

Nov. 19, 1940.

W. ASTLE

2,221,937

PLATE HEAT EXCHANGER

Filed Jan. 16, 1939

4 Sheets-Sheet 1

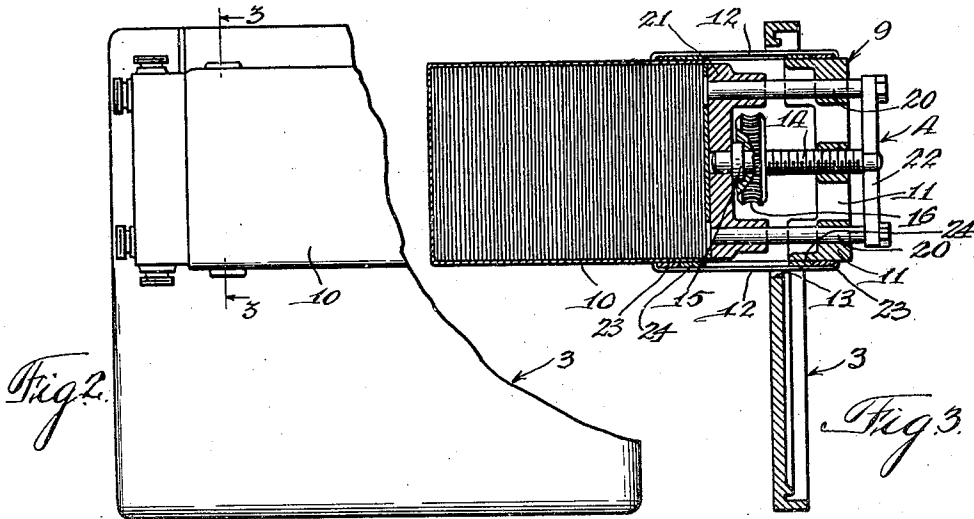
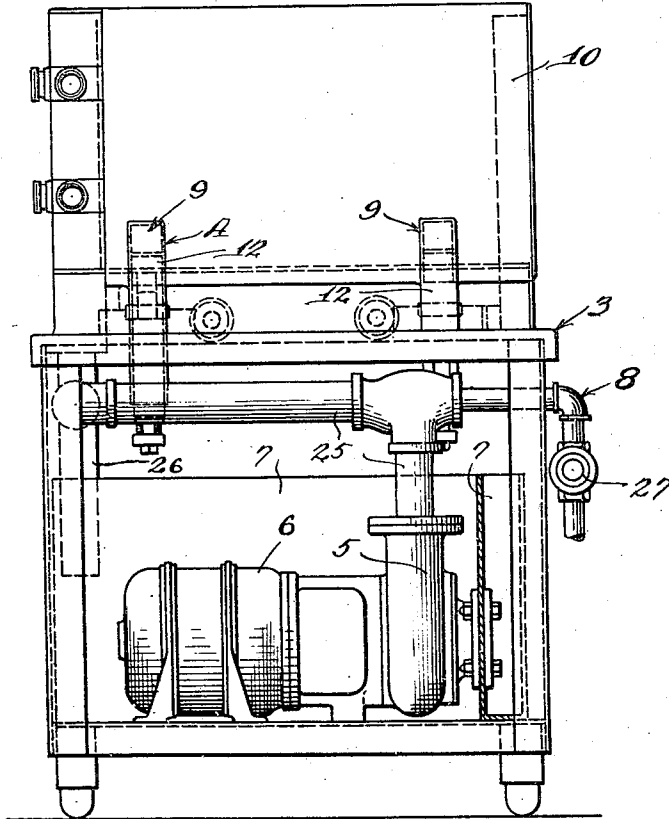


Fig. 1.

Inventor
William Astle.
By: Ambs, Phis, Ober & Muckelbauer.
Attys.

Nov. 19, 1940.

