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[54] PLATE HEAT EXCHANGER

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **165/167**
[51] **Int. Cl.** **F28b 3/08**
[58] **Field of Search** 165/157, 166, 167

[56] **References Cited**

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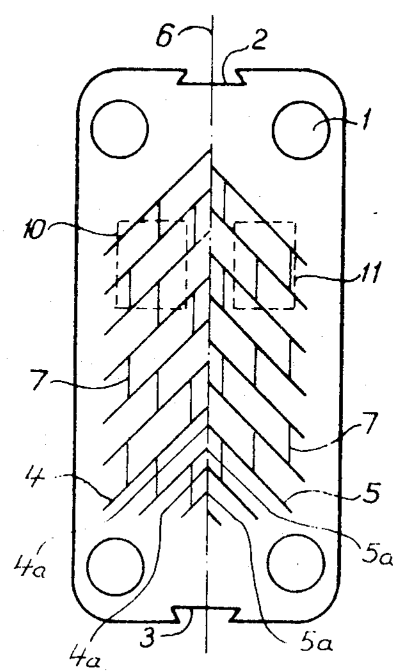
[57] **ABSTRACT**

A plurality of identical heat exchange plates have respective heat exchange surfaces provided with protuberances acting as turbulence-effecting and spacing means between adjacent plates, such plates being adapted for assembly with marginal gaskets to form plate interspaces for throughflow of two heat exchange media along said surfaces at opposite sides (faces), respectively, of each plate. The plate interspaces are of the same depth, and at least one plate is turned 180° relative to the other plates around an axis extending in the plane of the turned plate, the protuberances of each plate being arranged unsymmetrically and so disposed that two different kinds of plate interspaces are formed by such turning of said one plate, thereby creating different flow conditions for the heat exchange media.

