May 27, 1947. C. B. DALZELL ET AL 2,421,245

HEAT EXCHANGE ELEMENT

Original Filed Nov. 30, 1938 3 Sheets-Sheet 1

Fig. 1.

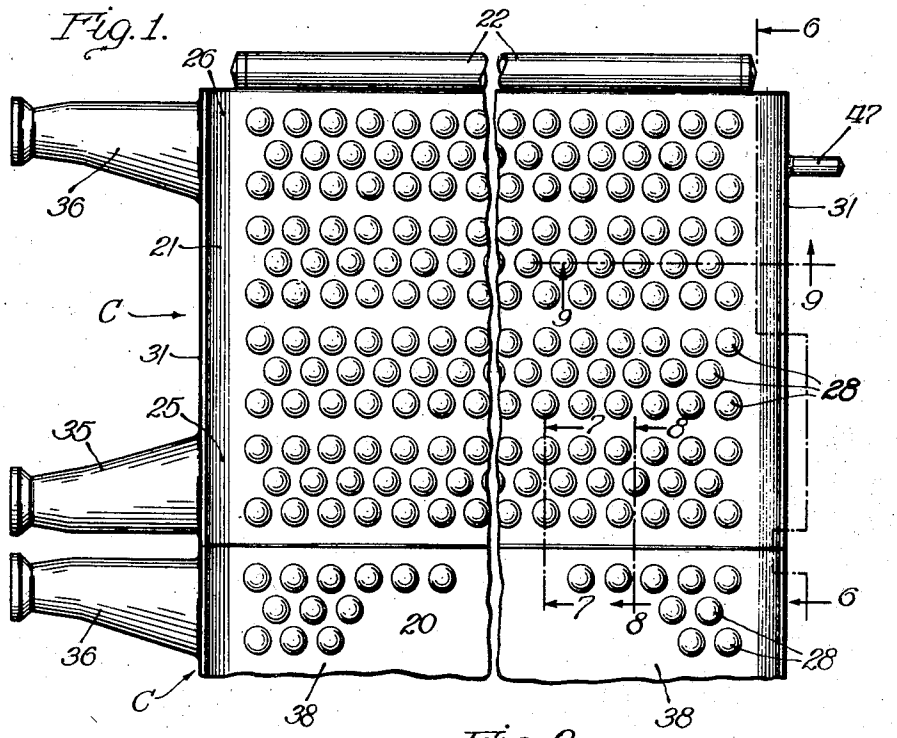


Fig. 2.

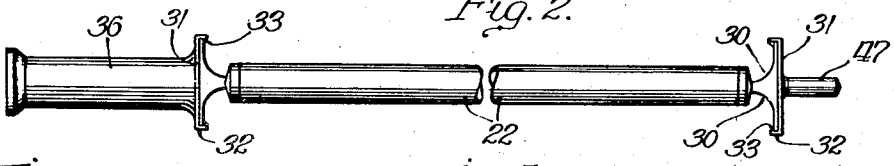


Fig. 3.

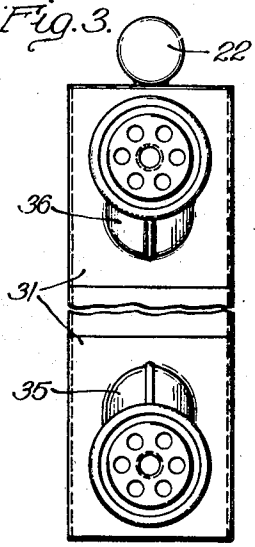


Fig. 5.

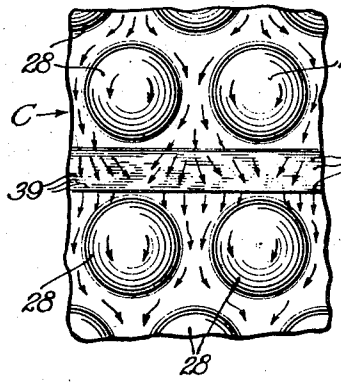
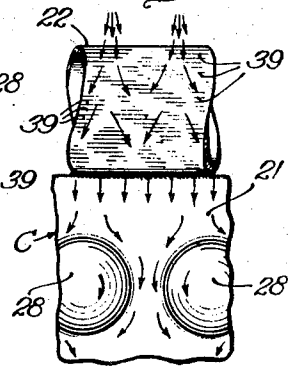


Fig. 4.



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Fig. 10.