W. ASTLE

2,221,937

PLATE HEAT EXCHANGER

Filed Jan. 16, 1939

4 Sheets-Sheet 2

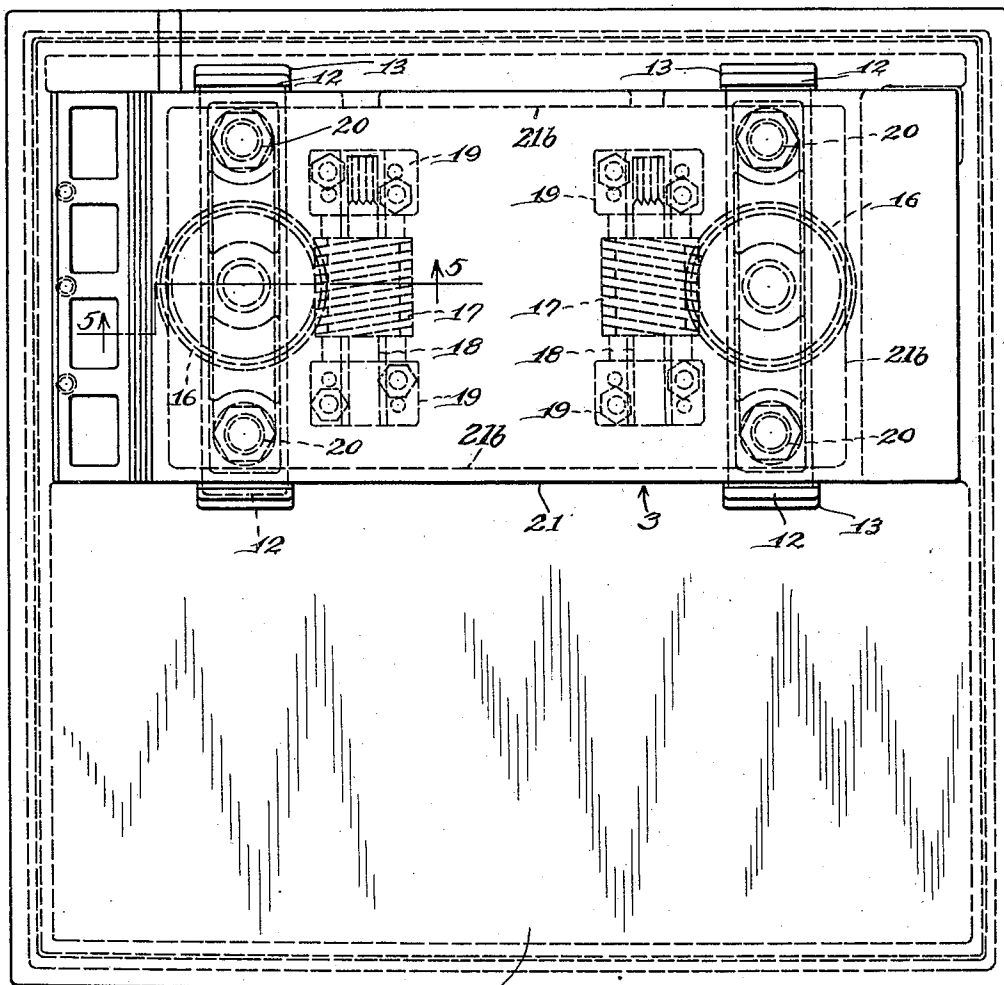
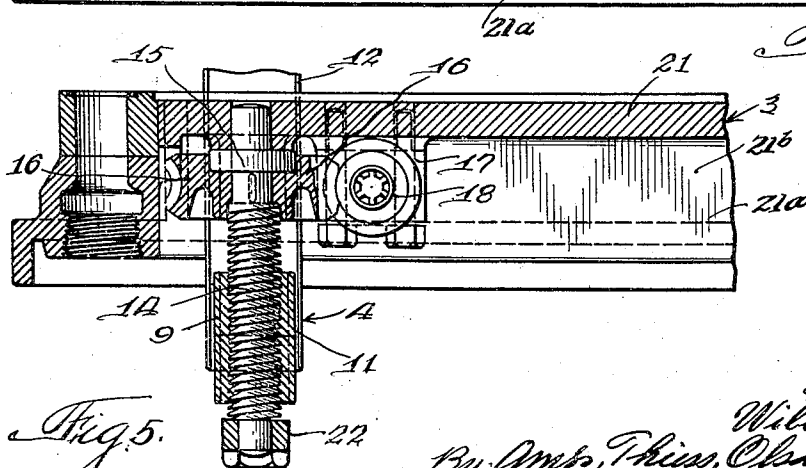


Fig. 5.

Fig. 4.

Inventor
William Astle
By Amos, Phin, Clark & Nicklauer
Attys.

Nov. 19, 1940.

