

Nov. 9, 1965

H. F. GOODMAN

3,216,494

HEAT EXCHANGER PLATE

Filed July 17, 1961

4 Sheets-Sheet 1

Fig. 1.

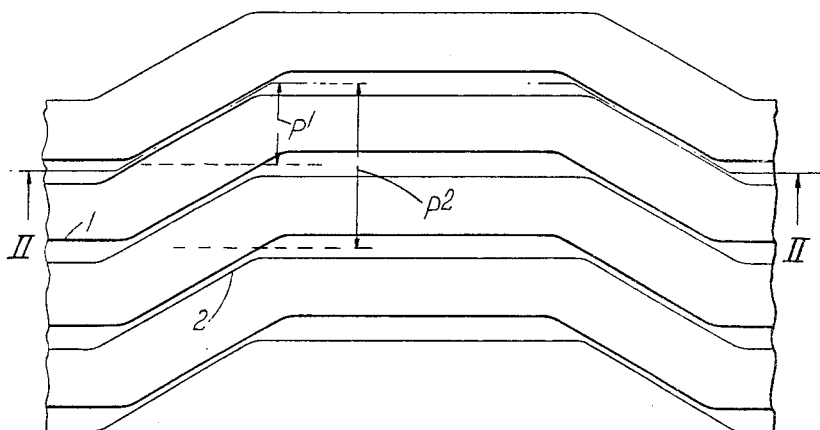
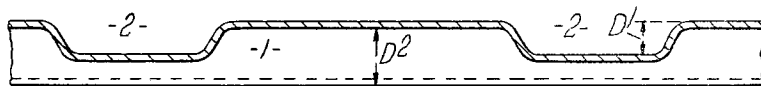


Fig. 2.



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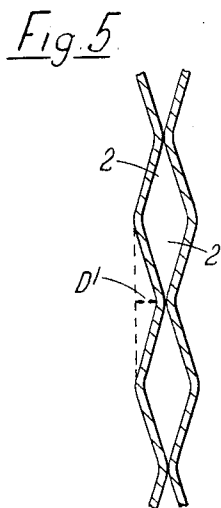
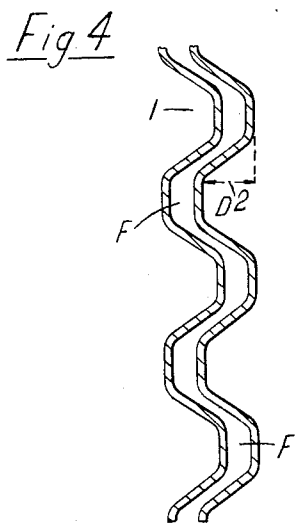
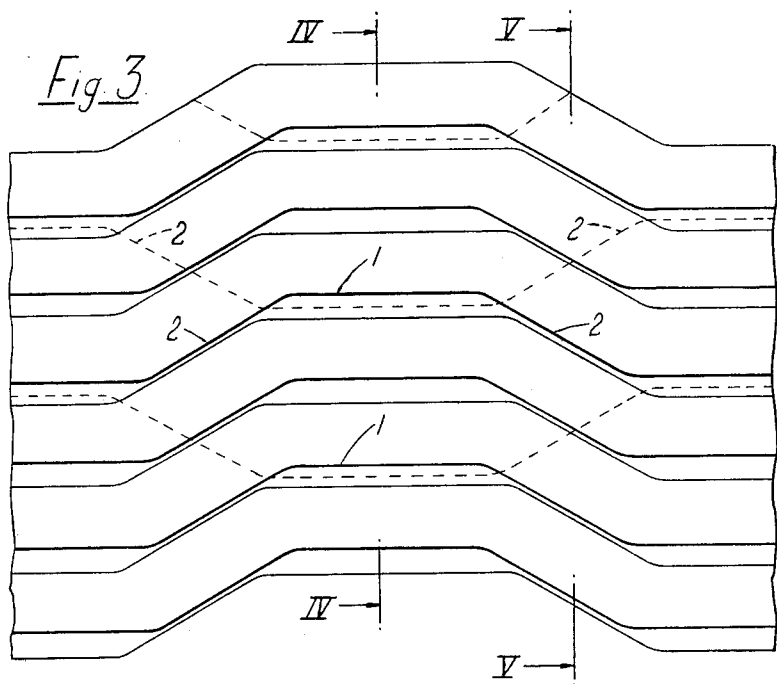
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4 Sheets-Sheet 2