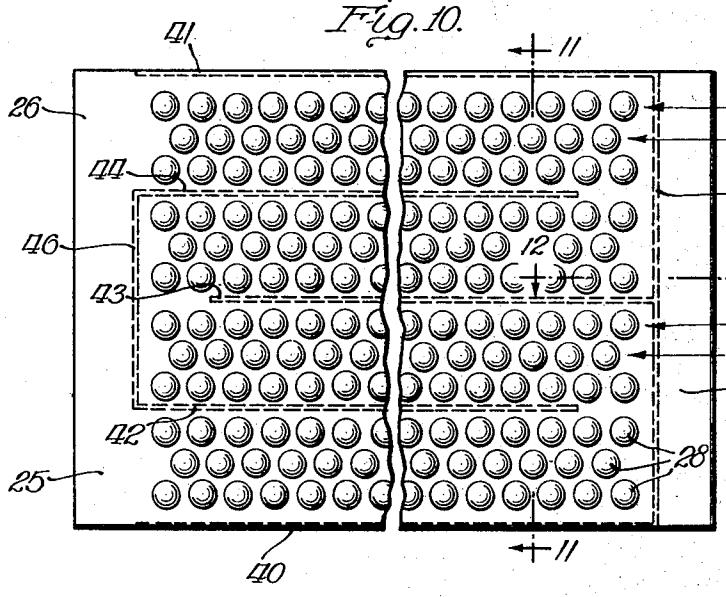


Fig. 11.

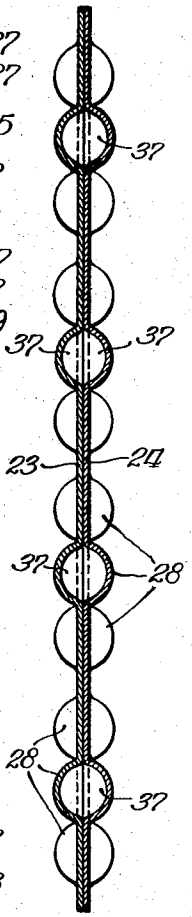


Fig. 6.

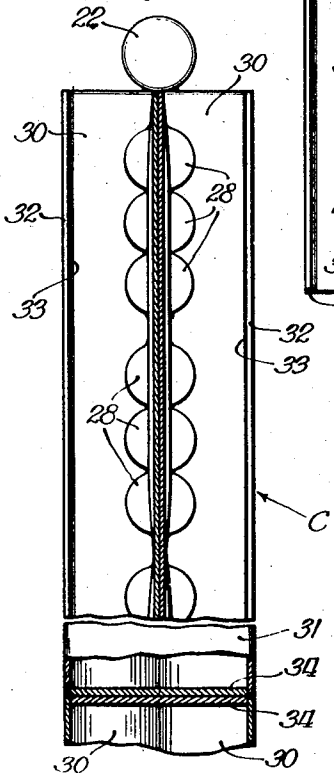


Fig. 7.

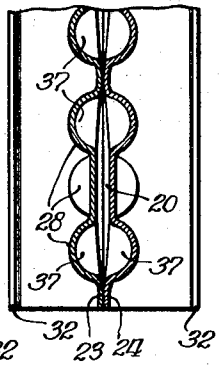


Fig. 8.

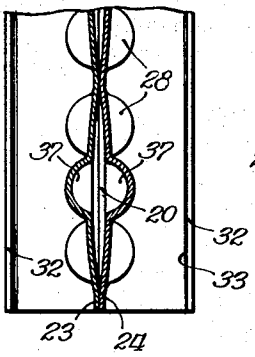
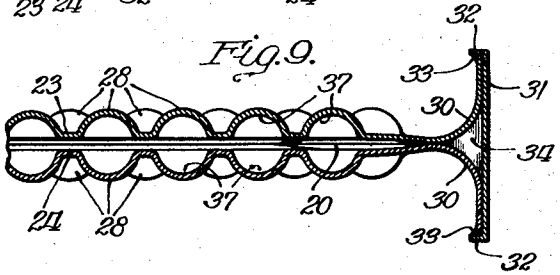


Fig. 9.



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Fig. 14.

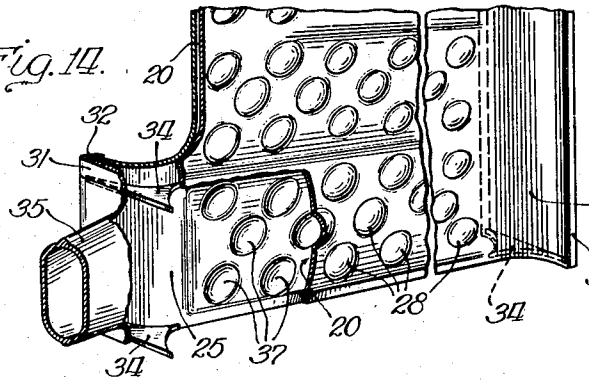


Fig. 15.

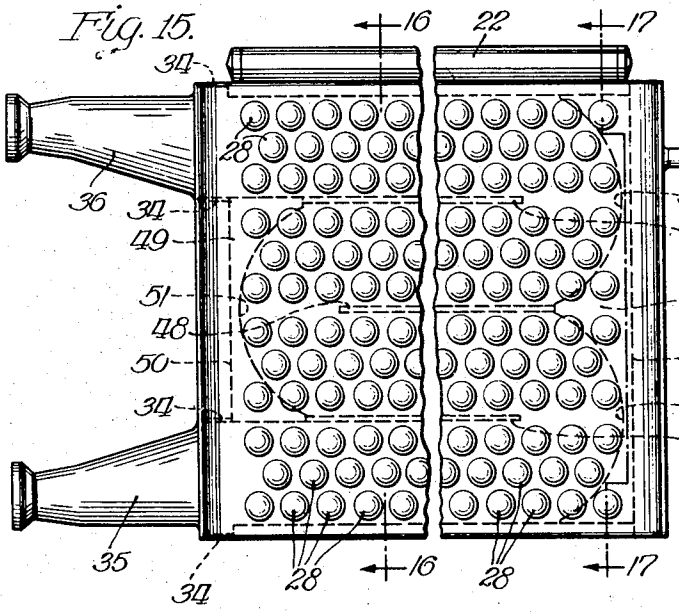


Fig. 16.