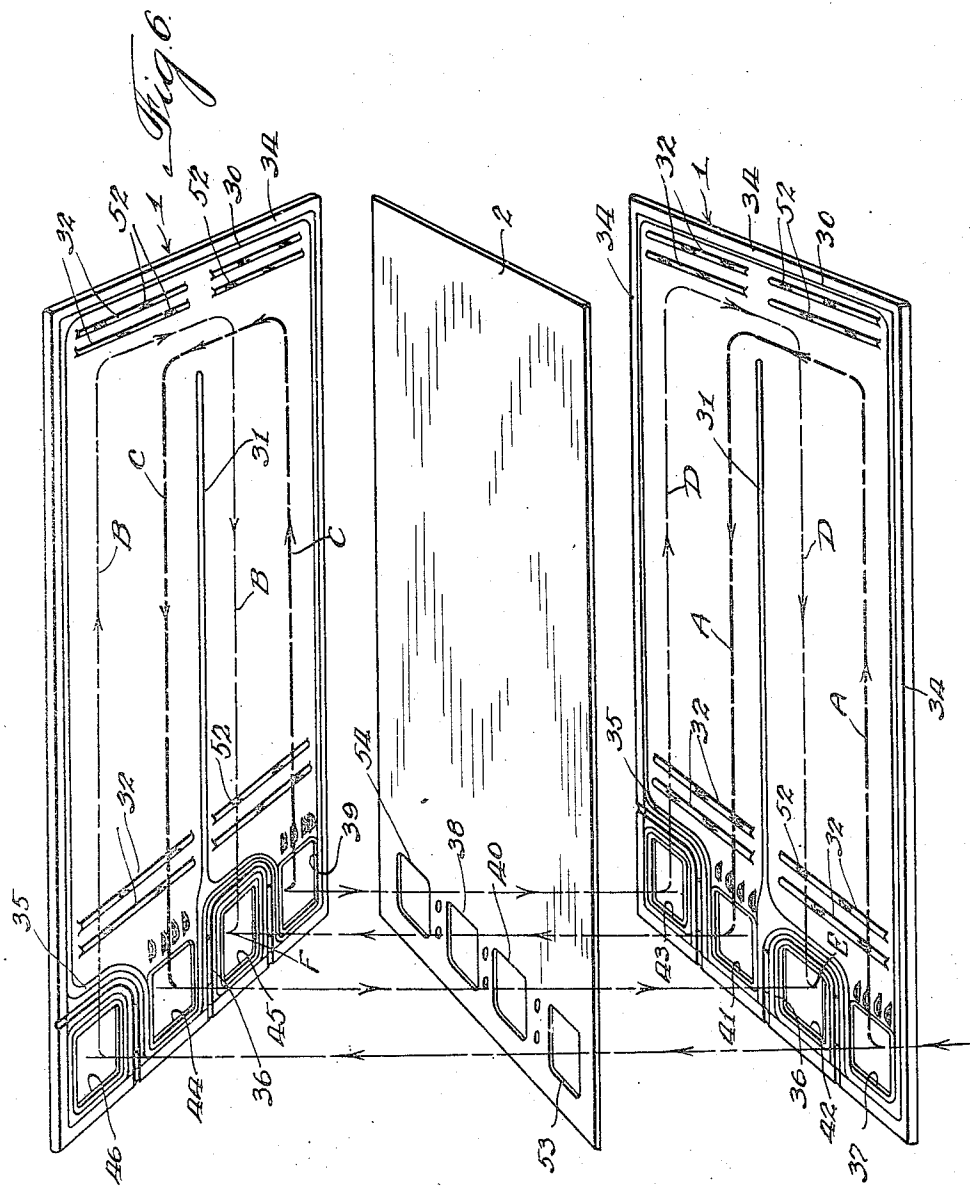
W. ASTLE

2,221,937

PLATE HEAT EXCHANGER

Filed Jan. 16, 1939

4 Sheets-Sheet 3



Inventor:
William Astle
By: *M. P. H. O. & M. L. H. O.*
Sattys

Nov. 19, 1940.

