

May 26, 1953

R. P. L. HYTE
PLATE HEAT EXCHANGER

2,640,194

Filed July 12, 1949

3 Sheets-Sheet 1

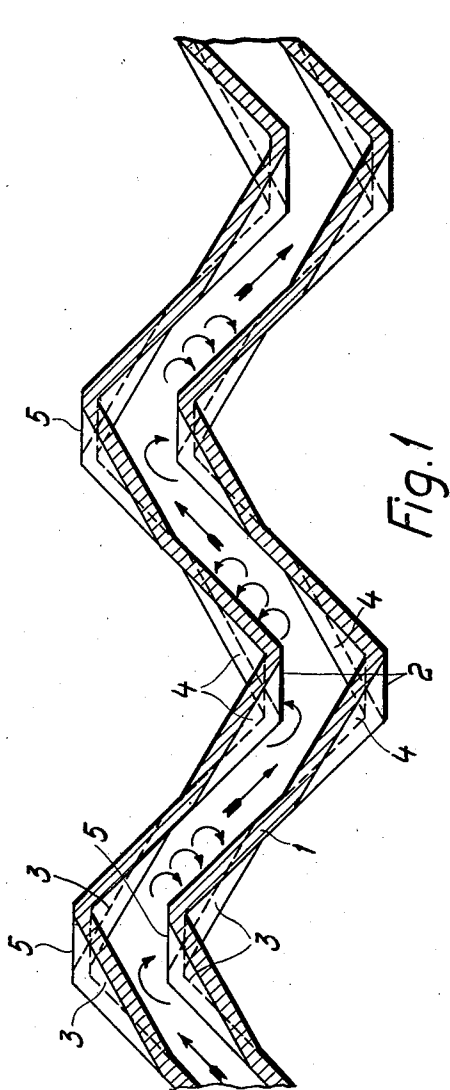


Fig. 1

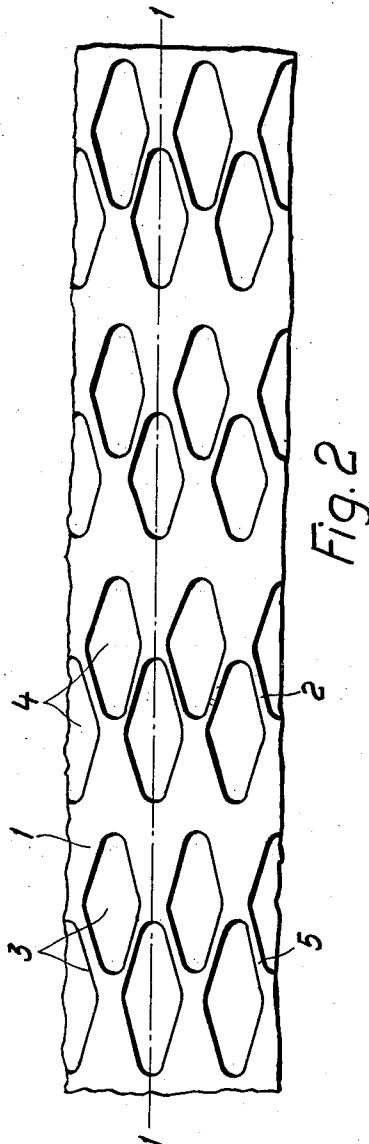


Fig. 2

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3 Sheets-Sheet 2

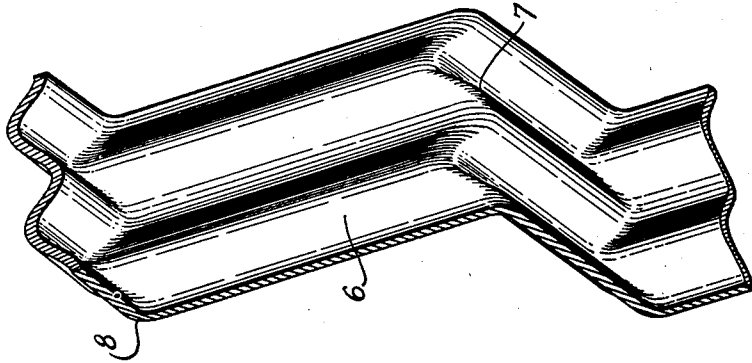


FIG. 4a.

