April 24, 1951 H. H. EHRMAN 2,550,339

PLATE TYPE HEAT EXCHANGER

Filed Aug. 3, 1948

Fig. 1

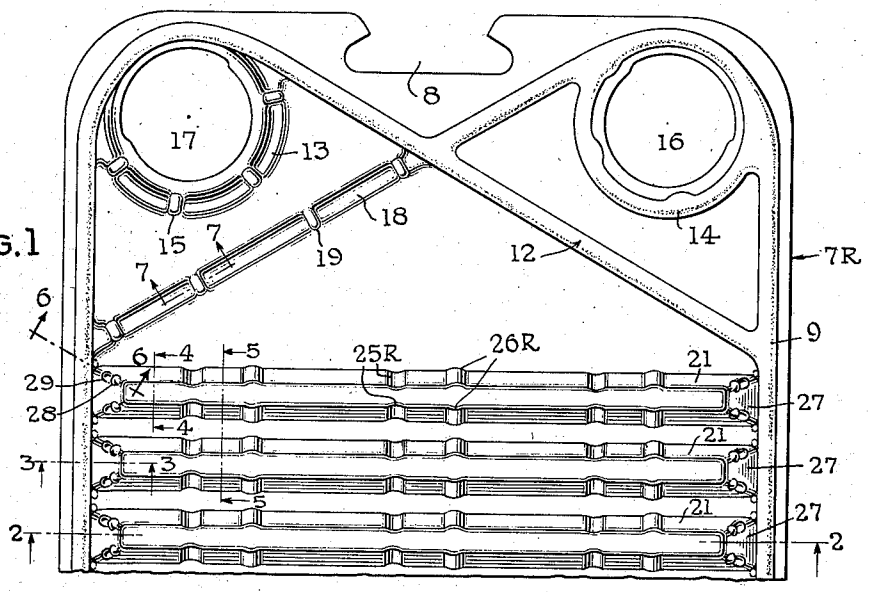


Fig. 2

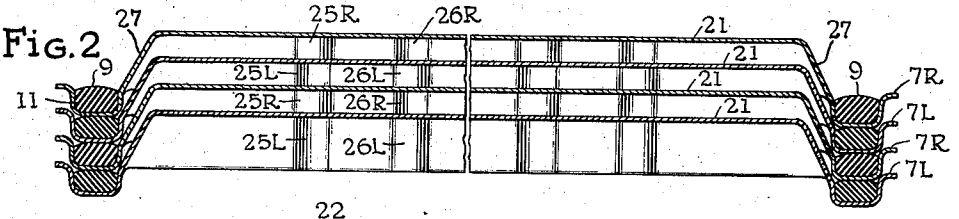


Fig. 3

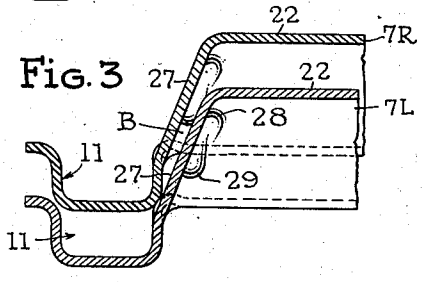


Fig. 4

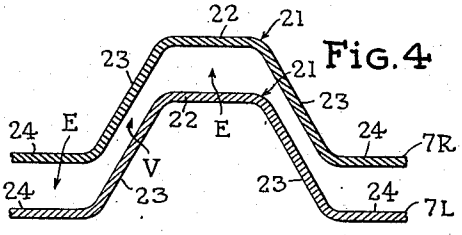


Fig. 5

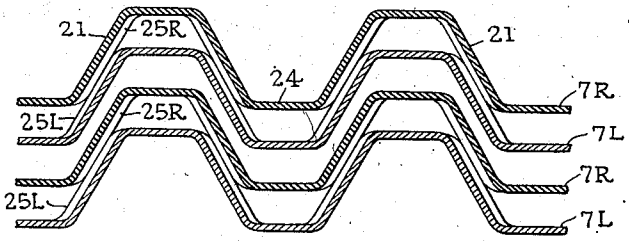


Fig. 6

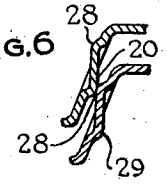
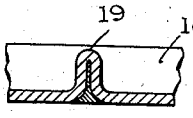


Fig. 7



Inventor

Herbert H. Ehrman

By

Dodge and Sons

Attorneys

Patented Apr. 24, 1951

2,550,339

UNITED STATES PATENT OFFICE

2,550,339

PLATE TYPE HEAT EXCHANGER

Herbert H. Ehrman, York, Pa., assignor to York Corporation, York, Pa., a corporation of Delaware

Application August 3, 1948, Serial No. 42,163

7 Claims. (Cl. 257—245)

1

This invention relates to heat exchangers of the plate type and particularly to exchangers of this character in which the plates are sheet metal stampings of the general type disclosed in the patent to Seligman No. 1,992,097, granted February 19, 1935, under which applicant's assignee is licensed.

