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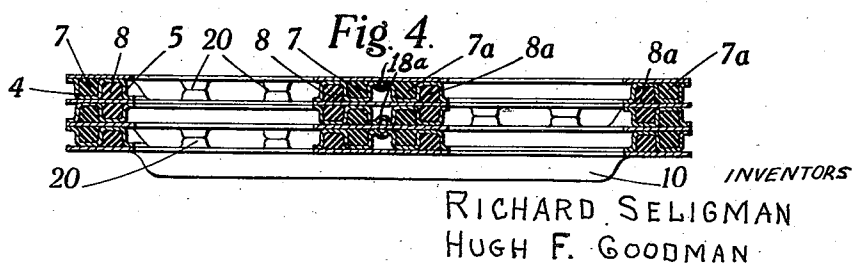
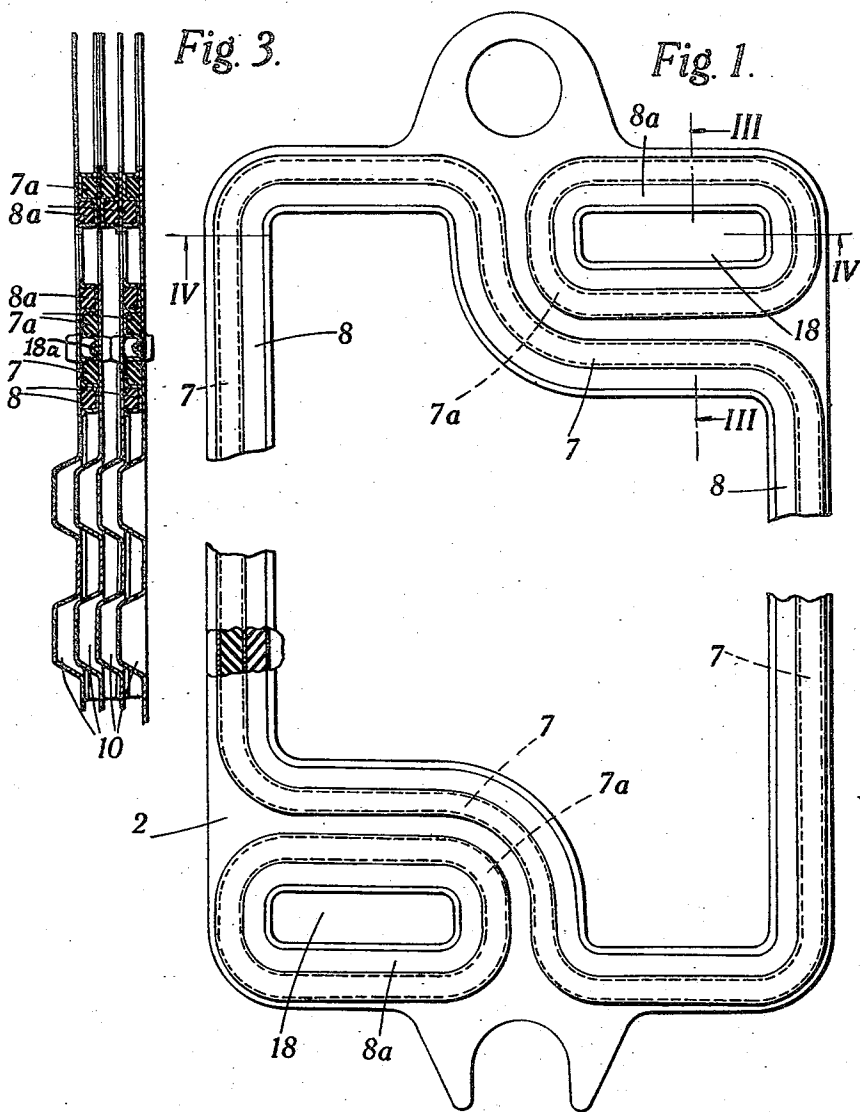
R. SELIGMAN ET AL