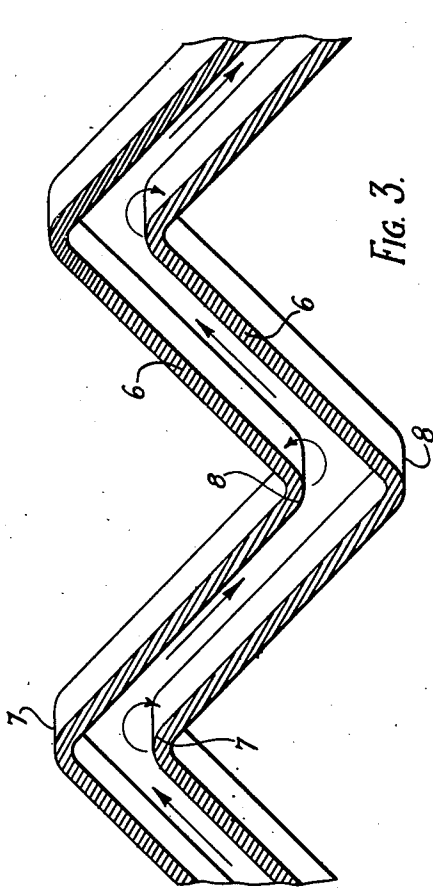


FIG. 3.

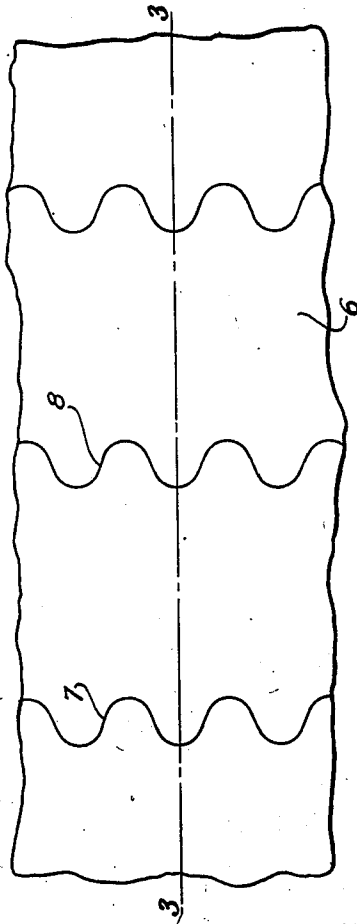


FIG. 4.

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3 Sheets-Sheet 3

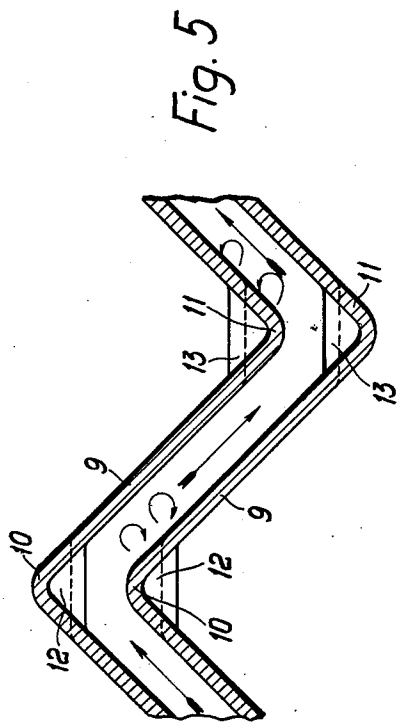


Fig. 5

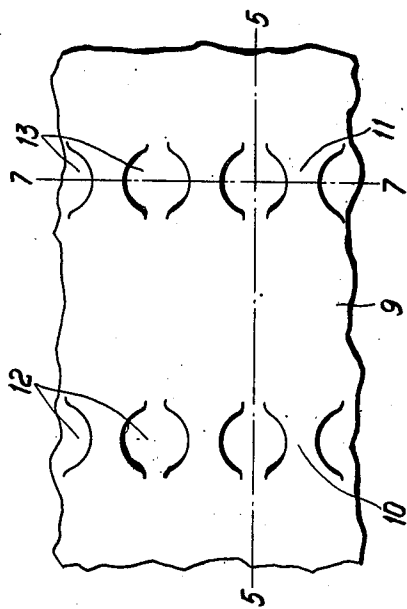


Fig. 6

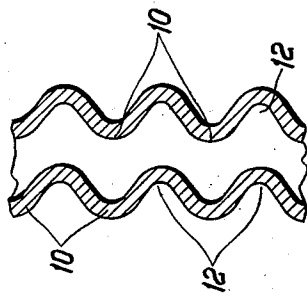


Fig. 7

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PLATE HEAT EXCHANGER

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10 Claims. (Cl. 257—256)

1

This invention relates to heat exchangers and more particularly to an improved plate heat exchanger which provides a more turbulent flow through the exchanger than has been possible heretofore.

The plates in which heat is transmitted from one flowing medium to another in plate heat exchangers are often corrugated with sharp edges for the purpose of increasing the area of the heat transmitting surfaces and intensifying the heat transmission. The latter effect is due to the shape of the channels which causes the flow of the liquid to become turbulent. The corrugations are arranged transversely relative to the direction of flow.