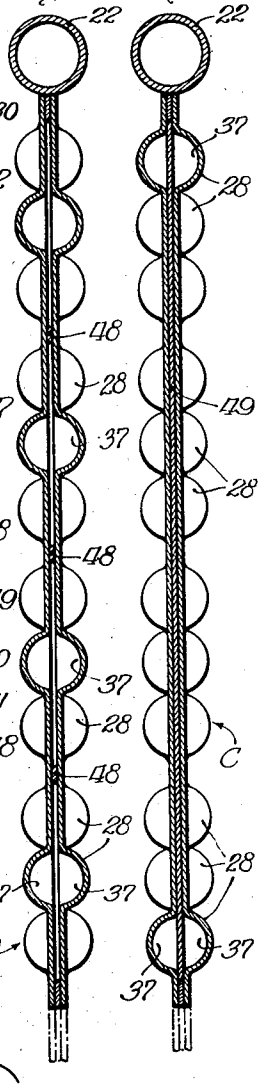


Fig. 17.

Fig. 12.

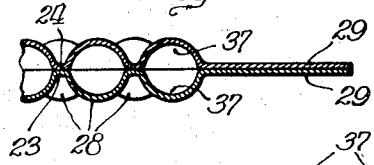
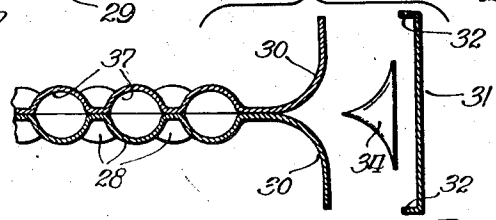


Fig. 13.



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UNITED STATES PATENT OFFICE

2,421,245

HEAT EXCHANGE ELEMENT

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Original application November 30, 1938, Serial No. 243,130. Divided and this application May 13, 1942, Serial No. 442,750

2 Claims. (Cl. 257—187)

1

The present invention relates to heat exchange devices for cooling or heating liquids, such, for example, as liquid dairy products, and more particularly to the multi-sectioned, sanitary, heat absorbing or refrigerant expanding unit for the compressor type of cooling machine adapted to be used in the top feed, trickle type of film coolers employing multi-unit, compact constructions. The present application is a division of our application Serial No. 243,130, entitled "Heat exchange device" and filed November 30, 1938, now Patent No. 2,383,292, which parent application fully discloses and describes the heat exchange section specifically claimed in this application. The process of making the heat exchange section is specifically described and claimed in our co-pending application Serial No. 250,670, entitled "Heat exchange element" and filed January 13, 1939, now Patent No. 2,306,526.

In heat exchange elements of the type referred to, such as are used for the handling of food products, it is essential that the sections be easily cleaned and of a sanitary construction providing smooth, unbroken surfaces free from cracks, crevices and shoulders for the flow of the milk or liquid to be treated and also to provide smooth passages for the flow of the heat exchange medium. Such sections must be simple in construction and employ the least possible number of operative parts. The accompanying drawings illustrate the invention in a heat exchange element of this type. However, the invention is not to be limited to the specific embodiment disclosed.

The principal objects of the present invention are to provide a new and novel, compact, sanitary, rigid and durable sheet metal heat exchange element constructed of relatively thin sheet metal, preferably stainless steel, in which are incorporated improvements in structure, organization and assembly; in which the heat transfer surface has been augmented and the embossings so constructed and arranged as to improve the heat exchange efficiency and capacity without increasing the overall dimensions; in which embossed or corrugated sheets of metal are arranged face to face in opposed relation and sealed along predetermined lines, thus providing sealed liquid passages intermediate the plates; in which the bracing elements are insulated and so formed as to prevent the sections from freezing together, as well as to act as fluid control and distributing elements and spacing means when a plurality of elements is operated in close side-by-side position; and in which the embossings of the sections are so constructed and arranged as to cause turbulence in the liquids flowing through the interior of the sections and over the outer surface of the sections.

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Another important object of this invention is to produce a heat exchange section provided on its inner and outer liquid contacting surfaces with means to obstruct the uniform laminar flow of the liquid, and to effect a dispersion, distribution and turbulent flow of the liquids in such a manner as to cause a difference in the speed of different portions of the liquid as they travel over and around or past the obstructions on the surfaces of the sections, resulting in violent turbulence within the liquid either on the interior or exterior of the sections or both as the various portions of liquid are rejoined and redivided as they travel over the surfaces, resulting finally in a more efficient heat transfer between the liquid on the outer surface of the section and the liquid flowing through the section.