2,217,567

PLATE-TYPE HEAT EXCHANGER

Filed April 20, 1937

5 Sheets-Sheet 1



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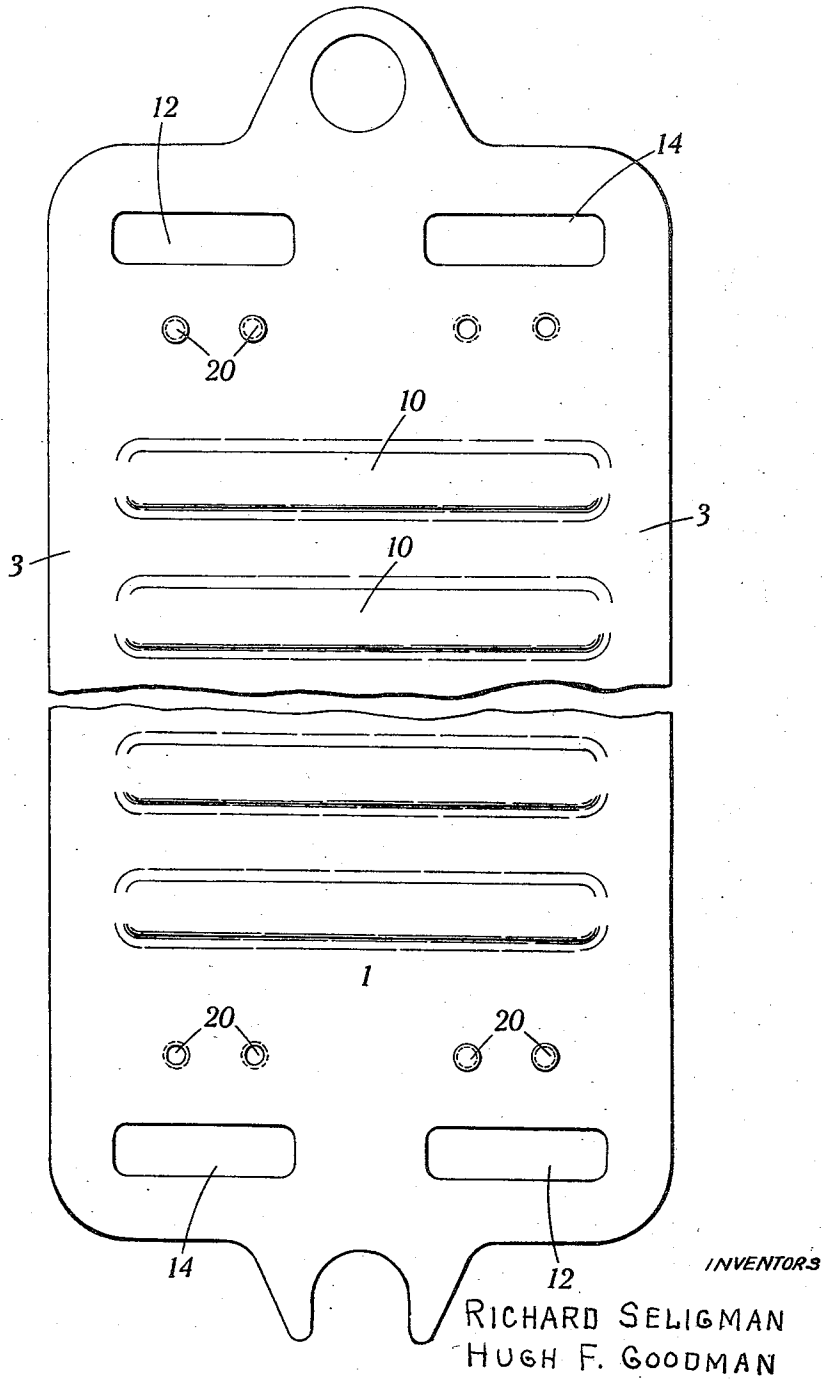
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PLATE-TYPE HEAT EXCHANGER

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5 Sheets-Sheet 2

Fig. 2.



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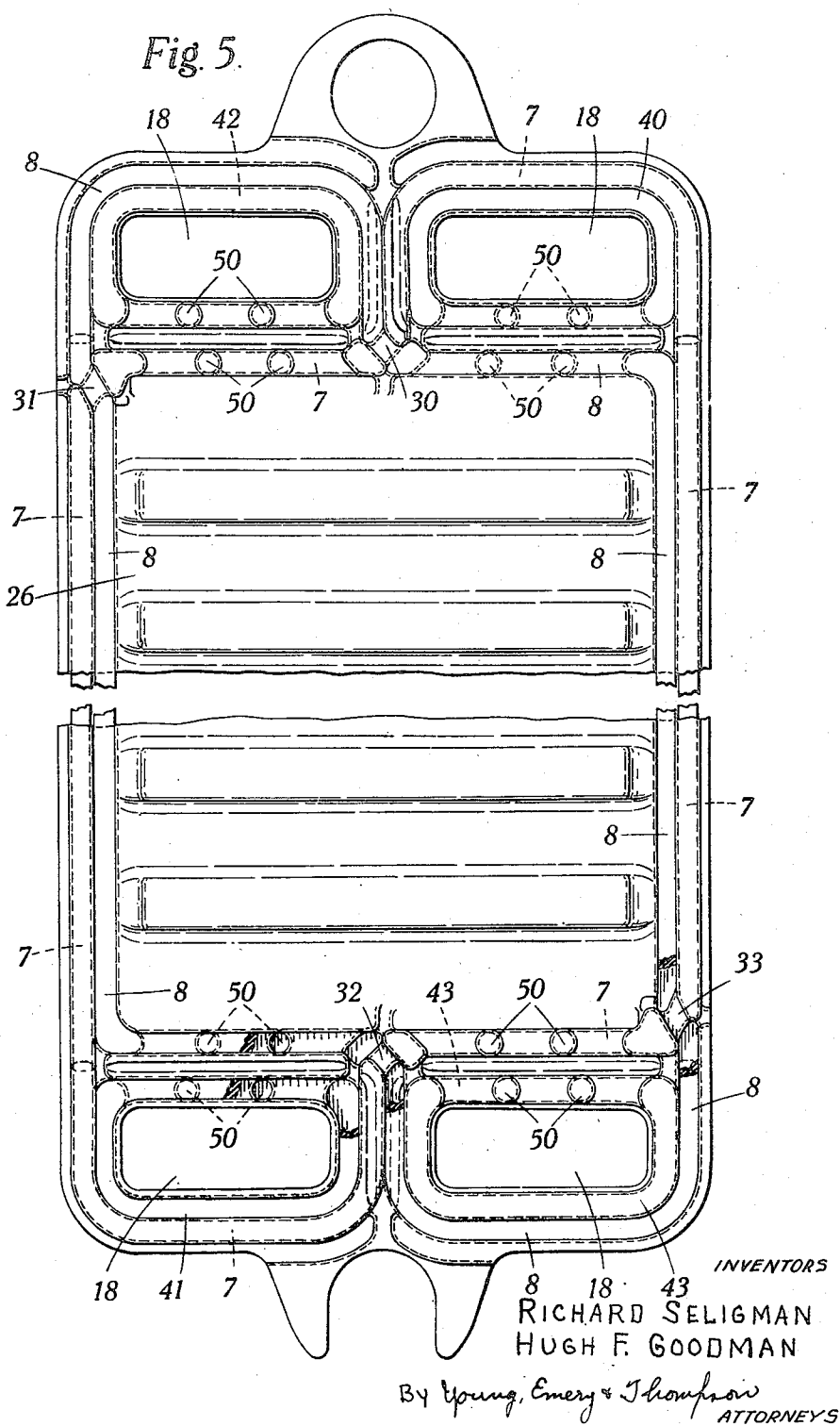
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PLATE-TYPE HEAT EXCHANGER