The object of the present invention is to provide a considerable increase in the turbulency of the liquid flow through the plate interspaces. This is accomplished essentially by forming the ridges of the corrugations with an irregular shape so that the tendency for laminar flow through the plate interspaces is greatly reduced or practically eliminated. In accordance with the invention, the ridges of the corrugations should therefore be jagged or toothed.

A corrugated plate comprises a series of curved surfaces consisting of upwardly projecting ridges alternating with depressions. In the practice of the invention it is important, first of all, that the ridges are of irregular shape, as mentioned above. However, the turbulency may be further increased somewhat by making the depressions or bottom portions of the plates of irregular shape as well. When the plates are manufactured by pressing thin sheet steel, it is a very simple matter to provide both depressions and ridges with similar distortions, because a certain distortion of the bottom of the corrugations also entails an equivalent distortion on the other side of the plate; that is, a depression always corresponds to a ridge or protuberance.

The distortions or irregularities of the ridges and depressions should not be too large. Their size must be determined in view of the thickness of the liquid layer between two adjacent plates in the heat exchanger; that is, a great number of small whirls, rather than a small number of large whirls, should be formed in the liquid layer. A suitable size for the distortions is that resulting when the distance between two adjacent tops of distortions is from one-half to twice the thickness of the liquid layer. However, distortions of the corrugations within much wider limits will favorably influence the turbulency and the heat transmission. Distortions of many different

2

forms may be used, and consequently the pattern formed by the distortions may vary widely.

For a better understanding of the invention, reference may be had to the accompanying drawings, in which

Fig. 1 is a longitudinal sectional view of a pair of assembled plates made according to the invention, the section being taken on the line 1—1 in Fig. 2;

Fig. 2 is a plan view of one of the plates shown in Fig. 1;

Figs. 3 and 4 are views similar to Figs. 1 and 2, respectively, but showing another form of the new plate;

Fig. 4a is a perspective view of part of one of the plates illustrated in Figs. 3 and 4, showing the sine wave in a plane normal to the heat exchange plate;

Figs. 5 and 6 are views similar to Figs. 1 and 2, respectively, but showing still another form of the invention, and

Fig. 7 is a sectional view on the line 7—7 in Fig. 6.

Referring to Figs. 1 and 2, the plates 1 are provided with transverse corrugations having flattened ridges 5 alternating with flattened depressions 2. Each ridge 5 is formed with transversely spaced indentations 3 which protrude downwardly into the ridge, while each depression 2 is formed with transversely spaced indentations 4 which protrude upwardly into the depression. As shown, the indentations 3 and 4 are diamond-shaped and are staggered so that adjacent indentations are at opposite sides of each ridge 5 or each depression 2, respectively. Thus, alternate indentations 3 of each ridge, for example, are at one side of the ridge, while the intermediate indentations 3 are at the other side of the ridge. In this way, the ridges and depressions are made jagged or toothed so that they are of irregular shape transversely of the plate.

It will be understood that the plates 1 in any desired number are assembled in parallel relation in the heat exchanger frame and are provided with the usual openings (not shown) for separate passage of the liquid to be heated (or cooled) and the heating (or cooling) medium into alternate plate interspaces. Since the invention is not concerned with details of the frame and the arrangement of the plate openings, which may be conventional, these are not illustrated.

Assuming that a liquid to be heated flows from left to right between the plates 1, as illustrated in Fig. 1, the liquid passing over each ridge 5 of the lower plate will be given an increased tur-

3

bulency by reason of the spaced recesses in the indentations 3 of the lower plate and the corresponding downward protrusions formed by the indentations 3 of the upper plate. Increased turbulence in this case is effected by the action of the clockwise eddies at the regions of the indentations 3, as shown by the arrows in Fig. 1. As the liquid flows under each depression 2 of the upper plate, increased turbulence is effected by reason of the recesses in the indentations 4 of the upper plate and the corresponding upward protrusions formed by the indentations 4 of the lower plate, the eddies created in the regions of the indentations 4 being counterclockwise, as shown by the arrows in Fig. 1. Since the eddy currents thus formed will vary in intensity at different points along the ridges 5 and depressions 2, due to the irregular shape imparted to the ridges and depressions by the indentations 3 and 4, respectively, a relatively violent turbulence is effected, thereby insuring a better heat transmission.

Referring to Figs. 3, 4 and 4a, each plate 6 is corrugated to form narrow, sharply defined ridges 7 and depressions 8 arranged in alternation. Each ridge 7 and depression 8 is in the form of a sine wave, as shown in Figs. 4 and 4a. Thus, each plate is provided in effect with longitudinal corrugations or flutes extending from each ridge 7 to its adjacent depressions 8.