It is characteristic of heat exchangers of the Seligman type that different liquids exchange heat through the plate and that the plate has approximately trapezoidal embossed ribs which are transverse to the direction of flow of the two heat exchanging liquids. The flows of the two liquids may be concurrent or countercurrent but in any case it is characteristic of this type of plate that the liquid flows alternately faster and slower in successive portions of its path, a characteristic which is adopted to improve the heat exchange. In the preferred form of plate, the trapezoidal ribs are all in relief on one side of the plate and are formed by striking up the sheet metal of the plate. Thus, there are substantially identical patterns on opposite sides of the plate but one is in relief and the other in intaglio.

This type of heat exchanger is used extensively in pasteurizing milk. In such a pasteurizer there usually are three sections, a heating section, and a cooling section in which respectively the milk exchanges heat with a hot fluid and with a wholly distinct cold fluid; and a regenerating section in which raw milk entering the pasteurizer derives heat from milk leaving the holder. It is inevitable, in an arrangement of this sort, that the pressure heads on the various liquids will vary throughout each section. It results that certain of the plates are subject to quite high pressure differentials.

Commercial embodiments of the Seligman invention make use of so-called "pips" to positively space the plates. As shown at 18 and 19 in Fig. 7 of the patent to Groat No. 2,181,230, November 28, 1939, these are bosses struck up from the plate and located in the wider intervals between the two plates, a location which is convenient for manufacturing reasons.

Experience with plates so designed demonstrates that the calculated heat exchange rates are sometimes not attained and that the losses of pressure head of the various liquids in flow through the exchanger are sometimes greater than theoretically they should be. I have determined the fact that the plates can be, and actually are, materially displaced by the pressure differentials above mentioned, with the result that some of the more constricted parts of the

2

flow path become greatly restricted and throttle the flows materially.

One feature of the present invention involves the elimination of the pips from the wide interplate intervals and the location of spacing ribs directly in the restricted sections of the flow path. In this way those parts of the plate which define the most constricted, and therefore the critical parts of the flow path, are positively spaced. This results in a much smaller possible percentage change in the cross sectional area of the constricted parts of the flow path. Indeed, as will be more readily understood after a detailed description of the structure, an error in the spacing produced by pips in the wide interplate intervals permits and may even cause a greatly magnified error of spacing of the plates where the flow path is constricted.

Another source of loss in the operation of these plates is the fact that the cross ribs must terminate short of the side edges of the plate which seal with one another, and this leaves a bypassage around the end of each cross rib. According to the present invention, the plates are designed to coordinate the cross sectional area of these by-passages with the cross sectional area of the main flow path in such a way that the flow preference is toward the main path and away from the by-passages.

In attaining the above results, advantage is taken of the characteristics of an embossed sheet metal plate, and the desired results are secured without requiring the use of unusual or difficult manufacturing methods.

The invention will now be described by reference to the accompanying drawing in which:

Fig. 1 is a face view of the upper end of a "right-hand" plate and includes the first, second and third ribs.

Fig. 2 is a section of assembled plates on the line 2—2 of Fig. 1. Counting from the top this view shows a right-hand, left-hand, right-hand and left-hand plate assembled, and is drawn at a larger scale than that of Fig. 1. The middle portion is broken away to reduce the horizontal extent of the view.

Fig. 3 is a fragmentary section (at a still larger scale) taken on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary section on the line 4—4 of Fig. 1 and at the same scale as Fig. 3.

Fig. 5 is a fragmentary section on the line 5—5 of Fig. 1. The scale is larger than that of Fig. 1.

Fig. 6 is a fragmentary section on the line 6—6 of Fig. 1.

Fig. 7 is a fragmentary section on the line 7—7 of Fig. 1.