An important feature of the invention is to provide liquid distributing and blending means to produce turbulence in the treating and treated liquids and to secure uniform distribution in the liquid as it passes over and through the sections to effect improved operation and increased heat exchange efficiency.

Other objects of the invention are to provide a heat exchange element of novel construction and also to provide a heat exchange element for liquids, which has the other features of advantage and improvement hereinafter described and set forth in the claims.

With the foregoing and other objects and important features in view, the invention consists of certain novel features of construction as will be readily apparent upon the examination of the details of construction and arrangement and various combinations as disclosed in the figures and description, all of which will be first fully described in the specification and then specifically pointed out in the appended claims, reference being made to the accompanying drawings in which:

Figure 1 is a side elevation of a multi-sectioned heat exchange element embodying our invention.

Figure 2 is a plan view of the heat exchange element shown in Figure 1.

Figure 3 is a fragmentary end view of the heat exchange element shown in Figure 1 and particularly emphasizing the inlet and outlet connections for the liquid to be circulated through the interior of the sections of the element.

Figure 4 is an elevational view of a portion

of the liquid distributing and heat exchange element reinforcing bar or bracing mounted at the upper edge of the section, showing the novel surface of the liquid distributing element and schematically illustrating the dispersion of the liquid as it travels over the uniquely surfaced reinforcing or bracing portion of the element before it reaches the upper portion of the uppermost sections of the heat exchange element.

Figure 5 is a side elevation of a portion of a heat exchange section provided with novel surfacing at spaced positions intermediate the treating liquid flow passages and along the path of travel of the liquid being treated to disperse the same and more uniformly distribute the liquid on the heat exchange surfaces.

Figure 6 is a transverse sectional elevation, partially in broken-away fragmentary section, of a heat exchange element embodying our invention taken along line 6—6 of Figure 1.

Figure 7 is a transverse sectional elevation of the heat exchange element embodying our invention, taken along the line 7—7 of Figure 1.

Figure 8 is a transverse sectional elevation taken along the line 8—8 of Figure 1.

Figure 9 is a longitudinal sectional plan taken along the line 9—9 of Figure 1.

Figure 10 is a longitudinal elevational view of the juxtapositioned metal stampings used in the construction of the heat exchange sections before assembly and before joining the same to form a multi-sectioned element, which figure shows the line of welding defining the liquid passages before the same have been shaped or the ends of the sections flared.

Figure 11 is a transverse sectional elevation taken along line 11—11 of Figure 10.

Figure 12 is a transverse sectional plan taken along line 12—12 of Figure 10.

Figure 13 is a sectional plan of an end portion of a partially fabricated section showing the various elements of the structure including the end plates for sealing the ends of the sections in separated position in relative order of assembly.

Figure 14 is a fragmentary perspective view, partially in broken-away section, of a portion of a heat exchange section embodying our invention.

Figure 15 is a longitudinal elevation of a modification of the heat exchange section embodying our invention.

Figure 16 is a transverse sectional elevation taken along line 16—16 of Figure 15.

Figure 17 is a transverse sectional elevation taken along line 17—17 of Figure 15.

Referring to the preferred illustration embodying the invention as it relates to the heat exchange element, which in its preferred form as illustrated in Figure 1 comprises a plurality of joined sections C, each heat exchange element as illustrated may, when a multi-zoned element is desired, include several zones or sections C provided with independent flow passages 20. These independent sections of the elements or units are all identical with the exception of the topmost sections 21 of each unit, which topmost section 21 is provided at its top edge with a cylindrical bracing and liquid dispersing element 22 substantially devoid of heat exchange relation with the rest of the section to which it is affixed. The flow passages in each of the sections or zones of the multiple-sectioned unit or element consist of outwardly bulged cooperative portions of two rectangular sheet metal stampings 23 and 24 intermediate a series of two

sets of continuously welded lines joining the stampings and defining the flow passages in between the two stampings 23 and 24. In the illustrations, as clearly shown in Figure 10, the various adjacent horizontal reaches of the flow passages are formed in the joined stampings by certain portions of each of the two sets of continous weld lines. It is desired at this point to indicate that the various sections of the two sets of continuous weld lines intermediate the adjacent reaches of the flow passage as shown in Figure 10 may also be of a spot welding construction instead of a continuous seam-welded line. By such a construction, it would be possible to provide bypasses intermediate adjacent reaches of the zigzag flow passage 20 to facilitate the discharge of refrigerant gas from the flow passage by reducing the distance through which the gas must travel to reach the discharge outlet. The two ends of the continuous flow passage 20 intermediate the opposed stampings constituting the section walls are located, in the preferred embodiment of the invention, at the lower and upper left hand corners of each section of the unit of the heat exchange element and are respectively the inlet port 25 and the discharge port 26. However, it should be evident that the flow passage 20 could be so arranged and constructed that the ends thereof would be located at opposite ends of the sections.

The zigzag passage 20 consists of a series of horizontal lengths of reaches of passage formed between outwardly bulged portions of the stampings 23 and 24, with appropriate bulged vertical passage segments so joined to the ends of the horizontal reaches of the passage 20 as to constitute a zigzag line of travel for the liquid circulating therethrough.