In the form of the invention illustrated in Figs. 5, 6 and 7, each plate 9 has transverse corrugations forming ridges 10 alternating with depressions 11. The ridges 10 are provided with transversely spaced indentations 12 which protrude downwardly into the ridges; and the depressions 11 are provided with similarly spaced indentations 13 which protrude upwardly into the depressions. Accordingly, the ridges and depressions appear as sine waves in planes normal to the plane of the plate and extending along the centers of the ridges and depressions, as illustrated in Fig. 7.

It will be understood that the plates shown in Figs. 3 through 7 function in essentially the same manner as previously described in connection with the plates shown in Figs. 1 and 2. In each case, because the ridges and depressions are given irregular shapes in planes disposed transversely of the plate, a high degree of turbulence is imparted to the liquid as it flows longitudinally between the plates, as indicated by the arrows in Figs. 3 and 5. The distance between adjacent indentations 3 or 4 (Figs. 1 and 2), between adjacent indentations 12 or 13 (Figs. 5-7), and between corresponding parts of the sine waves 7 or 8 (Figs. 3 and 4) is preferably between one-half and twice the thickness of the liquid layer between adjacent plates.

As shown in the drawings, the ridges and the depressions of each of the assembled plates are in vertical alignment with the ridges and depressions, respectively, of the other plates; and the indentations formed in the ridges and depressions of each plate are also in vertical alignment with the corresponding indentations in the other plates. In other words, the opposed walls of the channels are located at a constant distance from each other, wherever a vertical section is taken, either longitudinally or transversely of the plates. In this way, throttling of the liquid flow through the exchanger, due to the distortions of the ridges and depressions, is prevented. Thus, while the through-flow area of each channel is constant throughout, so that the flow rate of the liquid is not substantially reduced, the distortions of the

4

ridges and depressions create a much greater turbulence and consequently a greatly improved heat transfer capacity.

I claim:

1. A plate heat exchanger comprising a plurality of spaced heat exchange plates, each of which is corrugated to form alternate ridges and depressions extending transversely of the direction of liquid flow along the plate, the ridges having distortions spaced transversely of said direction to provide each ridge with an irregular shape transversely of said direction, whereby turbulence of said liquid flow is promoted, said ridges, depressions and distortions of each plate being aligned with similar ridges, depressions and distortions, respectively, of each adjacent plate, whereby the opposed walls of the channel formed therebetween are located at a constant distance from each other in the longitudinal as well as the transverse direction of the plates.

2. A heat exchange plate according to claim 1, in which the depressions also have distortions to provide each depression with an irregular shape transversely of said direction, whereby turbulence of said liquid flow is promoted.

3. A plate heat exchanger comprising a plurality of spaced heat exchange plates, each of which is corrugated to form alternate ridges and depressions extending transversely of the direction of liquid flow along the plate, the ridges and depressions having indentations spaced transversely of said direction to provide each ridge and depression with an irregular shape transversely of said direction, whereby turbulence of said liquid flow is promoted, said ridges, depressions and indentations of each plate being aligned with similar ridges, depressions and indentations, respectively, of each adjacent plate, whereby the opposed walls of the channel formed therebetween are located at a constant distance from each other in the longitudinal as well as the transverse direction of the plates.

4. A heat exchange plate according to claim 3, in which said indentations in the ridges form protrusions extending downwardly into the ridges, and said indentations in the depressions form protrusions extending upwardly into the depressions.

5. A heat exchange plate according to claim 3, in which the ridges are flattened at the top and the depressions are flattened at the bottom, the indentations being disposed at opposite sides of said flattened portions.

6. A heat exchange plate according to claim 3, in which the ridges are flattened at the top and the depressions are flattened at the bottom, the indentations being disposed in staggered relation at opposite sides of said flattened portions.

7. A heat exchange plate according to claim 3, in which the plate has corrugations extending longitudinally of said direction between adjacent ridges and depressions, to form said indentations.

8. A heat exchange plate according to claim 3, in which said ridges and depressions are each in the shape of a sine wave, to form said indentations.

9. A heat exchange plate according to claim 3, in which each ridge and depression is in the shape of a sine wave in a plane normal to the plate and transverse to said direction.

10. In a plate heat exchanger, a plurality of heat exchange plates each of which is corrugated to form alternate ridges and depressions extending transversely of the direction of liquid flow along the plates, the ridges having distortions

5

spaced transversely of said direction to provide each ridge with an irregular shape transversely of said direction, whereby turbulence of said liquid flow is promoted, the spacing between adjacent distortions of each ridge being between one-half and twice the thickness of the liquid layer between adjacent plates.

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