

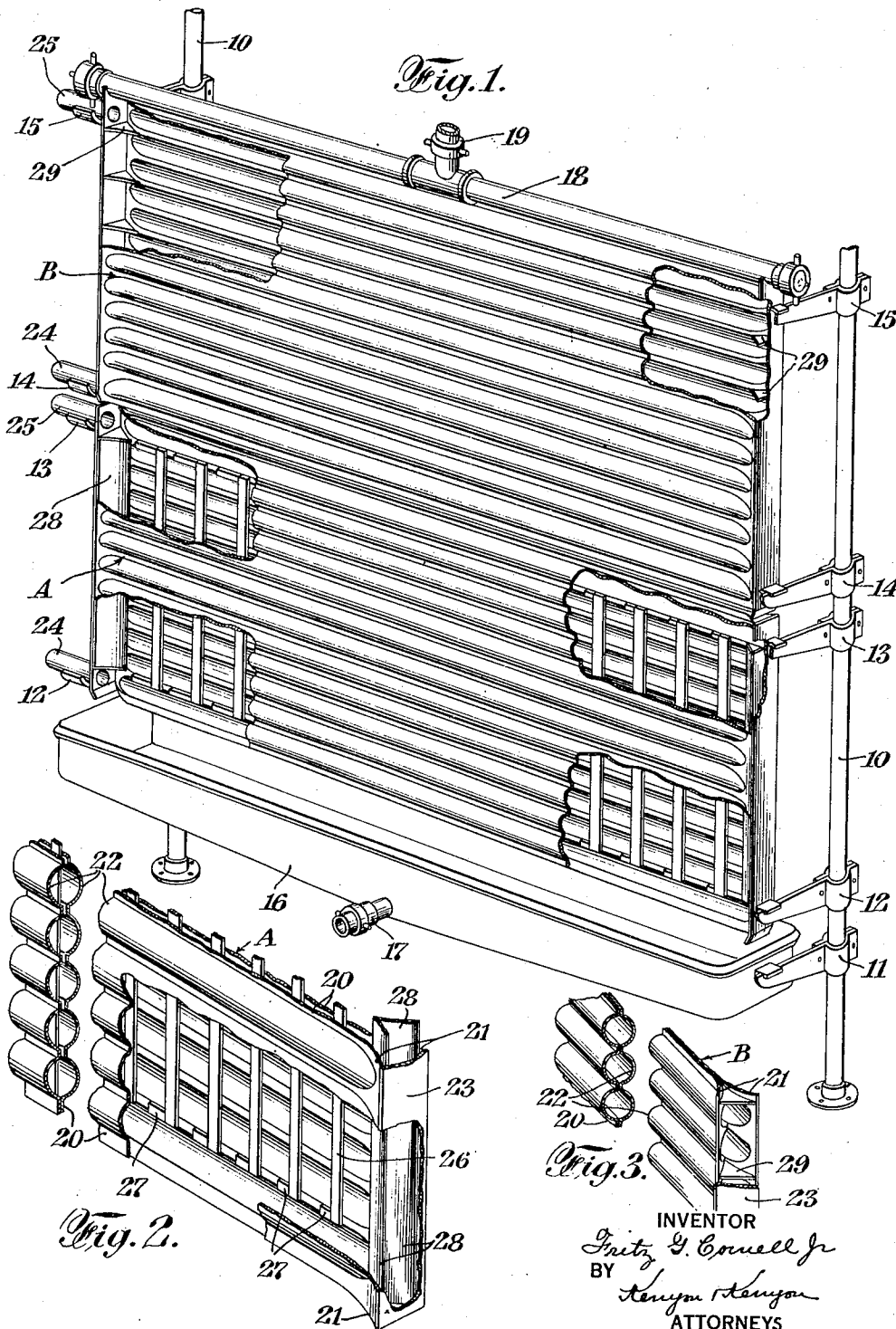
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HEAT EXCHANGE DEVICE

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HEAT EXCHANGE DEVICE

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This invention relates to heat exchange devices and more particularly to devices for attemperating liquids, such, for example, as liquid dairy products.

An object of this invention is a highly efficient and easily cleanable heat exchange device particularly adapted for treatment of dairy products.