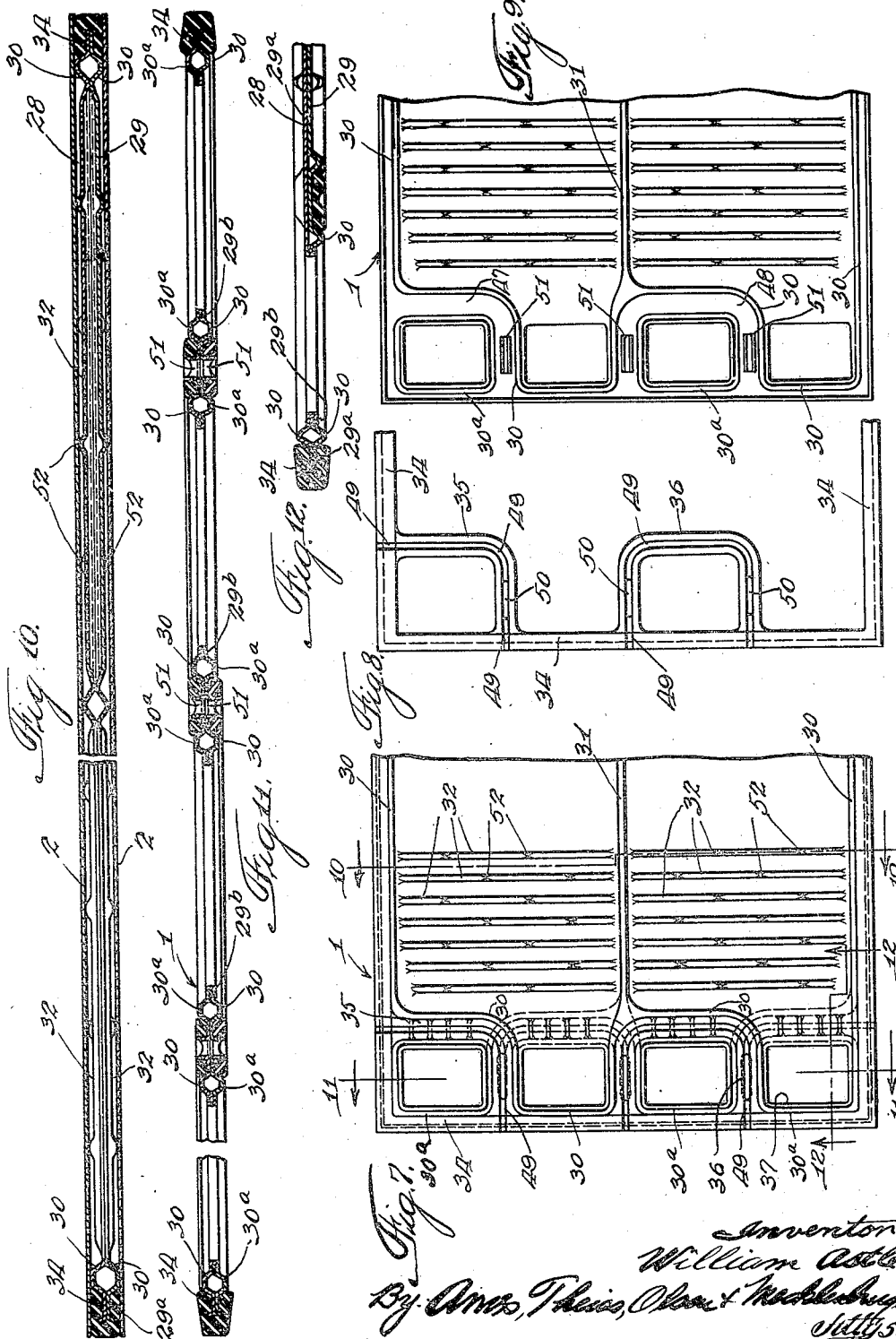
W. ASTLE

2,221,937

PLATE HEAT EXCHANGER

Filed Jan. 16, 1939

4 Sheets-Sheet 4



Inventor:
William Astle
By *Amos, Thomas, Owen & Maddalena*
Attys.

UNITED STATES PATENT OFFICE

2,221,937

PLATE HEAT EXCHANGER

William Astle, Chicago, Ill.

Application January 16, 1939, Serial No. 251,127

8 Claims. (Cl. 257—245)

My invention relates to plate heat exchangers. One of the objects of my invention is to provide an improved corrugated sheet metal heat exchange plate for cooperation with a juxtaposed plain plate.

A further object is to provide such a plate formed from two sheets of metal secured together back to back.

A further object of my invention is to provide a plate formed of two sheets of metal back to back, in which both plates are provided with turbulence-creating corrugations.

A further object is to provide a heat exchange plate in which the porting and flow-directing arrangement is such that either face of the corrugated plate may be juxtaposed with respect to a plain plate without affecting the fluid flow.