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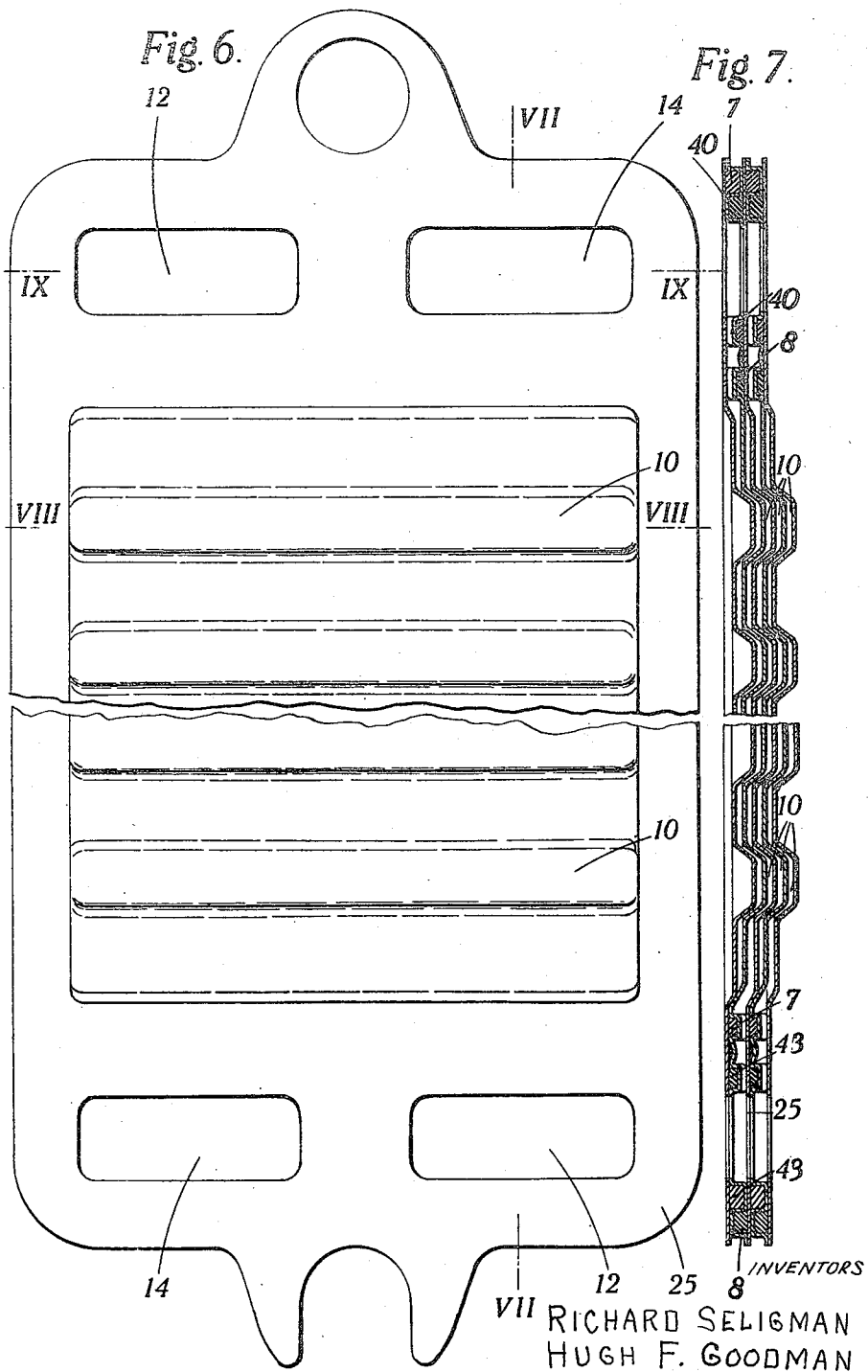
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PLATE-TYPE HEAT EXCHANGER

2,217,567

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Fig. 8.