A heat exchange device embodying the invention consists of two preferably parallel vertical plates joined together at the top and bottom edges and having each pair of vertical edges offset and spanned with an end strip. The plates are provided with opposed horizontal outwardly offset portions terminating at approximately the vertical edges and in one embodiment vertical members are interposed between the two parallel vertical plates, these members preferably terminating at the top below the upper outwardly offset portions and at the bottom above the lower outwardly offset portions respectively, to define vertical passages for the attemperating medium and horizontal channels defined by the upper and lower outwardly offset portions serving as supply ducts communicating with the vertical passages and providing means equalizing distribution of attemperating medium between vertical passages so that such medium flows directly counter-current to the dairy product which is caused to flow downwardly over the exterior surfaces of the plates. In another embodiment, the opposed horizontal outwardly offset portions cooperate to define a plurality of serially connected horizontal channels of any desired shape through which the attemperating medium flows back and forth alternately generally at right angles to the dairy product caused to flow downwardly over the exterior surfaces of the plates.

A novel feature and advantage of the construction embodying vertical members interposed between the two vertical plates to produce a counter-current flow is the provision of a common member to which the offset portions of the plates are attached rigidly and securely without depriving the vertical plates of full opportunity to expand and contract freely. At the same time, this arrangement so strengthens the structure by tying the parallel vertical plates together as to permit the employment of high pressures without distortion or damage to the parallel vertical plates. This is indicated by the fact that such a device composed of sheets of steel as thin as 18-gauge will satisfactorily withstand pressure of a thousand pounds.

Another novel feature and advantage of this construction (Fig. 2) is the removal of exhausted

attemperating medium from the inside of the cooling section much more rapidly by shortening the distance between the inlet and outlet than is possible when using serially connected channels. This is particularly the case when the attemperating material is ammonia liquid or other similar refrigerant which, while working, produces enormous quantities of gas between the time of entering and leaving other types of cooling sections. The vertical passageways provided allow the developing gases to pass within a minimum length of travel to the outlet, thereby more completely preventing ammonia liquid being displaced by gas bubbles. Furthermore, the gas bubbles forming between the parallel vertical plates and traveling directly to the outlet passageway assist in decreasing the density of the enclosed liquid ammonia as the gases increasingly develop and cause, as a result of encountering minimum friction as compared with passing through tubular coolers, the liquid to flow or percolate through the space between the parallel vertical surfaces at a rapid and consequently highly efficient rate, as indicated by actual commercial operations showing a B. t. u. transfer per square foot as much as 300% higher than in normal tubular coolers.

In the second embodiment, the plates are in contact between the horizontal offset portions to form channels and horizontal partitions are provided in the spaces defined by the offset vertical edges and adjacent spanning strips, such partitions being alternately arranged in said spaces to connect said channels in series from top to bottom and provide vertical passageways between two adjacent horizontal channels. With this construction, pairs of the channels are connected without the necessity of providing headers or return bends heretofore required.

Other objects, novel features and advantages of this invention will become apparent from the following specification and accompanying drawing, wherein:

Fig. 1 is a perspective view, partially broken away, of a heat exchange device embodying the invention;

Fig. 2 is a fragmentary perspective view, partially broken away of one embodiment of the invention, and

Fig. 3 is a similar view of a second embodiment of the invention.

A pair of vertical posts 10 are each equipped with brackets 11, 12, 13, 14 and 15. The brackets 11 support a collecting trough 16 provided with an outlet 17. The brackets 12 and 13 support a

heat exchange unit A while the brackets 14 and 15 support a heat exchange unit B. A distributor 18 is supported by the heat exchange unit B and is provided with an inlet 19.

Each of the heat exchange units A and B is composed of two vertical preferably parallel plates 20 preferably composed of stainless steel, which plates have their vertical edges 21 curved outwardly away from each other. Each plate 20 is provided with a plurality of horizontal outwardly offset portions 22 which are mutually opposed so as to define horizontal channels. An end strip 23 spans each pair of edges 21 to form closures therefor. The plates 20 are welded together at their top and bottom edges and each pair of vertical edges is welded to an end strip 23. Each unit A and B is provided with inlet and outlet pipes 24 and 25 respectively, which rest upon one set of brackets 12, 13, 14 and 15 and serve to support that end of the unit to which they are attached.