4 Claims, 5 Drawing Figures



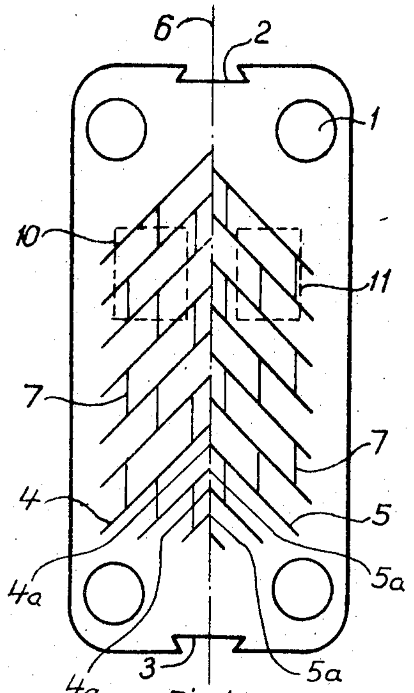


Fig. 1

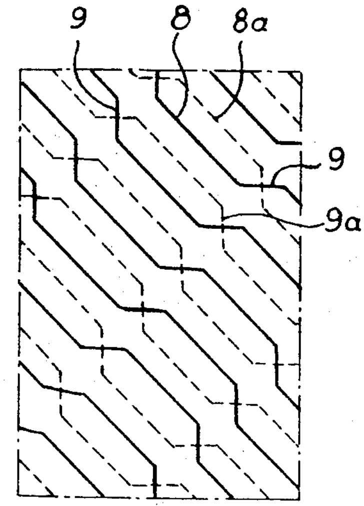


Fig. 2

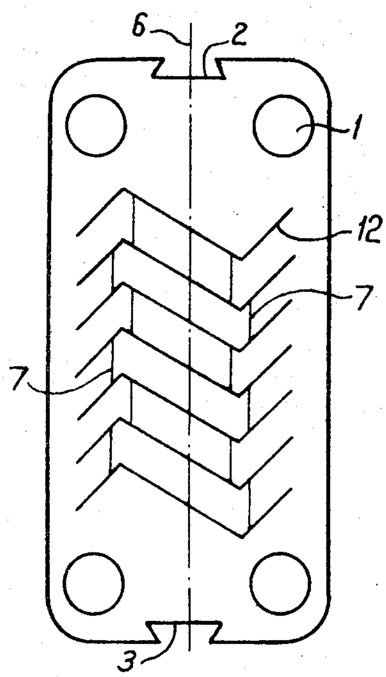


Fig. 3

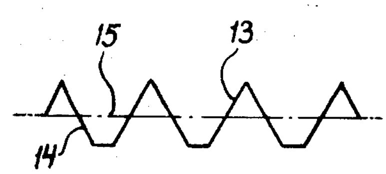


Fig. 4

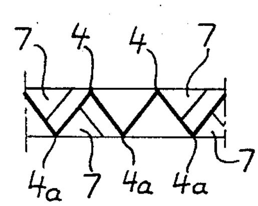


Fig. 5

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PLATE HEAT EXCHANGER

The present invention relates to a plate heat exchanger comprising identical heat exchange plates which on their heat exchanging surfaces have several protuberances acting as turbulence-effecting and spacing means between the plates, when the latter are assembled with marginal gaskets to form plate interspaces for the throughflow of two heat exchanging media, the interspaces being of the same depth. The plate heat exchanger according to the invention is characterized in that at least one of the heat exchange plates is turned 180° relative to the other plates around an axis extending in the plane of the plate, the turbulence-effecting protuberances of each plate being unsymmetrically shaped and/or located so that two different kinds of plate interspaces are formed by this turning of one plate, thereby creating different flow conditions for the heat exchanging media.

It is often desirable to be able to provide, in the same plate heat exchanger, plate interspaces having different thermal characteristics, so that a predetermined final temperature of one of the heat exchanging media may be achieved as accurately as possible. This desire has heretofore been fulfilled by making some plate interspaces in the heat exchanger deeper than the others. The depth of a plate interspace is considered to be (if no clearly definable planes for the heat exchanging portions of the plates are to be found) the distance between those two planes of adjacent plates which extend at each plate half-way between the two planes through the tops or crests of the turbulence-effecting protuberances on both sides of the plate. Deeper plate interspaces may be provided in a plate heat exchanger either by using thicker gaskets than normally or by using heat exchange plates of which the entire heat exchanging portions are displaced somewhat relative to the respective surrounding marginal portions, in the direction perpendicular to the planes of the plates. In both cases, however, the mutual support is lost between plates forming such deeper interspaces. This support, when the distance between the plates is normal, is provided at many points uniformly distributed over the heat exchanging portions of the plates by the usual turbulence-effecting protuberances, such as ridges or the like, in the heat exchanging surfaces.

In a plate heat exchanger constructed according to the invention, this support is not lost, as the depth of plate interspaces is not increased in order to give them changed thermal characteristics. Plate interspaces with changed thermal characteristics are created, instead, by forming the turbulence-effecting protuberances of the plates so that in some plate interspaces a more violent turbulence will be generated than in others. A great advantage of the present invention is that identical plates can be used, whereby the production costs may be kept down.

In the following description referring to the accompanying drawing, there will be described a number of different kinds of heat exchange plates from which a plate heat exchanger according to the invention may be assembled. In the drawing,

FIG. 1 is a schematic plan view of one kind of plate;

FIG. 2 is a fragmentary plan view of a modified embodiment of the plate shown in FIG. 1;

FIG. 3 is a view similar to FIG. 1 but showing another kind of plate;

FIG. 4 is a fragmentary cross-sectional view of another plate; and

FIG. 5 is a fragmentary cross-sectional view on the center line 6 in FIG. 1, as viewed from the right.

The plates shown in the drawing have the usual holes 1 for passage of the heat exchanging media and are provided at their ends with notches 2 and 3 acting as guiding means when a number of plates are to be assembled in a pack in a plate heat exchanger frame (not shown).