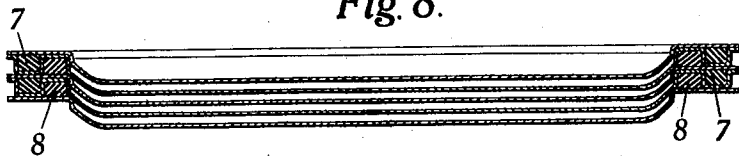


Fig. 9.

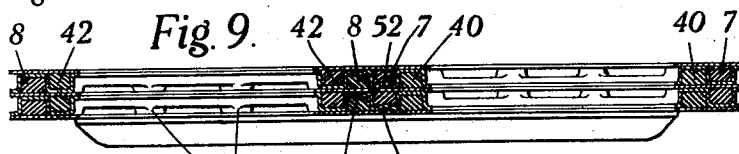


Fig. 10.

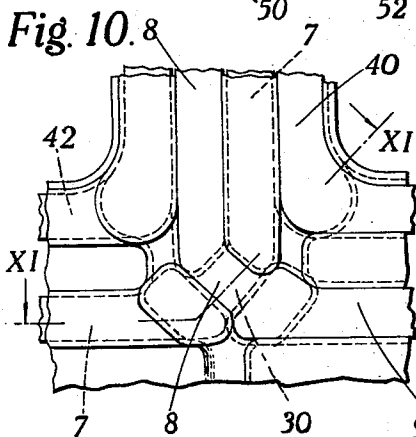


Fig. 11.

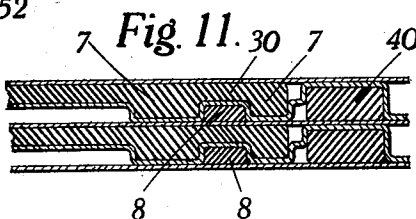


Fig. 14.

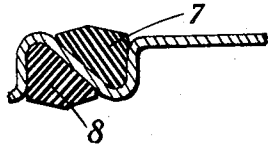


Fig. 15.

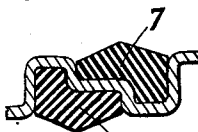


Fig. 12.

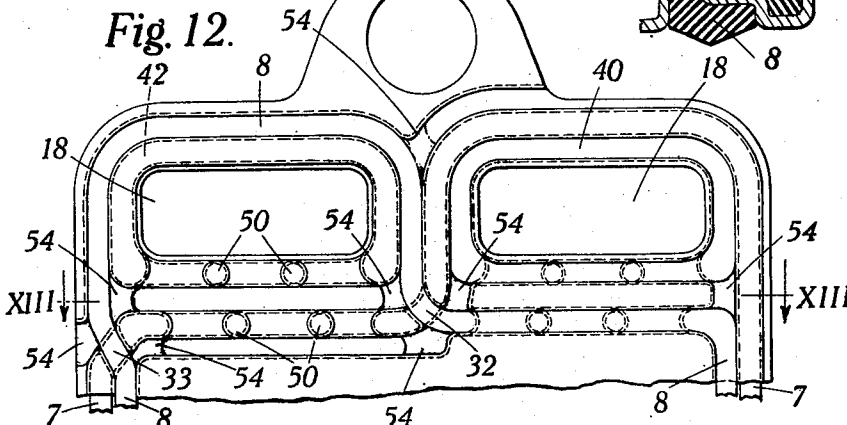
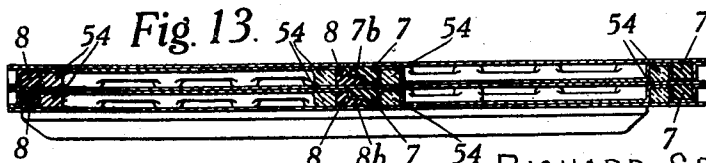


Fig. 13.



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2,217,567

PLATE-TYPE HEAT EXCHANGER

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Application April 20, 1937, Serial No. 138,062
In Great Britain April 22, 1936

16 Claims. (Cl. 257—245)

This invention relates to the construction or formation of the elements of surface heat exchangers of the built-up type comprising a plurality of pre-formed juxtaposed elements such as flat or curved (e. g. conical or spherical) plates clamped or held in spaced relation in such a manner as to provide passages or channels for the fluids in respect of which an exchange of heat is desired.

In some forms of heat exchangers of the above-mentioned type, the individual elements or plates are separated and spaced the required distance from one another by spacing members constituted by hollow frames of rectangular, annular or other formation suitably interposed between the marginal portions of each pair of adjacent heat exchange elements or plates, and, in order to ensure that the fluids or liquids between which an exchange of heat is desired shall be kept entirely separate, the frames or spacing members are sometimes provided with grooves or channels for the reception of a resilient packing material such as rubber.

In other forms of heat exchangers, the marginal edges of the elements or plates are themselves provided with one or more packing receiving grooves or channels which may be formed therein by a pressing or equivalent deforming operation.

One of the objects of the invention is to provide an improved form of heat exchange element or spacing member for use with heat exchangers of the above-mentioned type.

According to one feature of the invention, the marginal portions of the heat exchange element or of the spacing member are shaped by a pressing, folding, bending, spinning or equivalent deforming operation to form therein two sets of packing receiving grooves disposed one on each side of the plate.

According to another feature of the invention the heat exchanger is built up of a plurality of heat exchange elements or spacing members having marginal edges formed as defined in the preceding paragraph and alternating with heat exchange elements or plates having flat or plain marginal edges.

