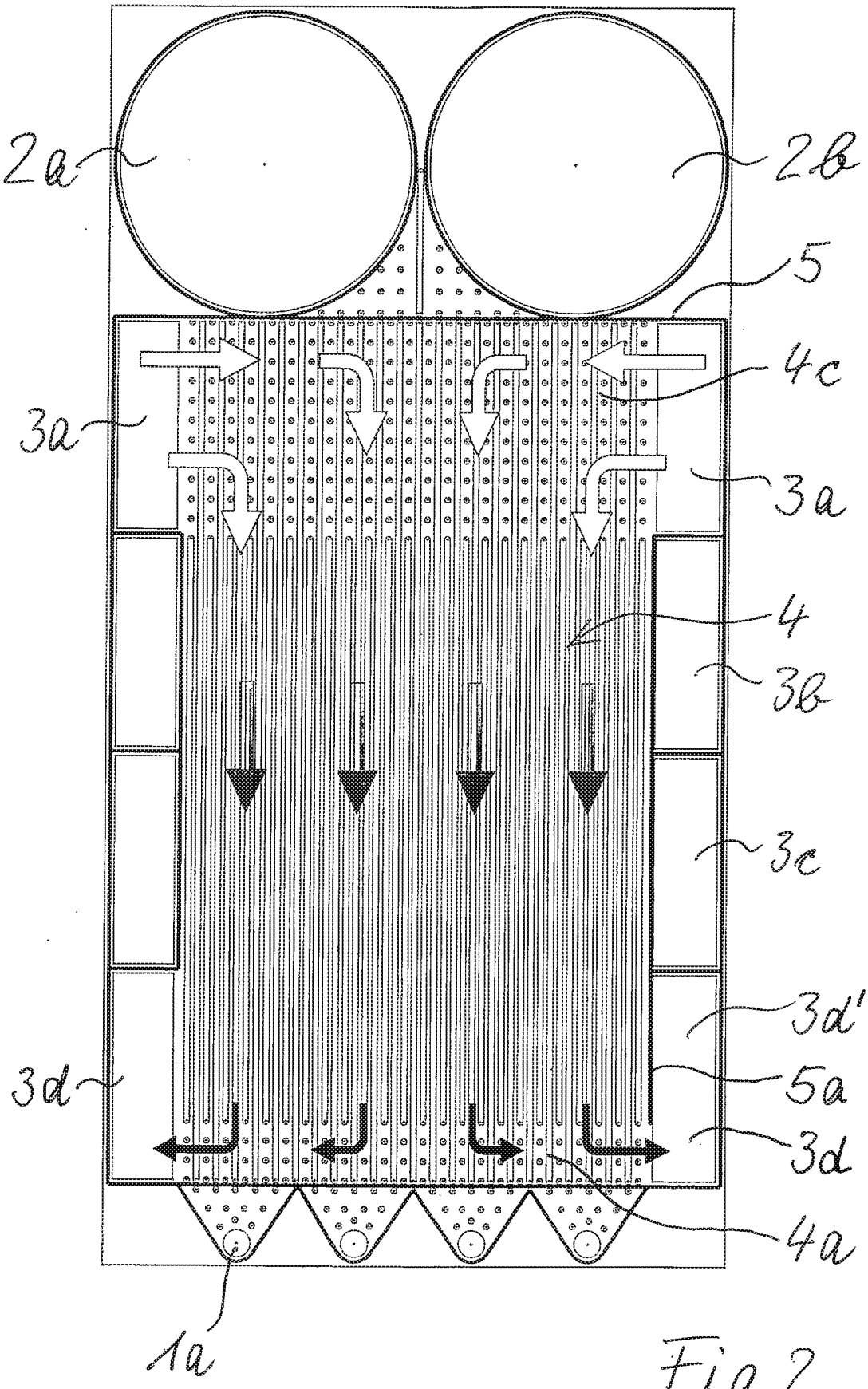

Fig. 2