The stampings 23 and 24 consist of a substantially co-planar metal sheet (preferably non-corrosive metal such as stainless steel) provided with a series of horizontal tiers of staggered rows 27 of outwardly directed, hollow, preferably semispherical protuberances 28 extending substantially across the face of the stampings 23 and 24 and leaving only vertical margins 29 at each end of the flat stampings. The vertically superposed rows 27 of protuberances are preferably three deep and the size of the protuberances 28 is such as to effectively block the space intermediate two adjoining protuberances in an adjacent row 27, thereby effectively diverting any liquid which may flow throughbetween the protuberances in the adjoining row. The depth, however, of the protuberance is not sufficient to cause a rupture of the liquid layer as it flows downwardly over the heat exchange sections C forming the heat exchange element. The vertical margins at the ends of the stampings 23 and 24 are flared outwardly, forming flanges 30. End plates 31 with inwardly directed flanges 32 are affixed to the free ends of flanges 30 as by weldings 33 between the end of the outwardly turned flange 30 of the stampings and the inwardly turned flange 32 of the end plates 31, with the exception of that portion of the flanges 30 immediately adjacent the inlet and outlet ports 25 and 26 for the passages 20. Triangular webs or partition elements 34 are affixed intermediate the flanges 30 at each end of each end plate 31, thereby sealing the vertical space intermediate the flanges 30 and the end plates 31, which space and its defining elements 30, 34 and 31 are substantially devoid of heat exchange relation with the passages 20 and the refrigerant or cooling medium or liquids

which may flow through the passages. Each section or zone C of the heat exchange element is provided with an inlet and outlet hinge arm 35 and 36 respectively for establishing communication between the liquid passages 20 and for supporting the weight of the multiple-sectioned heat exchange element when mounted in a frame or machine, and these hinge arms are joined to the sections at the inlet and outlet ports 25 and 26 respectively and in communication with passage 20. The inlet and outlet ports 25 and 26 are defined by portions of the flared flange 30 intermediate two triangular partition elements 34 adjacent the two ends of the passage 20 of the units. The ends of the hinge arms 35 and 36 are welded to or otherwise satisfactorily affixed to the outer edges of the flange 30 and partition 34 which define the inlet and outlet ports 25 and 26. The two rectangular stampings 23 and 24 are in face-to-face contact with each other and the oppositely directed corresponding protuberances 28 are in exact transverse alinement. It should, however, also be remembered that satisfactory heat exchange sections and multiple-sectioned elements may be made by arranging the transversely opposed protuberances in staggered or other satisfactory relation one to another whereby turbulence of the liquids may be secured. On the interior of each stamping the inner surface of the hollow semi-spherical protuberances 28 presents cavities 37 which have an agitating effect on the refrigerant or cooling liquid as it is speedily passed through the flow passage 20 when the sections are placed in operation as heat exchange elements.

In the past, heat exchange elements constructed for comparable use have been of the type employing superposed lengths of tubing connected at their ends by suitable headers associated therewith to form either parallel or series connections. Other types of comparable heat exchangers consist of corrugated sheet metal stampings placed face to face and joined by any satisfactory means, such, for example, as welding, in which exchangers the joined corrugations constitute the liquid passages and may be connected in series or parallel as the case may be. In each instance, however, the flow of the liquid over the old type of sections, whether they consist of superposed tubes or corrugated sheets with internal channels, as well as the flow of heat exchange medium on the inner side of the sections, has been in the form of undisturbed laminar flow. The liquid flowing over the outer surface of those types of sections has been in the form of uniform laminar film smoothly sliding over the wetted surface of the sections. Such a flow generally took the form of a laminar flow of liquid film in which the outer particles of liquid film would travel faster than the innermost particles of liquid film which were nearer the stationary wetted surface of the heat exchange section. One of the chief advantages of the new and novel sections embodied in this invention, as illustrated in Figure 1, results from the turbulent flow of liquid as it passes down over the various sections of the heat exchange element and engages the protuberances 28, resulting in the deflection of various particles of liquid as they engage the protuberances from their normal course of travel which they would have followed had the plates 23 and 24 not been provided with the protuberances or baffles 28. Such deflection of the particles of liquid in a thin liquid layer by the baffles or protuberances 28 results in the separation of one liquid particle