The aforesaid spacing members may be in the form of open frames or they may be co-extensive with the heat exchange elements. For instance, the portions of the spacing members located inwardly of their marginal edges may be utilised to separate one section of a heat exchanger from another.

Another aspect of the invention is concerned

with the depth of the packing receiving groove or grooves. In constructions where there are two packing grooves disposed one on each side of a plate, at such positions as a groove on one side of the plate is required to cross a groove on the other side of the plate, the two grooves may over a short portion of their length be formed of less depth, e. g., half of their normal depth. Also, in other regions, the depth of the groove or grooves may be varied along the length thereof.

In order that the invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the accompanying drawings in which—

Fig. 1 is a front or plan view of one form of spacing member or frame produced in accordance with the invention.

Fig. 2 is a front or plan view of a heat exchange element or plate intended for use with a heat exchanger made up of a plurality of such plates alternating with a plurality of spacing members or frames of the form shown in Fig. 1.

Fig. 3 is a sectional view of a series of heat exchange plates and spacing frames arranged alternately in a superposed relation, the section being taken on the line III—III of Fig. 1.

Fig. 4 is also a sectional view of a series of plates and frames arranged alternately in superposed relation, the section being taken on the line IV—IV of Fig. 1.

Fig. 5 is a front or plan view of a form of pressed heat exchange element produced in accordance with the invention.

Fig. 6 is a front or plan view of a heat exchange element intended for use with a heat exchanger built up of a plurality of such plates alternating with a plurality of heat exchange plates of the form shown in Fig. 5.

Fig. 7 is a sectional view of a series of plates of the forms shown in Figs. 5 and 6 arranged alternately in superposed relation, the section being taken on the line VII—VII of Fig. 6.

Fig. 8 is another sectional view similar to Fig. 7 but taken along the line VIII—VIII of Fig. 6.

Fig. 9 is another similar sectional view taken along the line IX—IX of Fig. 6.

Fig. 10 is a fragmentary detailed view to an enlarged scale of a portion of the plate shown in Fig. 5 where the packing strip on one side of the plate crosses over the packing strip on the other side of the plate.

Fig. 11 is a sectional view of a series of plates of the forms shown in Figs. 5 and 6 arranged al-

ternately in superposed relation, the said section being taken along the line XI—XI of Fig. 10.

Fig. 12 is a fragmentary front or plan view of another form of pressed heat exchange element or plate produced in accordance with the invention.

Fig. 13 is a sectional view of a series of plates of the forms shown in Figs. 6 and 12 arranged alternately in superposed relation, the section being taken on the line XIII—XIII of Fig. 12, and Figs. 14 and 15 illustrate alternative forms of packing that may be used.

In the form of the invention illustrated by Figs. 1 to 4 of the accompanying drawings, the heat exchanger is made up of a plurality of heat exchange elements or plates 1 of the form shown in Fig. 2 alternating with a plurality of spacing members or frames 2 of the form shown in Fig. 1, both the plates and spacing members consisting of sheet metal pressings composed of copper, tinned copper, stainless steel or other suitable metal, according to the nature and properties of the fluids or liquids to be used. The elements or plates 1 are provided with flat or plain marginal edges 3 and the marginal edges of the spacing members are formed with a pair of continuous grooves or channels for the reception of resilient packing material, such as rubber, disposed one at each side thereof. For this purpose the marginal edges of each spacing member have pressed therein two U-shaped channels 4 and 5 which, looked at from one side of the spacing member, constitute a U-shaped channel and an inverted U-shaped channel disposed immediately adjacent one another so that one external wall of one channel forms an internal wall of its neighbouring channel. Thus, each spacing member is made to carry two packing strips 7 and 8 and the heat exchange elements or plates are without packings. The said spacing members may, as illustrated, be in the form of open frames or, if desired, they may be co-extensive with the heat exchange elements as, for example, where it is desired to utilise a spacing member for separating one section of a heat exchanger from another.

The heat exchange surfaces of the elements (i. e., the parts thereof located inwardly of their flat marginal edges) may be smooth, rough, undulating, curved, corrugated or of any other desired form. In the embodiment illustrated, they are shown provided with a series of trough-shaped depressions, 10. Also, as shown, each heat exchange element is formed with four ports, namely, two ports 12, one of which constitutes an inlet port and the other an outlet port, and two ports 14, for use as transfer ports.

In practice, the heat exchanger is built up of a plurality of heat exchange plates and a plurality of spacing frames, the plates and frames being arranged alternately and the latter being alternately reversed, i. e., arranged back to front. Also, each spacing frame is formed with two ports 18, arranged for example, at diagonally opposite corners for registration with the corresponding ports in the heat exchange elements. The packing strips 7 and 8 surround and form borders for the fluid passages or chambers formed between each pair of successive plates, and are also shaped so that they extend around the outside or outer edges of the ports 12 and so that they are brought inwardly away from the marginal edges of the plates and around additional packing strips 7a and 8a (as can be seen from Fig. 1), which extend completely around the

transfer ports 18. In order to accommodate the packing strips 7a and 8a, the edges of the transfer ports 18 are also formed with a pair of U-shaped packing receiving grooves or channels disposed one on each side of the frame in a manner similar to the grooves 4 and 5 above referred to. Thus, the frames are provided with two sets of packing strips disposed one at each side thereof so that each set comprises a continuous packing strip (7 or 8) forming the boundary of a heat exchange chamber and two other separate packing strips (7a or 8a) each surrounding one of the transfer ports 18. One or more of the above-mentioned ports may, if desired, be omitted or blanked off in instances in which the fluids between which heat is to be exchanged or one of them is or are required to traverse a path different from that which is obtained by an alternate arrangement of plates and frames with ports as illustrated. It will be observed that all of the packing strips are fully supported at both side edges throughout their entire lengths.