In the drawing, the conventional edge or marginal gaskets extending around the heat exchanging surfaces and the holes 1 are omitted, as they do not form any part of this invention. It will be understood that such gaskets are provided in the conventional manner between adjacent plates in the pack so that the two heat exchange media are directed through corresponding holes 1 to their respective plate interspaces, where they flow at opposite sides (faces) of each plate along its heat exchanging surfaces surrounded by the gaskets. These heat exchanging surfaces are corrugated to form ridges and valleys on each side of each plate, such corrugations being formed in the fabrication of the plates and serving to effect turbulence of the heat exchange media flowing through the heat exchanger in the passages between the assembled plates.

In FIG. 1, the full lines 4 and 5 represent the ridges constituting the tops of the protuberances formed by the corrugations. The ridges 4 extend parallel to each other but form an angle with the ridges 5, which also extend parallel to each other. The two sets of ridges 4 and 5 are located, respectively, at opposite sides of a vertical line 6 extending through the center of the plate lengthwise thereof. At the center line 6, each ridge 4 is situated half-way between two ridges 5, and each ridge 5 is situated half-way between two ridges 4. Between adjacent ridges 4 and between adjacent ridges 5 are bridges 7 located at intervals along the ridges.

Of course, the corrugations also form a valley between each pair of adjacent parallel ridges 4 and 5. The bottoms of these valleys are shown by the lines 4*a* and 5*a*, respectively, in FIG. 1; but only a few of the valleys are thus shown in order to avoid undue complication of the drawing. It will be apparent that the bottom 4*a* of each valley forms a ridge on the opposite face of the plate and that each ridge 4 forms the bottom of a valley in said opposite face of the plate, as shown in FIG. 5; and the same is true with respect to the ridges 5 and the valley bottoms 5*a*.

Plates formed according to FIG. 1 may be used in different ways. If a plate interspace is to be provided which offers a relatively small resistance to throughflow of a heat exchanging medium, two plates maybe put together so that one of them is kept in the position shown in FIG. 1, while the other is placed upon the first but turned 180° around the center line 6. The ridges 4 of the turned plate will thus abut the bridges 7 between the ridges 5 of the underlying plate, and the ridges 5 of the turned plate will abut the bridges 7 between the ridges 4 of the underlying plate. Similarly, the ridges 4 and 5 of the underlying plate will abut the bridges 7 of the turned plate. A plate interspace is thus formed wherein the parallel ridges 4 of each plate extend parallel to the ridges 5 of the other plate.

On the other hand, if upon a plate positioned as shown in FIG. 1 there is placed another plate of the same kind which is turned 180° around an axis extending through the center of the plate and perpendicular to the plane of the plate, a plate interspace of another kind having other thermal characteristics is obtained. This is because the ridges of one plate will now cross and abut the ridges of the other plate. Consequently, the plate interspace offers a substantially greater resistance to throughflow of a heat exchanging medium than a plate interspace wherein the ridges **4** of each plate extend parallel to the ridges **5** of the other plate.

In the modification shown in FIG. **2**, the ridges **5** and their corresponding bridges **7** in FIG. **1** are replaced by turbulence-effecting ridges arranged somewhat differently. The latter ridges have portions **8** extending in the same direction as the ridges **5** in FIG. **1** and also have other ridge portions **9** extending in other directions, the ridge portions **9** having the same purpose as the bridges **7** between the ridges **5** in FIG. **1**. It will be understood that the other ridges **4** and their bridges **7** in FIG. **1** are replaced by ridges (not shown) similar to those shown in FIG. **2** except that the ridge portions **8** extend in the same direction as the ridges **4** in FIG. **1**. With the plate in FIG. **1** thus modified, if two of the modified plates are placed together, one of them being turned relative to the other 180° about an axis corresponding to the center line **6** in FIG. **1**, all of the ridge portions **8** of the two plates on each side of the center line will extend parallel to each other, while the ridge portions **9** of one plate will cross and abut the corresponding ridge portions **9** of the other plate. This is illustrated in FIG. **2**, where the dotted lines **8*a*** and **9*a*** designate ridges of the plate turned as described above.