A further object is to provide an improved sheet metal heat exchange plate having turbulence-creating corrugations on both faces for cooperation with juxtaposed plain plates so designed that all parts of the interplate flow space will drain properly.

Further objects and advantages of the invention will be apparent from the description and claims.

In the drawings,

Figure 1 is a side elevational view of a table type plate heat exchanger;

Fig. 2 is a plan view of the heat exchanger, parts being broken away;

Fig. 3 is a section substantially on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged plan view with the heat exchange plates removed;

Fig. 5 is a section substantially on the line 5—5 of Fig. 4;

Fig. 6 is an exploded perspective view showing three of the plates;

Fig. 7 is a face view of a portion of the corrugated heat exchange plates showing the gaskets in position;

Fig. 8 is a face view of the gaskets as they appear when assembled;

Fig. 9 is a face view of a portion of the corrugated plate before the gaskets have been applied;

Fig. 10 is a section on the line 10—10 of Fig. 9;

Fig. 11 is a section on the line 11—11 of Fig. 9;

Fig. 12 is a section on the line 12—12 of Fig. 9.

Referring to the drawings in detail, the construction shown comprises a plurality of corrugated flow-defining heat exchange plates 1, a plurality of plain plates 2 alternating with the

corrugated plates, a table 3 on which the plates 1 and 2 are stacked when in operative position, clamping means 4 for clamping the plates together and holding them together on the table 3, a pump 5 for supplying heat exchange fluid to the heat exchange plates, a motor 6 for driving the pump, a tank 7 from which the heat transfer fluid is withdrawn by the pump 5 and to which it is returned, and a steam supply pipe 8 for heating the heat transfer fluid.

If the heat exchanger is to be used as a pasteurizer, the plates may be divided into three sets,—an intermediate regenerative set, a cooling set for further cooling the pasteurized milk after it has passed through the regenerative set, and a heating set for further heating the raw milk after it has passed through the regenerative set.

The clamping mechanism shown comprises a pair of clamping devices 9 located adjacent opposite ends of the stack of plates. These clamping devices when actuated to effect a clamping operation pull downwardly on the sides of a housing member 10 which extends over the stack of plates. The resulting downward movement of the housing member clamps all of the plates snugly together, causing the gaskets to seal properly and confine the flow to the desired channels. The two clamping devices are similar in construction so the description of one will suffice for both.

Referring particularly to Figs. 1, 3, 4 and 5, each clamping device comprises a crosshead 11 underneath the table top connected with the housing member 10 by means of tension straps 12 extending through openings 13 in the table, an actuating screw 14 having a threaded engagement with the crosshead 11 and having a ball bearing thrust engagement at 15 with the lower side of the table 3, a worm wheel 16 keyed to this actuating shaft, and a worm 17 meshing with the worm wheel 16 and rotatable with an actuating shaft 18 in suitable bearings underneath the table top. The crosshead 11 is guided in its sliding movement by a pair of guides 20 secured to the raised portion 21 of the table 3. This raised portion 21 is connected with the lower portion of the table 21a by vertical webs 21b. A crossbar 22 is secured to the guides 20 for supporting the lower end of the screw 14. A suitable handle or lever (not shown) may be provided for rotating the shaft 18 on which the worm 17 is mounted. When the shaft 18 is rotated, it causes rotation of the worm wheel 16 and of the threaded shaft 14 to which the worm wheel is keyed. This forces the crosshead 11 downwardly and effects clamping action of the heat transfer plates.

The straps 12 may be attachably secured to the clamping cover 10 and to the crosshead 11 by means of hook-like members 23 on the strap engageable with hook-like member 24 secured to the cover 10 and crosshead 11, respectively.

When the pump 5 is driven by the motor 6, it withdraws heat transfer liquid from the tank 7 and supplies it to the heat transfer plates through the pipes 25. After passing through the heat transfer plates, the heat transfer liquid is returned to the supply tank through the pipe 26 to be recirculated. Steam can be supplied to the heat transfer liquid, the amount supplied being controlled by the valve 27 in the steam pipe 8.