With reference to the designations "right-hand" and "left-hand," it will be helpful to explain that in any group of assembled plates, two liquids are handled and each liquid must flow through alternate inter-plate intervals. Thus, at each of the four corners there is a port. Two of these (generally diagonally opposed) communicate with the face interval and the other two with the back interval, but such communication is through face ports in the next plate to the rear. Consequently successive plates as assembled must have passages leading from alternate corner ports to their respective front faces. To distinguish them, the plates are arbitrarily called rights and lefts. The plates are otherwise identical except for reversed arrangement of spacing lugs hereinafter explained.

The right-hand plate shown in Fig. 1 is generally indicated by the numeral 7R and in other figures right-hand plates are designated generally by 7R and left-hand plates by 7L. Again referring to Fig. 1, the slot which engages the support bar is shown at 8, it being understood that the plates when separated hang in vertical positions from a bar. All the plates are slidable along the bar and when in use are clamped between adjustable end plates to which the liquid conduits are connected. When the plates are so clamped they interengage and maintain the alinement of the group independently of the bar.

The usual marginal gasket appears at 9. It is mounted in grooves 11 pressed in the plate (see Figs. 2 and 3) and has cross-corner portions 12, and ring portions 14 the latter of which surround the corner port 16. The portions 12 and 14 are continuous so that the face of the plate is isolated from port 16.

To seal with the gasket of the next plate to the rear (a left-hand plate) and afford flow passages on the face side of the plate, that part of port 17 not surrounded by the gasket 12 is surrounded by rearwardly embossed portions 13 of the plate separated by bridges 15. Similar rearwardly embossed portions 18 separated by bridges 19 overlie the cross-corner portion of the gasket on the next plate to the rear. Fig. 7 shows how the metal is folded together and welded to form the bridges 19. Bridges 15 are formed in the same way.

While Fig. 1 shows only the upper two ports 16 and 17, it will be obvious to those skilled in the art that companion ports diagonally opposed to ports 16 and 17 are located at the lower end of the plate (see Fig. 3 of Seligman 1,992,097 or Fig. 1 of Seligman et al. 2,075,236) and that port connections to the face of the plate are reversed as between right-hand and left-hand plates.

All the details so far described except the welded bridges 15 and 19 are known in the art and have been embodied in commercial exchangers by applicant's assignee.

Extending across the plate from gasket to gasket are corrugations forming ribs 21, the upper three of which appear in Fig. 1. These ribs, as viewed in cross section in Fig. 4, are isosceles trapezoids and for manufacturing convenience they are all raised in the same direction from the plane of the plate proper. For convenience in description the part 22 will be called the top of the rib, the portions 23 the inclined sides of the rib, and the portion 24 between ribs the base. Short-radius fillets are used, as shown.

Just as is the case in Seligman 1,992,097 (see Fig. 6 of the patent) the effect of assembling

plates in a stack is to produce restricted Venturi throats V interposed between enlarged spaces E. According to the present invention positive spacing of the plates is assured by bosses which engage in the throat V and serve to inhibit undesired over constriction of these throats.

The preferred construction is to form on the inclined sides of the ribs cylindrical bosses arranged in pairs in which one boss 25R is struck inward and the other 26R is struck outward. Three such pairs are shown in Fig. 1 which shows a right-hand plate. On the left-hand plates the pairs are similarly located but as best shown in Fig. 2 bosses 25L are struck outward and 26L inward.

The effect is to cause the bosses on one plate to engage bosses on the next. This can best be understood by examining Fig. 5 and having due regard for the plane of section. Bosses 25R on the first and third plates respectively engage bosses 25L on the second and fourth plates. There is no engagement visible in Fig. 5 between the second and third plates but as will be clear from Fig. 2, bosses 26L on the second plate do engage bosses 26R on the third plate. Such engagement occurs throughout the entire series of plates and (in the form illustrated) at three spaced points in the length of every rib.

Each rib 21 ends in an inclined surface 27 leading from the inner margin of gasket 9 to the top 22 of the rib. As best shown in Fig. 3 the effect is to afford a passage B past the end of the rib. This affords useful heat exchange surface provided the passage B is not unduly wide, as it always has been heretofore. The degree of constriction is a function of the steepness of the surface 27.

According to the invention, the flow resistance at B (Fig. 3) is made equal to or greater than (i. e. not less than) the flow resistance offered by two Venturi restrictions V (Fig. 4) operating in series. The effect is to assure approximately uniform flow past all portions of the rib, so that all exchange surface operates efficiently. Since gasket sealing pressures and fluid pressure differentials tend to change the width of passage B local means to maintain it are provided by forming outward bosses 28 and inward bosses 29 along each corner at the ends of the ribs 21 as best shown in Figs. 3 and 6.