Where necessary or desirable, the plates or certain of them may be formed with projections or pressed-up portions 20 for contact with adjacent plates, projections or pressed-up portions to maintain the correct spacing between the plates or to prevent bending of the plates under an excess of pressure on one side. Also, around those edges of the ports 18 which are furthest from the edge of the plate, means, such as a groove 18a, may be formed for leading to the outer edges of the plates any liquid that may leak past the packing 7 or the packing 7a, thereby preventing any mixing of the two liquids between which heat exchange is being effected.

Figs. 5, 6, 7, 8 and 9 illustrate another mode of carrying the invention into effect in which the heat exchanger is built up of a series of heat exchange elements or plates, alternate elements of which are plain or flat at the marginal edges, whilst the others are each provided with two sets of packing strips accommodated, as in the case of the spacing frames shown in Fig. 1, in two grooves or channels disposed one on each side thereof. The plates of both sets consist of sheet metal pressings composed of copper, tinned copper, stainless steel or other suitable metal, the form of the plate with plain or flat marginal edges being illustrated in Fig. 6 and the form of the plate which carries the two sets of packing strips being shown in Fig. 5. It will be seen that the form of the plate 25 shown in Fig. 6 is similar in many respects to that shown in Fig. 2 and is provided with the same arrangement of ports 12 and 14. It will also be seen that the marginal edges of the plate 26 shown in Fig. 5 are over the major parts of their length formed in a manner similar to that described above in connection with the spacing frame shown in Fig. 1, and are provided with two continuous packing strips 7 and 8 of rubber or the like. In the case of the spacing members, the two continuous packing strips 7 and 8 are of opposite hand (i. e., one is left handed and the other right-handed) with the result that when placed in position on opposite sides of the spacing member, the one except for being smaller becomes a "mirror" image of the other and they follow parallel contours. The plates 26, however, are provided with packing strips of the same hand and the said packing strips in passing around two of the ports 18, viz., one at each end of the plate, cross each other at at least two points. Also, in instances in which the flow is from one port to the diagonally oppo-

site port, the packing strips cross each at four points, viz., the points marked 30, 31, 32 and 33 in Fig. 5. As, in the embodiment described with reference to Figs. 1-4, each of the packing strips is shaped to surround and form a border for a chamber formed between two successive plates and to extend around or embrace two diagonally opposite ports adapted to serve as inlet and outlet ports for such chamber.

At each of the aforesaid points of crossing, each of the packing strips is reduced in thickness and the depth of the grooves or channels formed for the accommodation of the packing strips is correspondingly reduced over a short portion of their length. For instance, at these regions, the packings may be one-half of their normal thickness and the grooves may be formed to correspond, this formation being shown more clearly in Figs. 10 and 11 which are fragmentary views to a larger scale illustrating the arrangement of the packing strips at one of the cross-over points, viz., at the point 30. Similar provisions are made for the crossing over of the packings at the other points.

In addition to the packing strips 7 and 8 the plate 26 is provided with a plurality of packing strips 40, 41, 42 and 43, one encircling each of the ports 18, the arrangement preferably being such that two of the ports, for example, the diagonally opposite ports, have their packing strips disposed on the same side of the plate. For example, in the construction illustrated the ports 18 at the lower left hand corner of the plate and at the upper right hand corner of the plate may be provided with packing strips 40 and 41 at their upper surfaces. These ports may be used as transfer ports for establishing communication between the heat exchange chambers disposed above and below the chamber bordered by the packing strip 8 shown in Fig. 5. Also, the ports 18 at the lower right hand corner of the plate and at the upper left hand corner of the plate 26 may be provided with encircling packing strips 42 and 43 accommodated in grooves or channels formed in the under-side of the plate so that such ports may be used for establishing communication between the chamber bordered by the packing strip 8 shown in Fig. 5 and the next but one chamber.

Over the major portions of their length the packing strips 40, 41, 42 and 43 are in the form of full-thickness packings and are accommodated in grooves having a depth corresponding with that of the grooves formed for the reception of the packings 7 and 8. In fact, it will be apparent from the sectional views shown in Figs. 7 and 9 that along three sides or edges of each of the ports 18 the marginal edge formation is similar to that provided for the reception of the packings 7 and 8. For instance, the port 18 at the lower left hand corner of the plate is enclosed along three of its edges by the packings 7 and 41 accommodated in a U-shaped and an inverted U-shaped groove so that one external wall of one groove forms an internal wall for its neighbouring groove.