In the modification disclosed in Fig. 2, the plates 20 are separated or spaced apart by vertical bars 26 which are interposed between the plates with the bars terminating just below and just above the top and bottom channels defined by the offset portions 22. At the bottom and top ends of the bars are provided members 27 which progressively decrease in size from left to right so as to form progressively increasing outlet and inlet ports for the bottom and top channels. The vertical bars are welded to both plates at each point of contact therewith. In each of the vertical spaces defined by a pair of vertical edges 21 and end strip 23 is arranged a strip 28 closed at its ends, this strip being of smaller cross-section than said vertical space and co-operating with the edges 21 to form narrow vertical passages communicating with the horizontal channels.

In this heat exchange unit, the attemperating liquid is introduced through the pipe 24 and is distributed throughout the full length of the bottom channel, substantially even distribution being effected by the progressively increasing area of the discharge outlets from the channel. Where ammonia or other similar refrigerant is used, the members 27 may be dispensed with as uniform distribution is not required for efficient cooling effect with such refrigerant. The attemperating medium then flows upwardly through the spaces between the plates 20 and into the top passage from which it is discharged through the pipe 25. The strips 28 limit the flow of the attemperating fluid through the vertical spaces at each end of the device and also make the curved edges 21 effective as attemperating areas, thus providing a maximum attemperating surface.

In the unit B, the portions of the plates 20 between the offset portions 22 are in contact and welded together thus forming tubular horizontal channels. In the vertical spaces at the ends of the unit are provided horizontal triangular partitions 29, those on the left end being arranged between the ends of the first and second channel and between the ends of the third and fourth channel and so on while the partitions at the left hand end of the device are arranged between the second and third channels and between the fourth and fifth channels, etc. With this arrangement, the channels are serially connected from top to bottom, the partitions completing the turning of the attemperating means at the ends of the channels. Attemperating medium is supplied to this unit through the pipe 24 and is caused to flow the

full length of the bottom channel to its right hand end where it is caused to return to the left through the second channel by reason of the partition 29. Such back and forth flow is continued until the attemperating liquid reaches the left hand end of the top passage from which it is discharged through the pipe 25. The attemperating fluid is thus caused to flow back and forth transversely to the direction of flow of the dairy product.

The two units A and B constitute a complete attemperating device in which ammonia or other similar refrigerant is caused to flow through the unit A while water is caused to flow through the unit B. The dairy product is supplied to the distributor 18 and flows down, first over the surface of the unit B and then over the surface of the unit A and is thereby progressively subjected to lower temperatures. The attemperated liquid is collected in the pan 16 and delivered through the outlet 17 to a suitable storage tank. Each unit presents a large cooling surface which is highly effective in attemperating the dairy product. Furthermore, as the plates 20 are generally of stainless steel, the device is highly sanitary and can be easily and quickly cleaned after each milk run.

The unit A provides for uniform distribution of the attemperating medium in counterflow relation to the dairy product and provides for the quick discharge from the unit of ammonia gas. Upon the conversion of ammonia from liquid to gas, the gas immediately rises to the top passage by a direct path and is promptly discharged. Moreover, on its upward passage, the gas carries liquid ammonia along with it and splashes the same on the inner walls of the horizontal passages, thus maintaining them in the desired wet condition. The ammonia is thus removed from the cooling unit almost immediately after it has lost its value as a refrigerant by conversion from liquid to gas. Furthermore, the co-efficient of heat transfer of the device is very high by reason of the prompt removal of the ammonia gas from the unit.

The unit B provides a long tortuous path for the attemperating medium and provides connection between horizontal channels without the necessity of projecting return bends or headers which have heretofore been common in devices of this character. The plates 20 are produced from flat metal sheets preferably of stainless steel by a forming operation in which the offset portions are pressed out and the edges curved back, certain cuts being made in the sheets for this purpose which are later welded so that the finished plates are continuous throughout their entire area. The top and bottom edges of the plates are suitably shaped so that they abut each other and are welded together while the vertical edges are welded to the end strips 21.

