

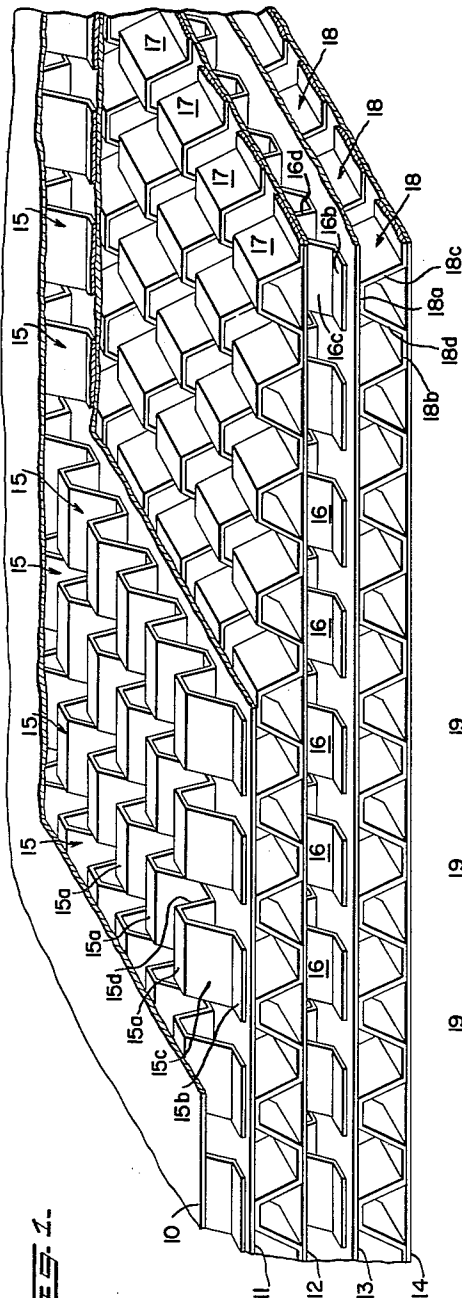
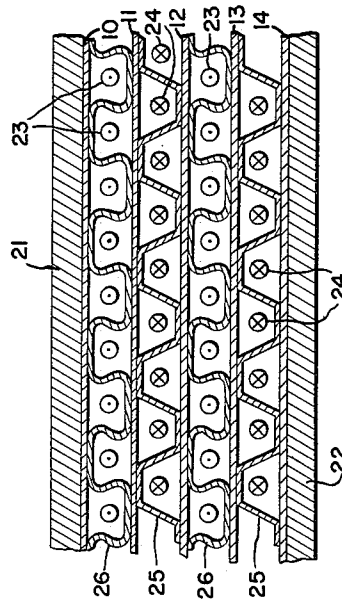
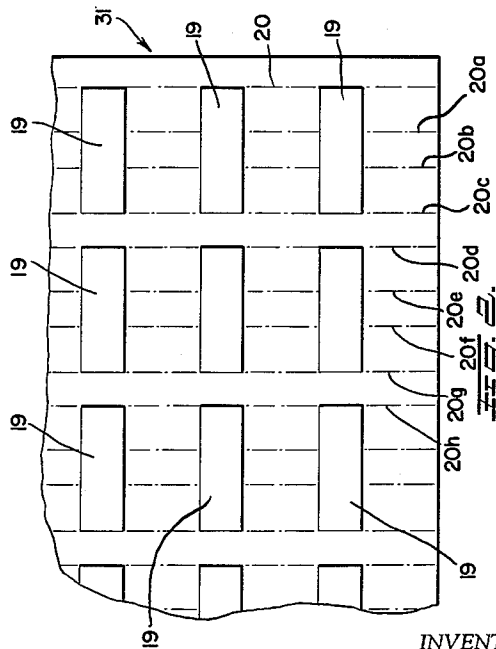
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HEAT TRANSFER PLATE CONSTRUCTION

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HEAT TRANSFER PLATE CONSTRUCTION

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The present invention relates to heat exchangers which consist of parallel plates, the intermediate spaces of which are alternately traversed, preferably in cross- or counter-flow pattern, by the media which are to be heated or cooled.