Quite obviously a small error in the spacing at the large inter-plate intervals between tops and between bases will have a minor effect on the throttling at E. Because restrictions V are smaller and because of the inclined relation, an error in spacing at E will produce a greatly magnified percentage error in spacing at V, and it is this fact that led to the location of the bosses 25, 26 so as to rigidly space the plates at the restricted throats V.

The invention can be applied to plates of various different designs. The effect is to space the plates accurately at the constrictions, where accurate spacing is important. Having thus stabilized flow conditions it then becomes practicable to equalize flow conditions as between all parts of every rib. The bridges 15 and 19 perform a like effect by sustaining clamping and hydrostatic pressures at the points indicated where the plates have large flat areas not adequately spaced in the constructions used in the prior art.

What is claimed is:

1. In a heat exchanger of the type in which a plurality of plates in spaced face to face relation seal at their margins and are ported to provide

for the flow of diverse fluids between plates and thus along the opposite faces of individual plates, the improvement which consists in forming the plates with corrugations transverse to the flow of said fluids, said corrugations being approximately isosceles trapezoids in cross section and so arranged as to afford substantially identical patterns on opposite faces of the plate, each pattern being relief where the other pattern is in intaglio, said corrugations throughout the heat exchange area of the plate having on their inclined lateral faces series of spaced bosses which engage inclined portions of opposed corrugations on at least one proximate plate, the bosses of respective series on successive plates being offset relatively to those on adjacent plates in the directions of the lengths of the corrugations, said series of bosses serving to space adjacent plates positively substantially throughout the areas within said margins, and at points where the interplate interval is relatively small.

2. The improvement defined in claim 1 in which the entire rib design in one face of the various plates is in relief and that on the opposite face is in intaglio.

3. The improvement defined in claim 1 in which the entire rib design in one face of the various plates is in relief and that on the opposite face is in intaglio, and the bosses are arranged in pairs, in each of which pairs one boss is struck outward and the other inward.

4. The improvement defined in claim 1 in which the entire rib design in one face of the various plates is in relief and that on the opposite face is in intaglio, the bosses are arranged in pairs in each of which pairs one boss is struck outward and the other inward, and the bosses of each pair are interchanged as to position on alternate plates in the group.

5. The improvement defined in claim 1 in which the corrugations form ribs which terminate adjacent the sealing margins of the plate in surfaces so steeply inclined to the general plane of the plate that between adjacent rib ends on two assembled plates, the flow interval is sufficiently restricted to offer resistance to flow at least as great as that offered to flow over the rib.

6. The improvement defined in claim 1 in which the corrugations form ribs which terminate adjacent the sealing margins of the plate in end surfaces which are steeply inclined to the general plane of the plate, and pairs of oppositely projecting bosses are formed on the folds where the end surfaces meet the side surfaces of the

ribs and afford inter-plate engagement, which maintains spacing of the end surfaces of assembled plates.

7. In a heat exchanger of the type in which a plurality of plates spaced in face to face relation seal at their margins and are ported to provide for the flow of diverse fluids between plates and thus along the opposite faces of individual plates, the improvements which consist in forming a part of the plate adjacent the ports without corrugations and another part of the plate more remote from the ports with corrugations transverse to the flow of said fluids said corrugations being approximately isosceles trapezoids in cross section and so arranged as to afford substantially identical patterns on opposite faces of the plate each pattern being in relief where the other pattern is in intaglio, said corrugations throughout the heat exchange area of the plate, having on their inclined lateral faces series of spaced bosses which engage inclined portions of opposed corrugations on at least one proximate plate, the bosses of respective series on successive plates being offset relatively to those on adjacent plates in the directions of the lengths of the corrugations, said series of bosses serving to space adjacent plates positively substantially throughout the areas within said margins, and at points where the interplate interval is relatively small; the parts of the plates devoid of corrugations being embossed to define flow channels on one face of the plate and sealing ribs on the other face thereof, said channels being divided by cross bridges which stiffen said sealing ribs and are each formed by folding a pleat in the metal of the plate in a direction transverse to the rib, said pleat being welded on the rib-forming side of the plate so as to maintain the continuity of the rib.

HERBERT H. EHRMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,039,216	Feldmeir	Apr. 28, 1936
2,181,230	Groat	Nov. 28, 1939

FOREIGN PATENTS

Number	Country	Date
561,314	Great Britain	Jan. 18, 1943
64,868	Denmark	Sept. 30, 1946