As previously indicated, the stack of heat transfer plates is made up of alternating plain and corrugated plates. The corrugated plates 1 may be practically identical in construction. Each corrugated plate comprises two metal sheets 28 and 29 secured together in any suitable manner as by soldering adjacent parts together as indicated at 29a, or by flanges over parts of the plates as indicated at 29b (Figs. 11 and 12), back to back, with corrugations extending outwardly from the meeting plane of the sheets. These corrugations include gasket-confining corrugations 30 and 30a, flow-directing corrugations 31, and turbulence-creating corrugations 32. The turbulence-creating corrugations 32 are so formed that when plates are stacked in horizontal position on the table in position for use, every portion of the upper side of all of the corrugated plates will be in gravity flow liquid drainage communication with the liquid drainage outlet. This will insure that no milk or other liquid being treated will be left in the set of plates when the plates are drained. Also, the corrugations on the under side of each corrugated plate are so formed that all portions of all of the plates are in gas-drainage communication with the gas-drainage outlet so that there will be no pockets in which gas may find a lodging to cause contamination. This may be seen in Fig. 6. As shown therein, the corrugations 32 do not extend completely across the flow space so that when the plates are drained the liquid and gas can drain from the spaces between the corrugations around the ends of the corrugations and can escape to the drainage ports.

The flow-directing corrugations 31 and gaskets 34, 35, and 36 on the plates are so disposed that those on the upper side of the plate 1 will direct the flow from the port 37 to the opposite end of the plate, as shown in Fig. 6, and thence back to a position opposite the port 38 in the plain plate and so that those on the under side of plate 1 will direct the flow from a port 39 along the under side of the plate to the opposite end of the plate and thence back to a position opposite the port 40 in the plain plate.

The gaskets on the upper side of the plate in Fig. 6 bound the film flow space and the two ports 37 and 41 and exclude the other two ports 42 and 43. The gaskets on the under side of the plate bound the film flow space on the under side of the plate and the two ports 39 and 44 and exclude the other two ports 45 and 46.

The gasket construction comprises a rectangular channeled gasket 34 surrounding and embracing the edges of the two sheet metal plates 28 and 29 which form the corrugated plate (Figs. 10, 11, and 12), an L-shaped gasket 35 which seats in an L-shaped channel 47 in the corrugated plate, and a U-shaped gasket 36 which seats in a U-shaped channel 48 in a corrugated plate, the

channels 47 and 48 being bounded by the corrugations 30 and 30a.

As shown in Figs. 6 and 7, the L-shaped gasket 35 on the front side of the plate is in one corner of the plate and the L-shaped gasket 35 on the other side of the plate is positioned on another corner of the plate. Also, the U-shaped gasket 36 on the front side of the plate is offset with respect to the U-shaped gasket on the rear side of the plate so that the transfer ports in the corrugated plain plates may function properly. This arrangement brings all of the ports adjacent a common edge of the plate. It will be noted that the gasket and porting arrangement is such that it will make no difference which side of the plate is placed uppermost, since in either position of the plate the same porting and gasket arrangement would be presented to the adjacent flat plate.

In order to insure that no fluid can flow from the enclosed flow space to the excluded transfer ports, the gaskets are provided with suitable leak-prevention channels 49 along which any milk which may escape past the ridges on the gaskets can flow to the outside of the set of plates. As a further drainage feature, the gaskets may be perforated or slotted as indicated at 50 to enable the milk in the channels to flow downwardly, thus avoiding the necessity of flowing laterally to the outside edges of the plates. The sheet metal plates are apertured or slotted at 51 in alignment with the slots in the gaskets, the material of the sheet metal plates surrounding these slots being struck upwardly so as to enter the slots in the gaskets, thus confining the gaskets to their proper position on the plates.

The flow-guiding corrugations 31 may be of such a height that they will just touch the surface of an adjacent plain plate when the plates are clamped together to compress the gaskets. The turbulence-creating corrugations in general are of such a height that a thin film flow space will be provided between the crests of the corrugations and the adjacent flat plates. They are, however, provided at intervals with raised portions 52 (Figs. 7 and 10) which will touch the plain plates when the plates are clamped together. This contact between portions of the corrugations and the flat plates helps to insure uniform spacing of the plates.