In the prior art heat exchangers consisting of a plurality of plates are known in which corrugated sheet metal members are arranged between the plates, so that channels in the direction of flow are formed between the sheet metal members and the plates through which the media may flow.

The present invention aims at a particularly favorable construction of such "plate" heat exchangers, i.e., heat exchangers formed by a plurality of plates which enables a construction of heat exchangers which are relatively small and therewith relatively inexpensive, of light weight, and space saving with simultaneous relatively high efficiency.

It is proposed, according to the present invention, that the channel walls formed by the corrugated sheet metal members be provided with interruptions or discontinuities in the direction of flow at least within those regions in which the channel walls do not abut against the plates. In that manner, the heat transfer is considerably increased as compared to heat exchangers having channels which are uninterrupted or continuous. This is due to the fact that the heat transfer is proportional to the temperature gradients along the wall. This temperature gradient is relatively steep at the beginning of the entrance or admission of a flow into a channel as at first all of the streamlines have the same temperature. However, in the course of flow through the channel the streamlines located in proximity of the walls cool off or heat up until an equilibrium condition is obtained in which the maximum temperature difference with respect to the wall is located in the center of the channel and decreases towards the sides relatively gradually. If the channel walls in accordance with the present invention are interrupted over and over again, then the flow with each interruption is repeatedly disturbed by the formation of turbulences, eddies or the like, i.e., the temperature is thereby again evened out over the entire cross section of flow so that the temperature gradient in proximity to the wall during the entrance into the next channel portion is again very great.

In that manner, it is possible to obtain the relatively high heat transfer over the entire length of flow through the heat exchanger which is present only with a simple continuous uninterrupted tube or pipe only directly at the entrance thereof.

A simple manufacture and construction including the desired interruptions is possible if the corrugated sheet metal members consist of many strips made of sheet metal which are disposed transversely to the direction of flow and at a distance from each other. On the other hand, it is also possible to manufacture a plate heat exchanger in accordance with the present invention in such a manner that the corrugated sheet metal members consist each of a uniform piece of sheet metal which is provided with recesses or openings which correspond to the desired interruptions. In that manner, an accurate mutual position of the partial channels is assured.

If, in accordance with a further feature of the present

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invention the channel pieces which are separated from each other by the interruptions are disposed transversely to the direction of flow, then it is possible to achieve with still greater certainty a disturbance of the temperature profile present at the end of each individual channel piece and may thereby also decrease the distance of the individual strips in the direction of flow.

According to a further feature of the present invention, a special construction or enclosure may be provided with plate heat exchangers in which the two media are at different pressures so as to absorb the pressure forces tending to force apart the limit or boundary plates of the high pressure parts, for example, in the shape of particularly strong terminal plates or terminal plates provided with ribs. In that manner, the channel walls arranged between the boundary plates of the high pressure portions are relieved to a large extent from the tensile stresses ordinarily required thereof for keeping together the boundary plates or may be relieved altogether from such ensile stresses. This is particularly advantageous in connection with a construction according to the present invention having sheet metal members provided with interruptions, as in such a construction, by reason of the interruptions, the connecting surfaces between the sheet metal members and the plates are also interrupted and such connections, for example, effected by soldering or brazing, from an over-all point of view cannot absorb as much tensile stress as with a connection with uninterrupted sheet metal members.

Furthermore, in connection with heat exchangers for media of different pressures, it is proposed in accordance with the present invention that the shape of the corrugations of the sheet metal members for the medium at lower pressure be provided with essentially rectilinear reinforcements or supports from plate to plate and that the shape of corrugations of the sheet metal member for the media which are under higher pressure be provided with essentially S-shaped, curved connections from plate to plate. In this manner, it is prevented to a large extent that the spaces which are subjected to lower pressure are squeezed together due to the forces produced thereby. On the other hand, if a limited movement of the boundary plates should take place in this sense, i.e., in the direction of compressing the low pressure spaces by a ready increase in the distance of the plates from each other which define the space for the higher pressure, then the corrugated sheet metal members of the high pressure space do not become detached from the boundary plates as they are sufficiently elastic as a result of the S-shaped curvature to follow this increase in distance.