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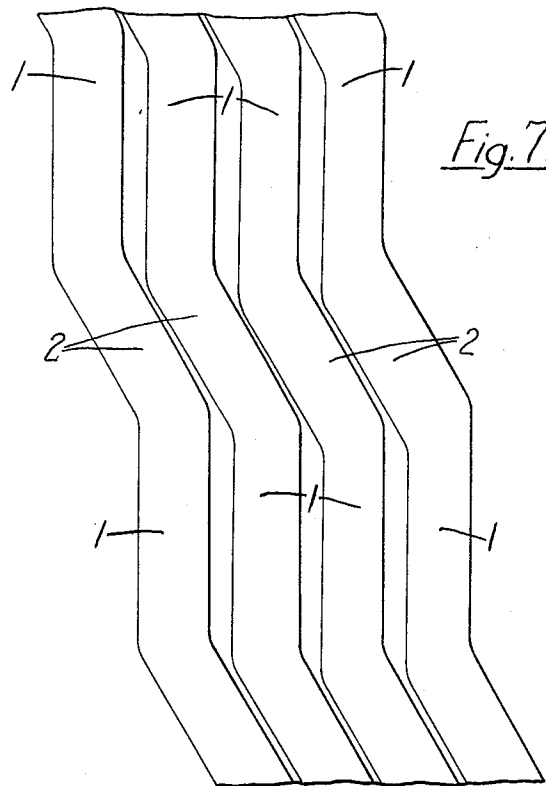
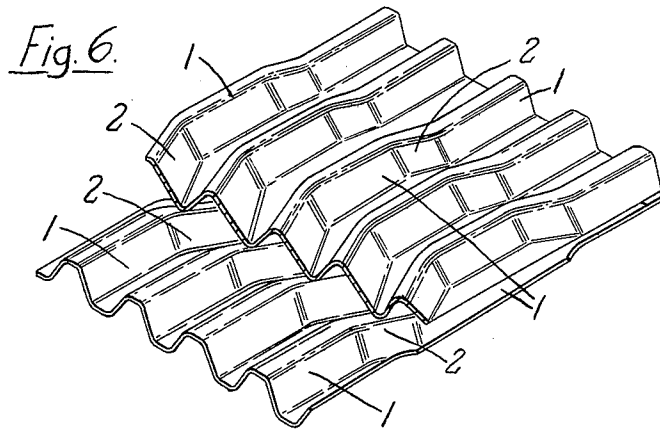
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4 Sheets-Sheet 3