from another and the rejoining of such separated particles with still other particles as they pass down over the surface of the stampings 23 and 24. Such separation and rejoining of the liquid particles results in active turbulence within the liquid layer itself as it passes downwardly, thereby improving the rate of heat transfer between the liquid layer on the outer surface of the sections of the heat exchange element and the heat exchange element proper which in turn is in heat exchange relation with the attempering liquid passing through the sections. Active turbulence is further induced by the inherent physical result of the liquid layer flowing downwardly over a series of staggered rows of protuberances or baffles which are so arranged and constructed that the space between any two adjacent protuberances in one row is completely blocked by a protuberance in an adjacent row whereby the liquid flowing over the outer surface of the sections of the heat exchange element is forced to follow a zigzag course in its passage downwardly. Active turbulence is also aided by a further inherent physical result in a layer of liquid flowing over a surface, part of which is covered by baffles or protuberances over which some of the liquid is forced to flow. However, the flow over the baffles or protuberances is in a much thinner layer than the flow of the liquid over the flat spaces between the protuberances or baffles. Due to the fact that the adjacent rows of protuberances are in staggered relation, the portion of the liquid layer which flows throughbetween two adjacent protuberances or baffles in one row will engage a protuberance in the next adjoining row, and, therefore, part of the liquid will be diverted toward one or the other side of the baffle or protuberance, thickening the portion of the liquid layer to which it passes and thinning the portion of the liquid layer from which it passed. This adjustment within the liquid layer itself will also in and of itself cause a turbulence in the liquid. As a result of the various factors just described, the efficiency of the element as a heat exchanger or rate of heat exchange of the element embodying this invention is greatly increased.

The flow of the heat exchange medium or refrigerant passing throughbetween the stampings 23 and 24 is also caused to be turbulent due to the effect upon the flow of the medium as it passes over the cavities 37 which line the walls of the flow passages 20. Such turbulence induced in the heat exchange medium or refrigerant will greatly increase the efficiency of the element as a heat exchanger and improve the rate of heat transfer between the stampings 23 and 24 of the sections C and the refrigerant passing through the liquid passage 20 on the interior of the joined stampings 23 and 24 forming the sections.

In the construction of a multi-zoned or multi-sectioned heat exchange element several separate individual units or zones 38 and 21 with a separate liquid passage 20 for each are welded together along their adjoining edges in superposed order as shown in Figure 1. Each zone or section is provided with separate liquid inlet and outlet connections in the form of hollow hinge arms 35 and 36 respectively. The spacing of the horizontal lengths of the flow passage 20 in each of the zones or sections of the compound units or elements which are combined to form an operative unit, is such that when two sections are joined in superposed order, the separate adjacent

horizontal elements of the flow passage 20 of the adjoining sections are spaced from each other equal to the spacing intermediate any two adjacent horizontal elements or reaches of a flow passage in a separate section. Such construction facilitates the fabrication of a multi-zoned unit from single individual zones or sections.

The multiple-zoned unit is desirable in that it shortens the distance of flow of any portion of the heat exchange medium or refrigerant passing through the interior of the zone or section. A multiple-sectioned unit is also easily adapted to the use of a plurality of heat exchange media in that any one or more of the zones of the unit can be supplied with any desired type of heat exchange medium while the remaining sections or zones of the unit may be supplied with one or more other types of heat exchange medium depending on the results to be accomplished and the liquid being treated on the outer surface of the unit.

In each unit consisting of a plurality of joined sections or zones, the uppermost section which is first to receive the liquid to be treated is provided along its upper edge with a horizontal, longitudinally extending, cylindrical stiffening element 22 which is welded to the top edge of the section C with the center line of the element 22 in a horizontal plane and in vertical alinement with the vertical plane of the section 21. By this arrangement the liquid supplied to the uppermost section 21 of each heat exchange unit will be directed against the surface of the stiffening element 22, preferably on both sides of the element 22, thereby assuring uniform liquid supply to each side of the topmost sections of the unit. To secure uniform distribution of liquid to be treated over the sides of the sections C the element 22 is provided with a grained finish as shown in Figure 4 in which the grains 39 extend in a direction crosswise to the path of the flow of the liquid passing downwardly from the source of supply over the stiffening element 22 toward the section 21 of the heat exchange unit. As the liquid particles contact the transversely directed grains 39 of the finish on the element 22, their flow is hindered, tending to cause a lateral dispersion of the liquid. By this procedure a complete, uniform dispersion and distribution throughout the entire length of the element 22 is obtained before the liquid, which is passed on to the upper surface of the element 22 in small rivulets, passes off of the lower portion of the element 22 onto the top portion of the upper zone 21 of the heat exchange unit. A similar finish with horizontal grains 39 is provided on the outer surface of the walls or stampings 23 and 24 of the sections C intermediate the horizontally extending reaches of the flow passages 20 as shown in Figure 5. This also aids in securing and maintaining more uniform dispersion and distribution of the liquid passing down over the outer surfaces of the section C. However, after the liquid once passes onto the surfaces provided with the staggered rows 27 of protuberances 28, it is maintained in substantially uniform distribution and active turbulence as it passes downwardly over the surface of the sections C. This is true even when the sections are not especially grained. In the fabrication of each section or zone 38 of the heat exchange unit, it is preferable to use two sheet metal stampings 23 and 24 provided with tiers of rows 27 of protuberances 28. The stampings are identical so as to constitute the reverse counterpart of each other when they are