For purposes of decreasing the losses in flow, the channel walls may be provided with rounded off end sides or with streamlined profiles as visualized in cross sections parallel to the plates. Furthermore, in those cases in which clogging up of the heat exchanger is feared by reason of foreign bodies being carried by the flow medium, the present invention proposes to let the cross sections of the flow channels of the individual channel pieces deviate from each other, preferably in such a manner that the channel pieces located at the entrance of the flowing medium into the heat exchanger have a larger cross sectional area.

Accordingly, it is an object of the present invention to provide a heat exchanger which offers a very favorable construction with the use of plates.

Another object of the present invention is to provide an extremely efficient heat exchanger which is, nevertheless, compact and sturdy, and has considerable space saving characteristics.

A primary object of the present invention resides in the provision of a heat exchanger which increases the efficiency thereof to a very considerable extent.

Another object of the present invention resides in the provision of a heat exchanger which increases the heat transfer capacity for a given size by simple and inexpensive means.

Still another object of the present invention resides in the construction of a heat exchanger which is designed to continuously disturb the flow lines so as to even out and therewith increase the effective temperature gradient throughout the system.

A still further object of the present invention is the provision of a heat exchanger which is so constructed as to even out temperature distribution over the entire cross section throughout the entire flow path thereby assuring a maximum heat transfer over the entire length of the flow of the medium through the heat exchanger.

A still further object of the present invention is the provision of a heat exchanger which, contrary to known devices, provides efficient heat transfer over the entire length thereof instead of only at the entrance as is the case with most present day known heat exchangers.

A still further object of the present invention resides in the provision of such a heat exchanger which fulfills all the aforementioned objects in a manner which lends itself readily to inexpensive manufacture.

Another object of the present invention is to provide a construction for a heat exchanger which readily resists any forces due to differences in pressure between the media within the heat exchanger.

Other objects of the present invention reside in the provision of a heat exchanger which minimizes flow losses by the construction of the end portions of the channels and which also lessens the danger of clogging up by the presence of foreign particles which may be carried through this system by the media.

These and other objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, three embodiments in accordance with the present invention, and wherein:

FIGURE 1 is a perspective view of a first embodiment of a heat exchanger in accordance with the present invention consisting of plates and constructed according to the cross current principle in which the corrugated sheet metal members are subdivided into individual strips.

FIGURE 2 is a plan view of a unitary sheet metal plate provided with appropriately shaped recesses in accordance with the present invention which may be used in the construction of a heat exchanger according to the present invention, and

FIGURE 3 is a cross sectional view through another embodiment of a plate heat exchanger in accordance with the present invention for use with the counter flow principle in which media of different pressure are to be used.

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, and more particularly to FIGURE 1, reference numerals 10 to 14 designate the plates which separate from each other the spaces for the media which are in mutual heat transfer relationship within the heat exchanger and which flow through the flow channels according to the cross-flow principle. An appropriately large number of individual sharp-edged undulated or corrugated individual sheet metal strips generally designated by reference numerals 15 and 16 form the channels for the first medium flowing from the right to the left or vice versa, whereas individual sheet metal strips generally designated 17 and 18 form the channels for the second medium flowing at essentially right angles to the direction of flow of the first medium. The strips 15-18 are formed from separate flat sheet metal strips having a width corresponding to the desired, predetermined length of each channel portion and may be shaped to assume the configuration shown in the drawing in any suitable manner.

As shown in FIGURE 1, each of the sheet metal strips 15 is formed so as to have flat portions 15a and 15b by means of which they are secured to the plates 10 and 11, respectively. The flat portions 15a and 15b are joined by essentially rectilinear portions 15c and 15d thereby giving the effect of undulated or corrugated sheet metal strips. The sheet metal strips 16, 17 and 18 are each provided with corresponding portions 16a, 16b, 16c and 16d; 17a, 17b, 17c and 17d; and 18a, 18b, 18c and 18d, respectively.

FIGURE 2 shows a flat sheet metal member generally designated by reference numeral 31 provided with appropriately shaped recesses 19. The sheet metal member 31 may be used to construct an arrangement corresponding to the individual strips of sheet metal members 15, 16 17 or 18 shown in FIGURE 1. This may be done by folding the sheet metal member 31 about lines 20, 20a, 20b, 20c, 20d, 20e, 20f, 20g, 20h, et cetera, shown in dot-and-dash lines in FIGURE 2, so that, for example, the portions located between 20c and 20d and between 20g and 20h correspond to the flat portions 15a or 15b, or to the flat portions 16a or 16b, et cetera, while other portions thereof will constitute the other corresponding portions thereof.