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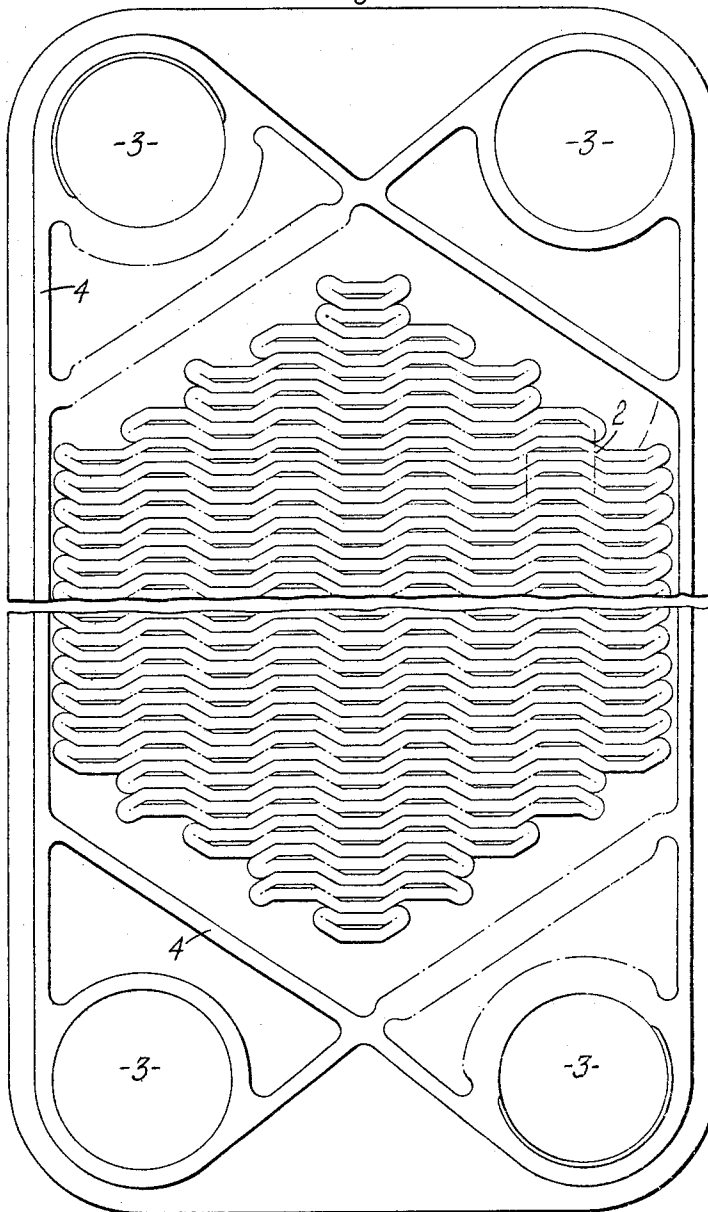
H. F. GOODMAN
HEAT EXCHANGER PLATE

3,216,494

Filed July 17, 1961

4 Sheets-Sheet 4

Fig. 8



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1

3,216,494

HEAT EXCHANGER PLATE

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Claims priority, application Great Britain, July 20, 1960,
25,335/60

10 Claims. (Cl. 165-166)

This invention relates to heat exchangers of the type known as plate heat exchangers, in which a number of plates are assembled in spaced face-to-face relationship to provide flow passages for the fluids between which heat is to be exchanged through the metal of the plates.

The fluids are usually contained within the plates by sealing strips of rubber or other resilient material disposed about the periphery of the plates.

There are two objects to be aimed at in the design of such plates: firstly it is desirable to produce a high degree of turbulence within the fluids so as to effect high rates of heat transfer and, secondly, to maintain the plates in accurate spaced relationship and to enable them to resist the fluid pressures acting on them without creating excessive flexing of, or stress within, the metal of the plates. These objects are often achieved by pressing into one face of the plates a number of transverse or inclined grooves (which form ribs on the other face) and which when co-operating with each other produce the desired turbulence, stiffen the plate surfaces and, in some cases, provide a series of points of contact between successive plates which, if the pressure difference between the plates is relatively high, are necessary to prevent deflection of the plates.

In one known form of plate the ribs are of V formation pressed to a depth equal to the distance between adjacent plates. The ribs form a continuous wavy surface, and are inclined at an angle, usually 45° or less, to the transverse dimension or width of the plate. On alternate plates the inclination of the ribs is reversed relative to the length of the plate so that when stacked and tightened together a number of points of contact occur between the ribs of successive plates. In plates of this kind a high degree of mutual support between adjacent plates can readily be arranged.

In another widely used form of plate, the ribs are not inclined widthwise of the plate, but are formed transverse to the length of the plate, and when co-operating with the corresponding ribs of adjacent plates form undulating flow passages which are particularly effective in producing the required physical effect of a high rate of heat exchange for a minimum of pressure drop in the fluid. It is usual to afford inter-plate support in this arrangement by means of local projections pressed into the faces of the grooves created by the forming of the ribs.

The object of the present invention is to combine the advantage of both styles of plate, i.e., the method of support provided by the first style of plate combined with the heat exchange efficiency of the second style of plate.

Broadly stated, the present invention comprises forming in the plates a number of ribs which are spaced longitudinally along the plates, and the length of each of which is made up by sections which are transverse and are spaced apart transversely across the plate, and by oblique sections which join the spaced transverse sections to one another.