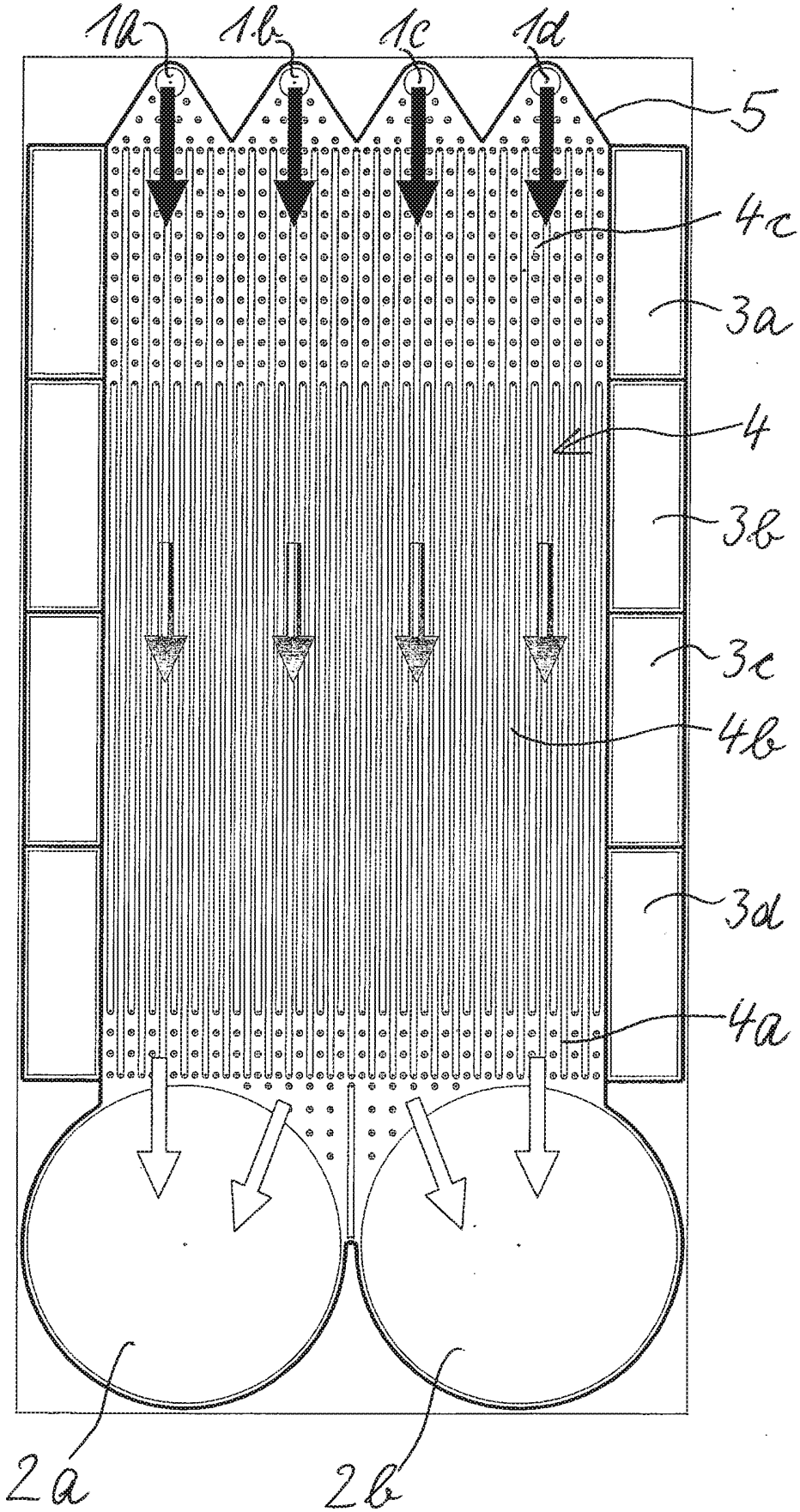

Fig. 3

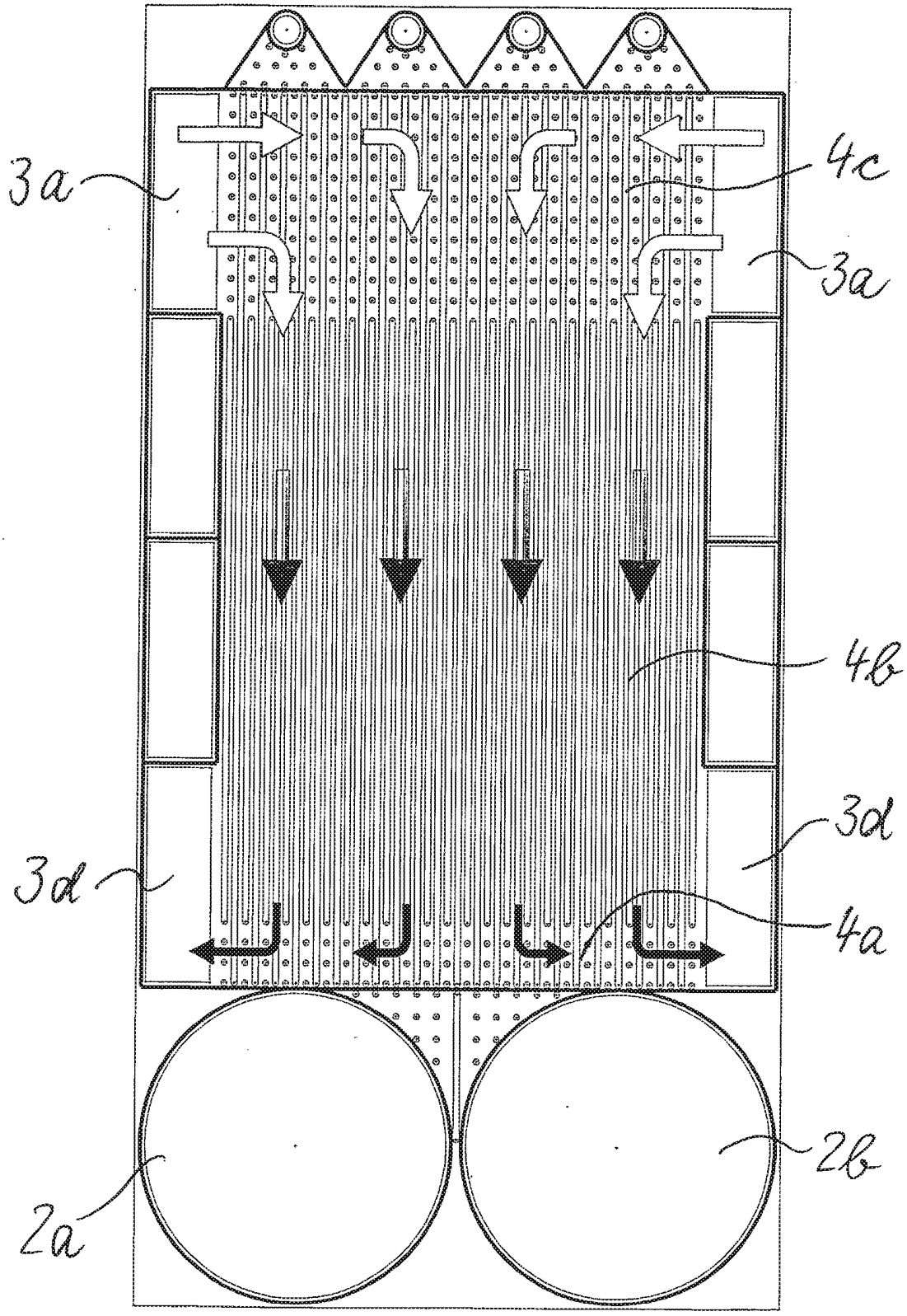