The bending or shaping operation of the sheet metal member 31 may be done in any suitable manner. It is understood that instead of providing configurations such as shown in FIGURE 1, the sheet metal member may also be shaped in any other suitable manner so as to provide, for example, corrugations essentially in the shape of those designated by reference numeral 26 in FIGURE 3.

FIGURE 3 shows a cross section through still another embodiment of a plate heat exchanger in accordance with the present invention in which, in addition to the heat exchange plates 10-14 two terminal securing plates 21 and 22 are provided. The gas streams flow in that embodiment according to the counter-flow principle as is indicated by the symbols of the point and tail of an arrow indicated in the drawing whereby the symbols 23 indicate the point of the arrow, i.e., the flow in the direction toward the viewer whereas the symbol 24 indicates the tail of the arrow, i.e., the flow in the direction away from the viewer. The medium with the direction of flow 23 is thereby to be at much higher pressure than that of direction of flow 24. Accordingly, the shape of the sheet metal strips is formed correspondingly different. If, under the influence of the higher pressure in the spaces for 23 the spaces for 24 are to be slightly compressed which, however, is to be prevented to a large extent by the rectilinear leg portions or supports 25, then the S-shaped bent sheet metal strips 26 do not tear off from the heat exchange plates 10-13 to which they are secured in any suitable manner as by soldering or brazing, as the S-shape assures sufficient elasticity for a yielding in the direction of tension.

As shown in FIGURE 3, the walls of each strip 26 are so constructed as to include flat parts and reversely curved portions, the curvature of one of these portions merging with the curvature of the other. These reversely curved portions are disposed intermediate of flat parts, the latter being parallel to and secured to respective pairs of adjacent heat exchange plates 10-13 shown in this figure. These reversely curved portions are thus free of direct connection to these plates and provide the elasticity just referred to, since their shape enables them to yield under the influence of the high pressure flow 23.

While I have shown and described several preferred embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of many changes and modifications in accordance with the present invention, and I intend to cover all such changes and modifications as encompassed by the appended claims.

I claim:

1. A plate type heat exchanger comprising a plurality

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of plates comprising a first set of adjacent plates defining first spaces intermediate each pair of said adjacent plates, said plurality of plates further comprising a second set of adjacent plates defining second spaces intermediate each pair of said last-named plates, said plurality of plates including at least one plate common to said first set and to said second set, said first spaces being adapted for flow therethrough of a high-pressure medium, said second spaces being adapted for flow therethrough of a low-pressure medium, said heat exchanger further comprising first undulated sheet metal strips in said first spaces having flat portions secured to said first-named adjacent plates and forming a plurality of channels in the direction of flow of said high pressure medium, said strips being spaced from each other in the said direction of flow of said high pressure medium, said heat exchanger further comprising second undulated sheet metal strips in said second spaces secured to said adjacent plates of said second set, said second undulated sheet metal strips forming a plurality of channels in the direction of flow of said low pressure medium, said second undulated sheet metal strips being spaced from each other in said direction of flow of said low pressure medium, said first set of adjacent plates being subject to movement relative to each other in response to pressure of said high pressure medium, said first undulated metal strips comprising means adapted for yielding movement in response to said movement of said first set of adjacent plates, said means adapted for yielding movement comprising reversely curved portions of said undulated strips, said reversely curved portions being

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intermediate said flat portions and being effective to relieve said flat portions from strains tending to separate said flat portions from said first-named adjacent plates.

2. A plate-type heat exchanger according to claim 1, wherein said reversely-curved portions are free of direct connection to said first set of adjacent plates.

3. A plate-type heat exchanger according to claim 1, wherein said second undulated sheet metal strips comprise rectilinear leg portions extending between each pair of said second set of adjacent plates.

4. A plate-type heat exchanger according to claim 1, wherein said first-named plurality of channels and said second-named plurality of channels extend in the same general direction.

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