Where, however, a fluid entering or leaving a heat exchange chamber formed between two adjacent plates is required to be led under a packing groove formed in one of the plates the packing groove is formed of lesser depth and the thickness of the packing strip is correspondingly reduced. For instance, as may be seen from Figs. 5 and 7 along the inner or fourth edge of each of the ports 18, the surrounding packings 40 and 43 and corresponding grooves are reduced to about one-half of their thickness or depth. Also, as

may be seen from Figs. 5, 7 and 11, the parts of the packings 7 and 8 and of their reception grooves which are disposed adjacent to and parallel with the aforesaid inner or fourth edges of the ports 18 are similarly reduced. If desired, the grooved parts of diminished depth may be provided with projections or pressed-down portions for abutment with the plate, so as to prevent the plate bending under an excess of pressure on one side. For example, projections or pressed-down portions 50 (Figs. 5 and 9) may be formed on the undersides of the grooves of diminished depth provided in the region of the outlet and inlet ports and the packing may be extended downwardly to fill the pressed-down portions.

As will be seen from the drawings the packing receiving grooves may be widened or formed with laterally extended portions at those parts where a change in the depth of the groove occurs, so as to ensure that the packings will be held snugly in their proper positions at these points. Leakage grooves 52 (Fig. 9) may also be provided in the under-sides of certain of the grooves for ensuring that any liquid leaking past the packings may be led away to the outer edges of the plates.

With the form of plate shown in Figs. 5 to 11 there occur certain regions in which both packings cannot readily be restrained at their side edges over the full height thereof with the result that a compromise is effected in these regions and each packing is restrained at its side edges over a part only of its height from the bottom upwards (see, for example, the right hand side of the section shown in Fig. 11). In this way both of the packings can be restrained throughout their full length although over a part of their length they are supported over a part only of their height. In instances in which it is desired that the packings shall be restrained or supported at their sides over the full height thereof throughout their length, metal inserts or strips 54 may be welded or otherwise secured in position adjacent the regions where one packing crosses over the other packing or at the other places indicated in Figs. 12 and 13. Under some circumstances, however, for instance, in cases where the heat exchanger is to be used for the treatment or pasteurisation of milk, such inserts may be dispensed with and the packings may be arranged so that they are fully restrained or supported at their sides at one side of the plate, e. g., the side which is to be in contact with the milk, and are only partially restrained or supported at their sides at the opposite side of the plate which is to be in contact with the water or other media used for the heating or cooling of the milk. According to an alternative mode of forming the packings and the packing grooves, the packings 7 and 8 and the grooves which accommodate them are formed with laterally off-set portions (see, for example, the off-set portions 7b and 8b of the packings 7 and 8 shown in Fig. 13) of reduced thickness arranged so that the off-set portion of one packing is adapted to over-lie the off-set portion of the other packing. Also, Fig. 14 shows another section of packing which may, in some instances, be used and in which the packing strips and their accommodating grooves have a V-shaped formation and Fig. 15 shows another alternative section of packing in which the strip on one side partially over-lies the strip on the other side of the plate.

It will be observed from the sectional views of a series of superposed plates that, in the particular form of heat exchanger chosen for illustra-

tive purposes, the parts are arranged so that each of the liquids or media between which heat is to be exchanged is caused to flow through alternate spaces or heat exchange chambers in parallel, but it will be appreciated that the path traversed by one or both of the media may be varied by suitably modifying the arrangement of the ports as, for example, by omitting or blanking-off certain of them to obtain a series, a series-parallel or other form of flow.

It is to be understood that the heat exchange elements or spacing members incorporating the features of the present invention may be flat, coned, spherical, corrugated, square, rectangular or of any other desired formation. Also, that the plates may be in the form of spinings or stampings and the spacing members may, in some instances, be built up from a drawn section or a section produced, say, by folding or extrusion.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is—

1. In a surface heat exchanger of the juxtaposed plate type, a sheet metal element having upwardly and downwardly pressed marginal edges forming two packing receiving grooves disposed one at each side thereof, the groove on one side of the element being in staggered relation to the groove on the other side of the element where they are parallel with one another at the same edge of the element.

2. An element for a surface heat exchanger of the juxtaposed plate type, consisting of a sheet metal pressing having marginal edges formed with a pair of packing receiving grooves pressed therein, said grooves being disposed immediately adjacent one another and one at each side of the element so that one external wall of one groove forms an internal wall of its neighboring groove.

3. An element for a surface heat exchanger of the juxtaposed plate type, consisting of a sheet metal pressing the marginal edges of which are formed with a pair of U-shaped packing receiving grooves disposed one at each side of the element, said grooves being formed by upwardly and downwardly pressed portions so that one external wall of one groove forms an internal wall of its neighboring groove.

4. An element for a surface heat exchanger of the juxtaposed plate type, consisting of a sheet of metal having marginal edges formed with an upwardly pressed portion and a downwardly pressed portion constituting a pair of packing receiving grooves disposed one at each side of the element, said grooves having laterally offset portions of reduced depth arranged so that the offset portion of one groove overlies that of the other groove.

5. An element for a surface heat exchanger of the juxtaposed plate type, consisting of a sheet of metal having marginal edges formed with an upwardly pressed portion and a downwardly pressed portion constituting a pair of packing receiving grooves disposed one at each side of the element, said grooves crossing each other at least two points.

6. An element for a surface heat exchanger of the juxtaposed plate type, consisting of a sheet of metal having marginal edges formed with an upwardly pressed portion and a downwardly pressed portion constituting a pair of packing receiving grooves disposed one at each side of the element, said grooves crossing each other at

at least two points, and the depth of the grooves being varied at these points.