In FIG. **2**, the full lines **8** and **9** may be considered as the modified ridges in the dotted area **11** in FIG. **1**, and the dotted lines **8a** and **9a** may be considered as the modified ridges in the opposing area of the second plate after it has been turned as described above, the latter area corresponding to the dotted area **10** in FIG. **1** before the second plate is thus turned. To avoid confusion, the valleys between the ridges in FIG. **2** are not shown.

If two plates modified according to FIG. **2** are put together, one of them being turned 180° relative to the other around an axis perpendicular to the plane of the turned plate and extending through the center of the plate, ridge portions **8** of one plate will cross and abut ridge portions **8*a*** of the other plate in the entire plate interspace, whereby the resistance to throughflow of a heat exchanging medium will be greater and the plate interspace will consequently have different thermal characteristics.

The plate shown in FIG. **3** has a number of parallel ridges **12** which extend differently compared to the ridges of the plates in FIGS. **1** and **2**. The ridges **12**, between which a number of bridges **7** extend as in the plate according to FIG. **1**, are so located that when two plates are put together, one of them being turned relative to the other 180° around an axis extending perpendicular to the plane of the plate and through the center of the plate, a plate interspace is formed wherein the ridges of one plate extend parallel to the ridges of the opposing areas of the other plate but abut the bridges **7** therebetween. However, if the said one plate is turned relative to the other 180° around the center line **6**, a plate interspace is formed wherein the ridges of the one plate cross and abut the ridges of the other plate. In the two kinds of plate interspaces thus obtainable by means of plates according to FIG. **3**, the flow will be influenced differently and the different plate interspaces will consequently have different thermal characteristics.

The plate shown in FIG. **4** has turbulence-effecting ridges **13** on one side, which are shaped differently compared to turbulence-effecting ridges **14** on the other side of the plate. The central plane of the plate is illustrated by a dotted line **15**. All the tops of the ridges on both sides of the plate are situated at the same distance from this central plane. The ridges of a plate having a cross-section according to FIG. **4** may extend across the heat exchanging surfaces as illustrated in FIG. **2**, the portions corresponding to the ridge portions **8** preferably having a direction parallel to the short sides (ends) of the plate. By means of two plates of this kind, in the same way as by plates according to FIGS. **1**, **2** or **3**, plate interspaces having different thermal characteristics may be obtained by turning one of the plates relative to the other.

Only a few different kinds of plates have been described above, by means of which a plate heat exchanger according to the invention may be assembled. Other kinds and modifications are contemplated within the scope of the appended claims.

I claim:

1. For use in a plate heat exchanger, a plurality of identical heat exchange plates having respective heat exchange surfaces provided with protuberances acting as turbulence-effecting and spacing means between adjacent plates, said plates being adapted for assembly with marginal gaskets to form plate interspaces for throughflow of two heat exchange media along said surfaces at opposite sides, respectively, of each plate, said plates being characterized in that said interspaces are of equal depth and at least one plate is turned 180° relative to the other plates around an axis extending in the plane of the turned plate, said protuberances of each plate being arranged unsymmetrically and so disposed that two different kinds of plate interspaces are formed by said turning of said one plate, thereby creating different flow conditions for the heat exchange media.

2. Heat exchange plates according to claim **1**, wherein said protuberances on each side of each plate are formed by ridges extending in parallel spaced relation, some of the interspaces containing ridges of one plate extending parallel to ridges of the adjacent plate, at least one other interspace containing ridges of one plate forming an angle with ridges of the adjacent plate.

3. Heat exchange plates according to claim **2**, comprising also bridges extending between the ridges of each plate and acting therewith as spacing protuberances.

4. Heat exchange plates according to claim **1**, wherein said protuberances on one side of each plate are shaped differently than the protuberances on the other of said plate.

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