Fig. 4

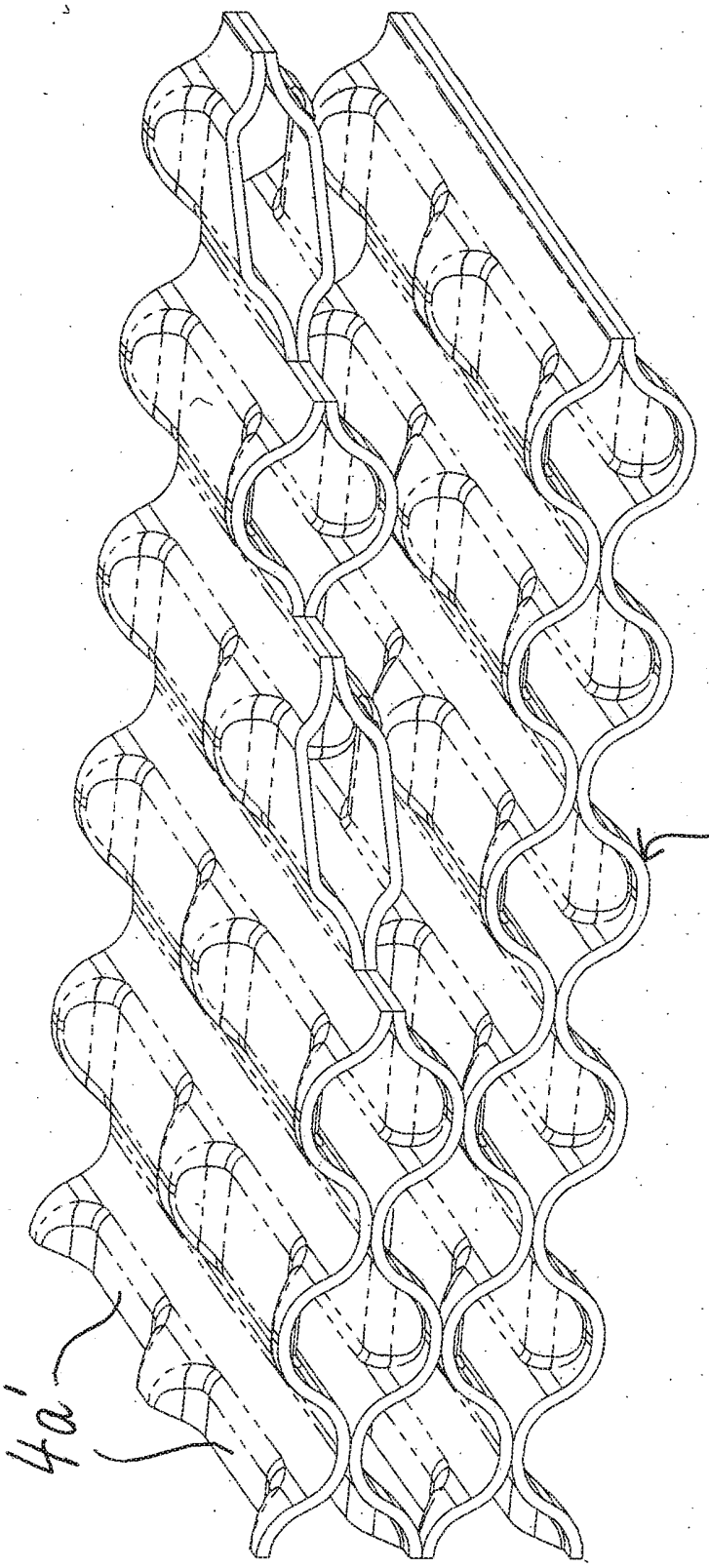