In one arrangement, each pressed out rib is made up of a series of relatively short transverse sections spaced apart both transversely and longitudinally to form a plurality of longitudinal rows of transverse sections, the transverse sections in each row being spaced from one another longitudinally in the row. The transverse sec-

2

tions of each row intermediate two contiguous rows are joined with transverse sections in the two contiguous rows by oblique sections of successively reversed inclinations so as to form a wavy, or undulating, rib line as seen in face view.

In another arrangement, each rib comprises a number of transverse sections progressively out of transverse alignment and joined to one another by oblique sections having the same sense of slope.

The longitudinal distance between the two transverse rows of transverse sections in each rib is made equal to half the longitudinal pitch between successive transverse rows of complete ribs. Adjacent plates are arranged so that their transverse sections overlies each other and so that their oblique sections are of opposite inclination and, therefore, cross each other to provide mutual support. This is readily achieved from similar pressings (so far as the rib formations are concerned) if there are an even number of oblique sections in each row (so that the portions at the extreme end of each row are of opposite inclination) and successive plates are reversed end to end.

The depth of the oblique sections of the ribs must be equal to the space between successive plates, but the transverse portions may, if desired, be of greater depth so that these portions nest within each other.

The invention is illustrated in the accompanying drawings in which FIGURES 1-6 are views of a plate having one form of rib, FIGURE 1 being a face view of a part of the plate, FIGURE 2 a section on the line II-II of FIGURE 1, FIGURE 3 a face view showing two such plates in their face-to-face relationship, FIGURE 4 a section on the line IV-IV of FIGURE 3, FIGURE 5 a section on the line V-V of FIGURE 3, and FIGURE 6 a perspective view showing two such plates assembled with one partly broken away to expose the other plate; FIGURE 7 is a face view of part of a modified form of plate; FIGURE 8 is a face view of a typical form of plate having formed in it the ribs of the style shown in FIGURES 1-6.

Referring firstly to the construction shown in FIGURES 1-6 and FIGURE 8: each plate has pressed into one face a series of short transverse grooves 1 arranged in rows extending longitudinally on the plate and the transverse grooves in adjacent rows are joined by oblique grooves 2 of successively reversed inclination so that, in effect, each recess is formed to have an undulating line as seen in the face view of FIGURE 1. The longitudinal pitch P^1 between the transverse grooves 1 in each row is made equal to one half the longitudinal pitch P^2 between the rows. The plate being of uniform thickness, the formation of the grooves in the one face produces corresponding ribs on the other face.

More particularly considering the construction shown in FIGURES 1-6 and FIGURE 8, each plate has pressed into one face a series of grooved recesses which extend generally across the plate and are deployed adjacent to one another longitudinally of the plate. The recesses comprise short transverse groove sections 1 bounded by transverse rib sections arranged in transverse section rows extending longitudinally of the plate, and oblique groove sections 2 bounded by oblique rib sections arranged in oblique section rows extending longitudinally of the plate, the oblique section rows intervening between and alternating with the transverse section rows. In each grooved recess, the oblique sections 2 are of successively reversed inclination and are interposed between and join the transverse sections to form, in effect, an undulating grooved recess as seen in the face view of FIGURE 1. The longitudinal pitch P^1 between the transverse sections of two adjacent grooved recesses in the same transverse section row is equal to half the longitudinal pitch P^2 between a transverse section of one grooved recess in one transverse

section row and the transverse section of the adjacent grooved recess in an adjacent transverse section row.

The depth D^1 of the oblique grooves 2 (as shown in FIGURE 5) is equal to the space required between successive plates in the assembly of plates.

When now such plates are assembled face-to-face with the oblique sections of the ribs of opposed plates opposed to one another but at opposite inclinations, as is indicated in FIGURES 3 and 5, the plates will be supported from one another within their flow area by these oblique sections crossing and bearing against one another: the depth D^2 of the transverse grooves 1 may be chosen to suit requirements as the walls of the grooves (as is shown in FIGURE 4) overlie one another to provide the required undulating flow passage F which is thus defined between the plates.

Although the depth D^2 can be less or greater than the depth D^1 , it can advantageously be made equal to the depth D^1 ; with such a selection the press tools required for pressing-out the plates are more easily produced and the plates can be supported in production against a flat surface.