assembled face to face in reverse relation as shown by Figures 11 and 12. The stampings 23 and 24 have in substance the plane of the sheet of metal from which they were stamped, and peripheral unstamped vertical marginal edges 29 of the juxtapositioned plates are co-planar as shown by Figures 10 and 12. The sheets are then welded together at their upper and lower edges along the weld lines 40 and 41 as shown in Figure 10, which weld lines extend along these edges over the vertical unstamped portions of the end margins. The internal horizontal flow spaces 20 of the sections C are then laid out and their edges sealed by seam-welding of the stampings along the horizontal lines 42, 43 and 44 intermediate the tiers of superposed staggered rows 27 of the protuberances 28. It may be well to repeat at this point that the seam weldings 42, 43 and 44, which in the preferred embodiment of this invention are continuous seam welds, may also take the form of interrupted weld lines, whereby a modified flow passage 20 provided with bypasses intermediate the horizontal reaches of adjacent sections would be provided to facilitate a more ready escape of the evaporated refrigerant from the various elements of the passage 20 toward the outlet port 26. The joining of the corresponding ends of one of the group of alternate horizontal weld lines including the lines 40 and 41 along their righthand end as shown in Figure 10 by vertical weld line 45 and joining the remaining horizontal weld lines at their corresponding opposite ends by vertical weld line 46, as clearly shown in Figure 10, defines the flow passage 20. In each instance the horizontal weld lines and the vertical joining lines are no closer to the remaining horizontal weld lines and their joining lines than the width of a tier of rows 27 of the protuberances or baffles 28. This arrangement of vertical and horizontal weld lines defines a zigzag flow passage 20 with its open ends or ports 25 and 26 at the lower and upper lefthand corners respectively of the stampings 23 and 24 forming the sections C of the heat exchange unit or element.

Having thus joined the stampings 23 and 24 along the weld lines just referred to, the vertical unstamped portion or edges 29 of each stamping are then flared outwardly to become flanges 30 as clearly shown in Figure 13. Triangular web or partition elements 34 are provided at the ends of the vertical spaces intermediate the outwardly turned flanges 30 at the opposite ends of the sections C as shown in Figure 14, and also at vertical spaces intermediate the flanges 30 at the left end of the sections C immediately above and below the inlet passage 25 and outlet passage 26, and communicating with the opposite ends of the zigzag liquid flow passage 20 as is also clearly shown in Figures 1 and 14. Each section or zone is then provided at its inlet and outlet openings 25 and 26 with inlet and outlet hollow hinge arms 35 and 36 respectively, which are welded or otherwise satisfactorily affixed to the free edges of the flanges 30 at the lower and upper lefthand corners of the sections C, and also to the free edges of the triangular partitions 34 defining the upper and lower boundaries of the inlet and outlet ports 25 and 26 to the liquid passage 20 and in communication therewith. End plates 31 with inwardly turned flanges 32 are then provided to complete the enclosure of the vertical space intermediate the outwardly turned flanges 30 at either end of the section or zone C and between the triangular partitions 34. The end plates 31 are fixed

to the flanges 30 by welding 33 or other satisfactory means between the flange 32 and the outer free edge of the flange 30 as is clearly shown in Figure 9.

Each of the topmost sections 21 of the heat exchange unit comprised of a plurality of sections C is also provided with a cylindrical, horizontally grained section and unit bracing element 22 extending across the uppermost edge of the section 21 intermediate the outwardly turned flanges 30. The horizontal grain lines 39 of the element 22 constitute liquid distributing and dispersing means to act on the liquid supplied to the element 22 in rivulets for uniform distribution throughout the entire length of the upper portion of the sections 21. Similar grain lines 39 are provided on the surface of the stampings 23 and 24 intermediate the horizontally extending tiers of rows of protuberances 28. To complete each of these respective sections C, provided at their ends with end plates 31, and only in the instance of the uppermost sections 21, the end plate 31 is provided near its upper extremity with a latch or catch 47. Such a catch facilitates the proper mounting and positioning of the heat exchange unit when assembled in compact order in an enclosed heat exchanger of the swinging section type for which the unit is particularly adaptable as is clearly shown in our co-pending application Serial No. 243,130, now Patent No. 2,383,292.

To provide the individual zones or sections C of the multi-zoned units or heat exchange device with internal flow passages 20, the outlet hinge arms 36 of the completed multi-sectioned elements are each sealed and the inlet hinge arms 35 are each connected to a source of fluid pressure; such as hydraulic pressure. The pressure is adjusted until the portions of the plates or stampings 23 and 24 intermediate the weld lines defining the liquid flow passages 20 have been bulged out to the desired shape as shown by the sectional drawings, Figures 7, 8, 9, and 14, depicting internal views of the sections, and Figures 6 and 14 depicting the bulged effect on the liquid passage boundary portions of the stampings 23 and 24. However, the stampings 23 and 24 may be stamped originally with the bulged portions to form the flow passages 20, and in such instances hydraulic pressure would not be required to form the internal flow passage 20.