Fig. 5

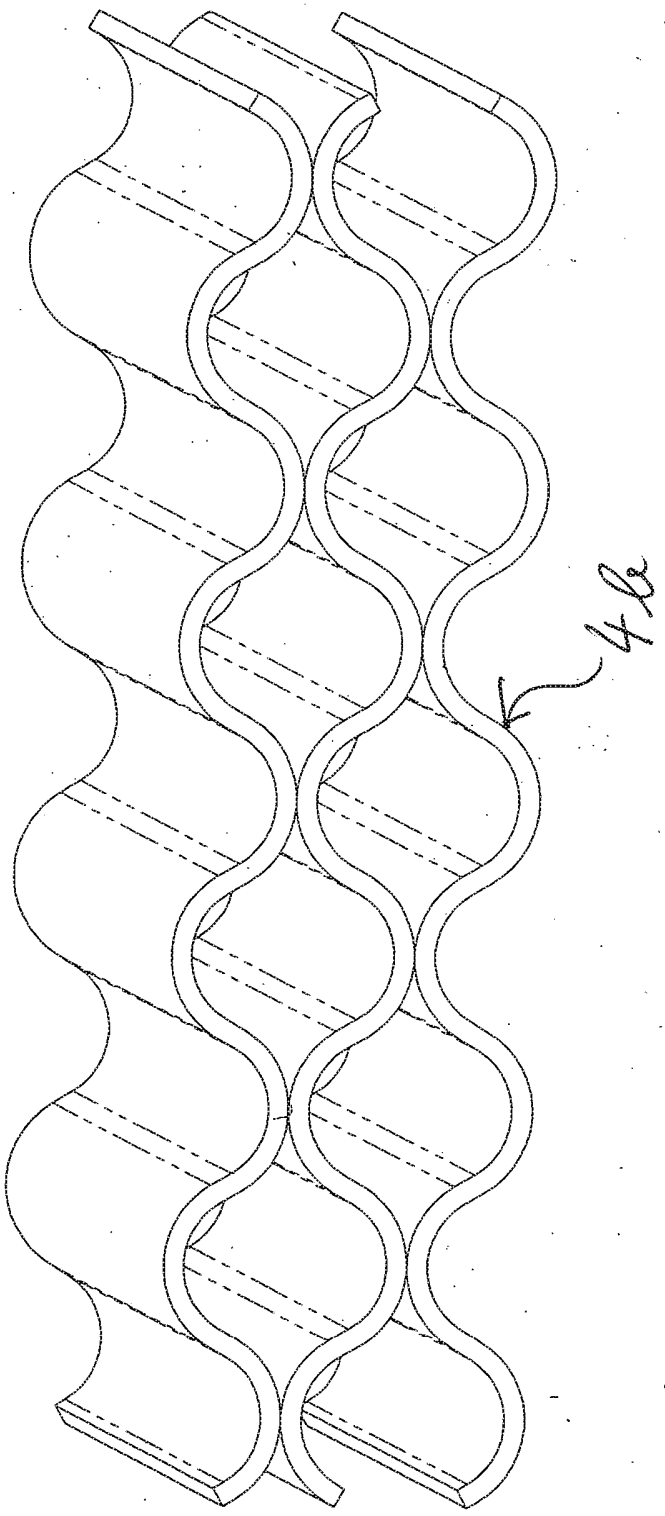

Fig. 6