In the modification shown in FIGURE 7, the transverse sections 1 of the grooves are still in transverse alignment, but the sections 1 in the various rows are joined by oblique sections 2 all of the same inclination, so that the various sections are in an alignment which is oblique to the length of the plates.

The oblique sections are (as is shown) of V cross-section and it will be clear that the apex or ridge of the V's on one plate provide ribs which cross, are engaged, and supported by the apex or ridge of the V's on the adjacent plate.

As is indicated in FIGURE 8, the plates of this invention would be formed with openings 3 to provide, by the assembly of the plates, the usual supply and return ducts for the two fluids between which heat exchange is required through the plates, and with the usual gaskets 4.

With plates so produced and assembled, the required inter-plate support is provided and, at the same time, longitudinal undulating passages F are provided for the liquids.

What we claim is:

1. A plate type exchanger for heat exchanging media comprising in combination at least two heat exchanger elements each having pairs of thermoconducting plates with the plates of each pair arranged in face-to-face relation and having a longitudinal extent and a transverse extent, each of said plates being formed with ribs arranged in a series longitudinally along the plate and each comprising sections which are transverse to the length of the plate and sections which join the transverse sections and are disposed obliquely to the length of the plate and assembled face-to-face with the oblique sections of each pair of plates crossing and bearing against one another intermediate their ends to provide interplate support and with the transverse sections overlying one another to provide an undulating flow passage extending longitudinally of said plate and transversely with respect to said ribs.

2. A heat exchanger as claimed in claim 1 and wherein in each plate each rib of the series comprises a number of transverse sections, and oppositely inclined oblique sections joining the transverse sections.

3. A heat exchanger as claimed in claim 1 and wherein in each plate each rib comprises a number of transverse sections joined to one another by similarly sloped oblique sections.

4. A heat exchanger as claimed in claim 1 and wherein the depth of each transverse rib-forming groove in each

plate is equal to one half of the required spacing of adjacent plates.

5. A heat exchanger as defined in claim 1 wherein the oblique sections have a V cross-sectional shape whereby the ridges of the V's of one plate cross and are supported by the ridges of the V's of the adjacent plate.

6. A heat exchanger plate as claimed in claim 1 and wherein the transverse sections and the oblique sections are formed to equal depths.

7. A plate type exchanger for heat exchanging media comprising in combination at least two heat exchanger elements each having pairs of thermoconducting plates and the two plates of each element having a longitudinal extent and a transverse extent, each of said plates being formed with a series of grooved recesses and intervening ribs which extend generally transversely across the plate and are deployed longitudinally of the plate, said recesses comprising transverse groove sections bounded by transverse rib sections arranged in first rows extending longitudinally of the plate with the transverse sections respectively in alternate ones of said first rows being spaced from one another longitudinally of the plate, and oblique groove sections bounded by oblique rib sections arranged in second rows extending longitudinally of the plate and intervening between and alternating with said first rows, the plates of each pair being assembled face-to-face with the transverse groove sections of the respective plates overlying one another to provide undulating flow passages extending longitudinally of said plates and transversely with respect to said groove sections, and the oblique rib sections of the respective plates crossing and bearing against one another intermediate their ends to provide interplate support.

8. A heat exchanger according to claim 7 in which the oblique groove sections and oblique rib sections of each of said series in alternate ones of said second rows are of reversed inclination.

9. A heat exchanger according to claim 7 in which the oblique groove sections and oblique rib sections of each of said series in alternate ones of said second rows are of similar inclination.

10. A plate type exchanger for heat exchanging media comprising in combination at least two heat exchanger elements each having pairs of thermoconducting plates with the plates of each pair arranged in face-to-face relation and having a longitudinal extent and a transverse extent, each of said plates being formed with a series of grooved recesses and intervening ribs which extend generally transversely across the plate and are deployed longitudinally of the plate, said recesses comprising transverse groove sections bounded by transverse rib sections arranged in first rows extending longitudinally of the plate with the transverse sections respectively in alternate ones of said first rows being spaced from one another longitudinally of the plate, and oblique groove sections bounded by oblique rib sections arranged in second rows extending longitudinally of the plate and intervening between and alternating with said first rows.

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