It is to be understood that the heat exchange structure above described is not limited to the use of any particular type of supporting arrangement, but can be used in conjunction with any desired form of supporting means, the supporting means herein shown being merely an example of one form of such means.

I claim:

1. A heat exchange device comprising two vertical plates joined together at their top and bottom edges and having their vertical edges curved away from each other and having opposed horizontal outwardly offset portions terminating adjacent said curved edges, said por-

tions mutually co-operating to define a plurality of horizontal channels, an end strip spanning each pair of vertical edges, vertical bars interposed between said plates and being joined to said plates at points of contact therewith, and a vertical strip of V-shaped cross-section arranged in each space defined by a pair of vertical edges and adjacent end strip.

2. A heat exchange device according to claim 1 characterized by members at the ends of the vertical bars, said members varying progressively in width from one edge of the plates to the other.

3. A heat exchange device comprising two vertical plates joined together at their top and bottom edges and having their vertical edges offset, an end strip spanning each pair of vertical edges, said plates having opposed horizontal outwardly offset portions terminating adjacent said vertical edges and mutually cooperating to define a plurality of horizontal channels, vertical bars interposed between said vertical plates and terminating below and above the top and bottom channels respectively and a vertical strip of V-shaped cross-section arranged in each space defined by a pair of vertical edges and adjacent end strip.

4. A heat exchange device comprising two vertical plates joined together at their top, bottom and vertical edges, said plates having opposed horizontal outwardly offset portions mutually co-operating to define a plurality of horizontal channels, vertical means extending between said plates and connected thereto between successive offset portions to form a vertical passage leading from the bottom to the top channel and communicating with the intermediate channels, an inlet for the bottom channel and an outlet for the top channel.

5. A heat exchange device according to claim 4, in which said means comprises vertical bars interposed between said plates and connected thereto between said channels.

6. A heat exchange device comprising two vertical plates joined together at their top, bottom and vertical edges, said plates having opposed outwardly offset portions mutually co-operating to define a plurality of horizontal channels, and vertical bars interposed between said plates and being welded to said plates between said channels.

7. A heat exchange device according to claim 6 in which said plates have their vertical edges offset and spanned by end strips, and a vertical member arranged in each space defined by a pair of vertical edges and adjacent end strip, said member being of smaller cross-sectional area

than said space to define a vertical passage leading from the bottom to the top channel and communicating with the intermediate channels.

8. An attemperating device for use with refrigerant such as ammonia to afford maximum refrigerant boiling surface exposure to the product being cooled with a minimum travel of developing refrigerating gases between the points of liquid refrigerant inlet and gas outlet, said device comprising vertical plates having offset portions mutually co-operating to define a plurality of horizontal channels, and a series of reinforcing elements extending vertically between said plates and fastened thereto between successive offset portions, said elements being so spaced as to furnish orifices positioned to provide for a minimum length of gas travel.

9. An attemperating device comprising two vertical plates joined together at their top and bottom edges, said plates having opposed horizontal offset portions mutually co-operating to define a plurality of horizontal channels, a series of vertical reinforcing elements extending between said plates and being fastened thereto between successive offset portions, said reinforcing elements also serving to space apart the plates to provide a passage communicating with all of said horizontal channels, and end strips spanning the vertical edges of said plates.

10. An attemperating device for use with refrigerant such as ammonia to afford maximum refrigerant boiling surface exposure to the product being cooled with a minimum travel of developing refrigerating gases between the points of liquid refrigerant inlet and gas outlet, said device comprising co-operating plates, one plate having offset portions defining a plurality of horizontal channels at different elevations, and a series of reinforcing elements extending between said plates transverse to said channels and fastened to said plates between successive offset portions, said elements being so spaced as to furnish orifices positioned to provide for a minimum length of gas travel.

11. An attemperating device comprising two co-operating plates interconnected at their edges, one plate having offset portions defining a plurality of horizontal channels at different elevations, and a series of reinforcing elements extending between said plates transverse to said channels and fastened to said plates between successive offset portions, said reinforcing elements also serving to space apart the plates to provide a passage communicating with all of said horizontal channels.

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