7. An element for a surface heat exchanger of the juxtaposed plate type, consisting of a sheet of metal with marginal edges having pressed therein an upwardly pressed portion and a downwardly pressed portion forming a pair of packing receiving grooves disposed one at each side of the element, an external side wall of one groove forming an internal side wall of its neighboring groove, and packings in said grooves, said packings being supported at their sides over the full height thereof.

8. In a surface heat exchanger for fluids, a plurality of spaced plate-like flow controlling elements providing flow passages for two fluids in heat exchange relation, said elements having marginal edges formed with an upwardly pressed portion and a downwardly pressed portion constituting a pair of packing receiving grooves disposed one at each side thereof, resilient packings in said grooves, said packings forming borders for the flow passages.

9. In a surface heat exchanger for fluids comprising heat exchange elements separated by a spacing frame, a spacing frame having marginal edges formed with an upwardly pressed portion and a downwardly pressed portion constituting a pair of packing receiving grooves disposed one at each side thereof, packings in said grooves, said packings forming upper and lower borders for a fluid space provided within the spacing frame between a pair of heat exchange elements disposed one at each side thereof.

10. In a surface heat exchanger for fluids comprising heat exchange elements separated by a spacing frame, a spacing frame formed with a transfer port, the marginal edges of the frame being formed with two sets of packing receiving grooves, one set of packing receiving grooves being constituted by an upwardly pressed portion and a downwardly pressed portion which together form a pair of parallel continuous packing receiving grooves disposed one at each side of the frame, packings in said grooves, said packings forming upper and lower borders for a fluid space provided within the spacing frame and between heat exchange elements disposed one at each side thereof, the second set of packing receiving grooves being constituted by an upwardly pressed portion and a downwardly pressed portion which together form a pair of parallel continuous packing receiving grooves disposed one at each side of the frame around the transfer port therein, which transfer port is outside the said fluid space.

11. In a surface heat exchanger for fluids comprising a plurality of spaced heat exchange elements providing flow passages for two fluids in heat exchange relation, a heat exchange element having marginal edges formed with an upwardly pressed portion and a downwardly pressed portion constituting a pair of packing receiving grooves disposed one at each side thereof, packings in said grooves, said packings forming upper and lower borders for a pair of fluid passages disposed one at each side of the said element, said grooves and packings crossing each other at at least two points and said grooves and packings being of diminished depth at these points.

12. In a surface heat exchanger for fluids comprising a plurality of spaced heat exchange elements providing flow passages for two fluids in heat exchange relation, a heat exchange element formed with a transfer port, the marginal edges

of the element being formed with an upwardly pressed portion and a downwardly pressed portion which together form a pair of packing receiving grooves disposed one at each side of the element, said grooves extending along opposite sides of the transfer port, packings in said grooves, said packings forming boundaries of a pair of fluid passages disposed one at each side of the element, another packing receiving groove extending around the transfer port and a further packing in said last-mentioned receiving groove.

13. In a surface heat exchanger for fluids comprising a plurality of spaced heat exchange elements providing flow passages for two fluids in heat exchange relation, a heat exchange element formed with a plurality of ports, the marginal edges of the element having pressed therein a U-shaped groove and an inverted U-shaped groove constituting a pair of continuous packing receiving grooves disposed one at each side of the element, said grooves crossing each other at at least two points and extending along opposite sides of each port, further U-shaped grooves pressed in the marginal edges of the ports so that each port is surrounded by a U-shaped groove and an inverted U-shaped groove, and packings accommodated in each of the said grooves.

14. In a surface heat exchanger for fluids comprising a plurality of spaced heat exchange elements providing flow passages for two fluids in heat exchange relation, a heat exchange element formed with four ports, providing an inlet port, an outlet port and two transfer ports, the marginal edges of the element having pressed therein a U-shaped groove and an inverted U-shaped groove constituting a pair of continuous packing receiving grooves disposed one at each side of the element, said grooves crossing each other at at least two points and extending along

opposite sides of each port, said grooves also being diminished in depth at the cross-over points, further U-shaped grooves pressed in the marginal edges of the ports and packings in each of the said grooves.

15. In a surface heat exchanger for fluids comprising a plurality of spaced heat exchange elements providing flow passages for two fluids in heat exchange relation, a heat exchange element formed with a plurality of ports, the marginal edges of the elements having pressed therein a U-shaped groove and an inverted U-shaped groove constituting a pair of continuous packing receiving grooves disposed one at each side of the element, said grooves crossing each other at at least two points and being of diminished depth at these points, further U-shaped grooves pressed in the marginal edges of the ports, and packings accommodated in each of the said grooves.

16. In a surface heat exchanger for fluids comprising a plurality of spaced heat exchange elements providing flow passages for two fluids in heat exchange relation, a heat exchange element formed with a plurality of ports, the marginal edges of the element having pressed therein a U-shaped groove and an inverted U-shaped groove constituting a pair of continuous packing receiving grooves disposed one at each side of the element, said grooves crossing each other at at least two points and being of diminished depth at these points, said grooves also extending along opposite sides of each port, further U-shaped grooves pressed in the marginal edge of the ports so that each port is bordered by a U-shaped groove and an inverted U-shaped groove, packings accommodated in each of the said grooves, the said grooves and the said packings being of diminished depth in the vicinity of the said ports.

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