By referring to Fig. 6, it will be seen that the flow on one side of the heat transfer plate is always counter-current to the flow on the opposite side of the plate. The plates may be arranged so as to provide for a series of parallel flow paths, one series for the liquid being treated and the other series being for the heat transfer liquid. The flow paths of the two liquids are indicated by lines and arrows in Fig. 6. Assuming for purposes of illustration that Fig. 6 is in a regenerative set and that the flow of raw milk is upward and the flow of pasteurized milk is downward, the raw milk flow is shown as entering at the port 37 in the lower plate and dividing to flow in parallel paths, part of it flowing over the upper face of the lower plate along the path A, A and part of it flowing through the port 53 in the plain plate and through the port 46 in the upper corrugated plate and over the upper surface of the corrugated plate along the path B, B, the two film flows A, A and B, B uniting at F as the milk from the upper surface of the lower plate flows upwardly through the port 38 in the plain plate and through the port 45 in the upper corrugated plate. The pasteurized milk flowing downwardly may enter at the port 39 in the upper corrugated plate, dividing at

this port into parallel flow paths, one part of it flowing along the lower face of the upper corrugated plate in the path C, C and the other stream flowing through the port 54 in the plain plate and the port 43 in the lower corrugated plate, and flowing along the lower surface of the corrugated plate in the path D, D. The two film flow streams are again united after having traversed the heat exchange plates, the film flow C, C along the lower surface of the upper corrugated plate flowing downwardly through the port 40 in the plain plate and through the port 42 in the lower corrugated plate where it unites at E with the stream D, D flowing along the lower face of the lower corrugated plate.

Further modifications will be apparent to those skilled in the art and it is desired, therefore, that the invention be limited only by the prior art and the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A plate heat exchange apparatus of the juxtaposed plate type comprising three juxtaposed plates providing for film flow therebetween, the outer two of said plates having flat heat transfer surfaces and the intermediate plate comprising two metal sheets secured together, back to back, each of said sheets having turbulence-creating embossments extending away from the meeting plane of said plates into the path of the fluid film flow, liquid drainage and gas drainage outlets for the interplate flow spaces, said embossments being so shaped and positioned that when the plates are in horizontal position all portions of the flow spaces between the plates including the portions between the corrugations are in gravity flow liquid drainage communication with the liquid drainage outlet and in gas drainage communication with the gas drainage outlet.

2. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange element comprising two metal sheets secured together back to back, each of said sheets having turbulence-creating embossments extending away from the meeting plane of said sheets into the path of the fluid film flow, and a channeled gasket embracing the edges of both of said sheets and bounding the film flow space on both sides of said element.

3. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange element comprising two metal sheets secured together back to back, each of said sheets having embossments extending away from the meeting plane of the sheets and a channeled gasket embracing the edges of both of said sheets and bounding the film flow space on both sides of said element and held against lateral displacement by said embossments.

4. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange element comprising two metal sheets secured together

back to back, each of said sheets having embossments extending away from the meeting plane of the sheets and a channeled gasket embracing the edges of both of said sheets and bounding the film flow space on both sides of said element, the edges of said sheets embraced by said gasket being bent away from each other to retain the gasket in place.

5. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange plate for juxtaposition with respect to an adjacent plate to form a film flow space therebetween, and a channeled gasket surrounding and embracing the edge of said heat exchange plate to define film flow spaces on both sides of the heat exchange plate.

6. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange plate for juxtaposition with respect to an adjacent plate to form a film flow space therebetween, and a channeled gasket surrounding and embracing the edge of said heat exchange plate to define film flow spaces on both sides of the heat exchange plate, said heat exchange plate having a port therethrough and a second gasket non-integral with said channeled gasket and cooperating with a portion of said channeled gasket to form a transfer passage excluding a film flow space.

7. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange plate for juxtaposition with respect to an adjacent plate to form a film flow space therebetween, and a channeled gasket surrounding and embracing the edge of said heat exchange plate to define film flow spaces on both sides of the heat exchange plate, said heat exchange plate having a port therethrough and a second gasket non-integral with said channeled gasket and cooperating with a portion of said channeled gasket to form a transfer passage excluding a film flow space, and said second gasket having a medial drainage channel to take care of leakage from one side toward the other of said gasket.

8. In a plate heat exchange apparatus of the juxtaposed plate type, a heat exchange plate for juxtaposition with respect to an adjacent plate to form a film flow space therebetween, and a channeled gasket surrounding and embracing the edge of said heat exchange plate to define film flow spaces on both sides of the heat exchange plate, said heat exchange plate having a port therethrough and a second gasket non-integral with said channeled gasket and cooperating with a portion of said channeled gasket to form a transfer passage excluding a film flow space, said second gasket having a medial drainage channel to take care of leakage from one side toward the other of said gasket, and said plate having a drain opening therethrough in communication with said drainage channel.

WILLIAM ASTLE.