In Figure 15 is shown a modified form of heat exchange section C, which differs only from the previously described sections by using horizontal spacing elements 48 and 49 intermediate the stampings 23 and 24 along the position occupied by the weld lines in the preferred embodiment shown in Figure 1 and Figure 10, which weld lines define the liquid flow passage 20. The spacing elements 48 used along the horizontal weld lines comprise straight, narrow, metallic strips of a thickness equal to the desired thickness of the heat exchange medium passage 20. The vertical spacing elements 49 along the position occupied by the vertical weld lines in the preferred form and defining liquid passage 20 are straight along their outer edges 50, but are curved along their inner edges 51 to facilitate the passage of liquid through the liquid passage 20. The spacer elements 49 are also of a thickness equal to the desired thickness of the liquid passage 20. The only other difference in the modified form of section shown in Figures 15, 16 and 17, when compared to the preferred embodiment of the invention as previously described and shown in the preceding figures, is the final shaping or bulging operation performed on the preferred embodiment of the invention, which shaping or bulging operation employing fluid pressure is not necessary in the modified embodiment of my invention as illustrated in Figures 15, 16 and 17 which employs the use of the spacing elements 48 and 49. In this later described modified type of section the bulging operation is not required in that the flow passages 20 are formed by and defined by the spacing strips or elements 48 and 49.

It will, of course, be evident that the heat exchange device and the unique elements incorporated therein are particularly adapted for use in the treatment of foodstuffs, such as milk, requiring sanitary treatment, and the entire device is so constructed as to incorporate only sanitary features to make it acceptable for such use. However, the heat exchange element is also well adapted for use in the heating or cooling of other liquids which do not necessarily require sanitary handling, but in which heating or cooling operation it is desired to secure a high rate of heat transfer and in which use it may also be desired to assemble the individual elements in close side-by-side compact relation as illustrated in a heat exchange machine fully described in our co-pending application Serial No. 243,130, now Patent No. 2,383,292, of which this application is a division. The improved heat exchange element is simple and unique in construction, in which construction various novel features are resorted to as well as novel methods of fabricating the respective elements. The plurality of sections or zones which go to make up a multiple-sectioned heat exchange element are provided with staggered superposed rows of protuberances on their outer surfaces to assure turbulent flow and uniform distribution of the liquid passing over the outer surface of the sections. Such turbulent flow results in an increased efficiency and improved rate of heat transfer as well as the desired uniformity of distribution of the liquid being treated over the sections. The counterpart of the protuberances, i. e., the cavities on the inner surface of the sections, line the walls of the flow passages through which the refrigerant or other cooling or heating medium is circulated. The cavities thus lining the flow passage effect a turbulence in the liquid to produce an improved rate of heat transfer between the refrigerant or other cooling or heating medium passing through the flow passage and the sections C, which sections, on their outer surfaces, are in heat exchange relation with the liquid being treated. The uniquely finished, cylindrical stiffening or bracing element affixed to the upper portion of the uppermost section of each unit, which bracing element is also substantially devoid of heat exchange relation with the heat exchange medium passing through the interior of the section, also tends to longitudinally brace the section as well as the entire unit and also to receive the liquid from the source of supply and distribute the same throughout the entire length of the upper portion of the uppermost section. Such features relating to the distribution effected by the uniquely finished bracing element, combined with the protuberances or baffles extending outwardly from the normal face of the section, assure uniform distribution of the liquid over the surface of the heat exchange section joined to form the unitary elements. The cylindrical bracing element at the top of the heat exchange section being substantially devoid of

heat exchange relation with the refrigerant, as pointed out above, prevents the crystallization of liquid on the outer surfaces of the cylindrical bracing and distributing element, thereby preventing the accumulation of ice thereon, which accumulation, if it occurred, would prevent the satisfactory operation of the heat exchange element to which the distributing and bracing element was affixed.

Each of the heat exchange sections is also provided at either end with a transverse bracing element or end plate affixed to the outwardly flared vertical ends of the stampings constituting the walls of the individual heat exchange sections. The outwardly flared ends of the stampings, as well as the end plates, are united in sealed relation one to another and are substantially devoid of heat exchange relation with the heat exchange medium passing through the liquid flow passages on the interior of the respective sections. Being thus substantially devoid of heat exchange relation, there will not be a tendency of crystallization of spattered liquid to form on the outer surface of the outwardly flared flanges at the ends of the sections of the multi-sectioned heat exchange element, or on the bracing end plate affixed thereto, thereby aiding in the satisfactory operation of the heat exchange element.

Various changes in material and detailed arrangement of the various elements of the heat exchange device as shown and described to explain the invention may be made in accordance with the common knowledge of those skilled in the art and yet come within the scope of the invention as set forth in the appended claims.

The invention is hereby claimed as follows:

1. In a heat exchange element for liquids, opposed sheet metal portions forming a double-walled structure, said sheet metal portions of the double-walled structure having certain parts thereof secured together and certain offset parts

spaced apart and in end to end communication to provide a refrigerant passage between said walls, and liquid distributing means fixed to the top edge of the heat exchange element and forming an integral portion thereof for uniformly distributing liquid over the top outer portion of said element, said distributing means having a horizontally grained flow diverting finish on its liquid contacting surface.

2. In a sheet metal evaporator, two vertically disposed sheets joined together at contiguous points and sealed at their peripheries and having a sinuous flow passage therebetween formed by opposed outwardly bulged portions of said sheets, a multiplicity of flow diverting protuberances on the outer surfaces of said sheets, and flow distributing means on the outer surfaces of said sheets intermediate the elements of said sinuous passage for uniformly distributing the flow of liquid over the surface of said sheets.

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