Aug. 21, 1945. C. B. DALZELL ET AL 2,383,292

HEAT EXCHANGE DEVICE

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Fig. 1.

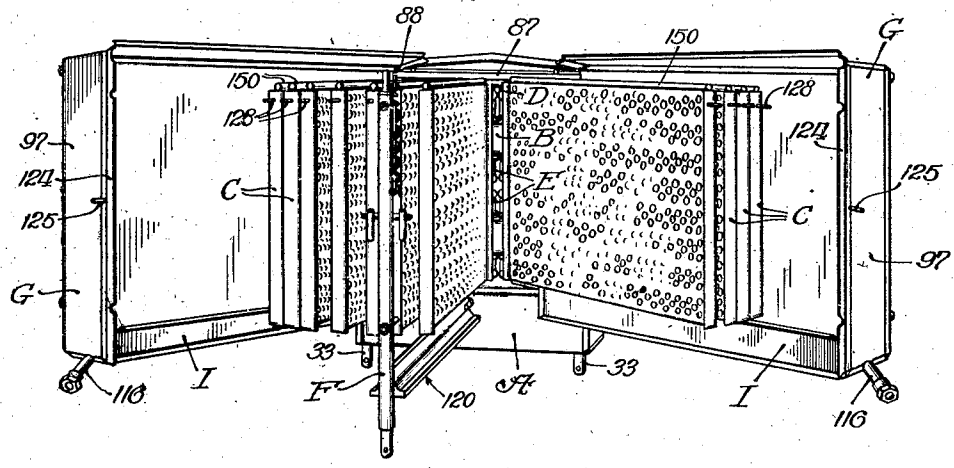


Fig. 2.

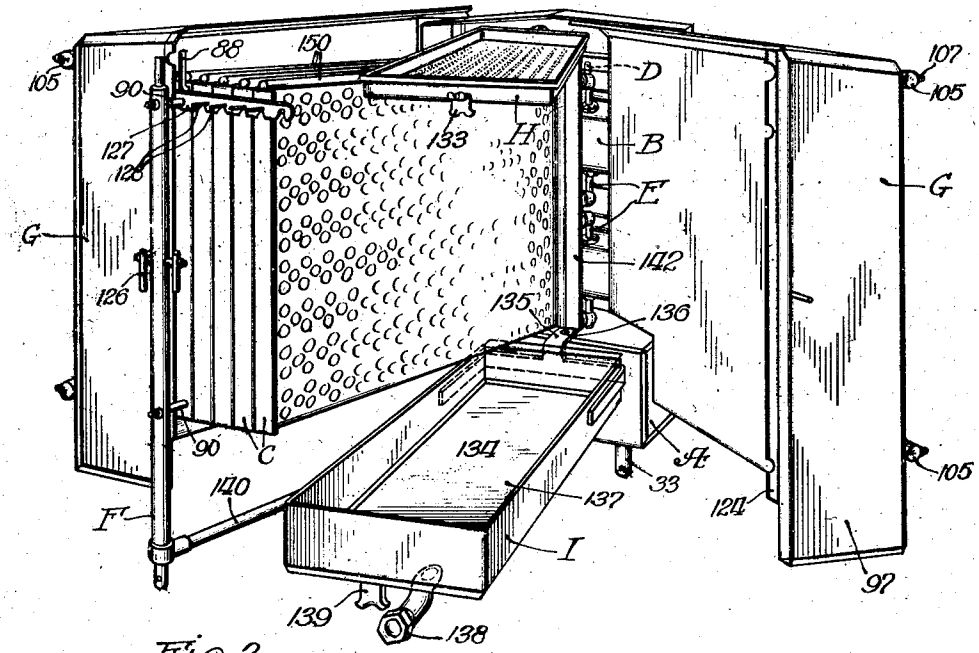
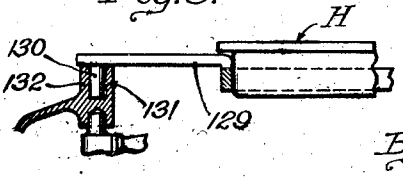


Fig. 3.



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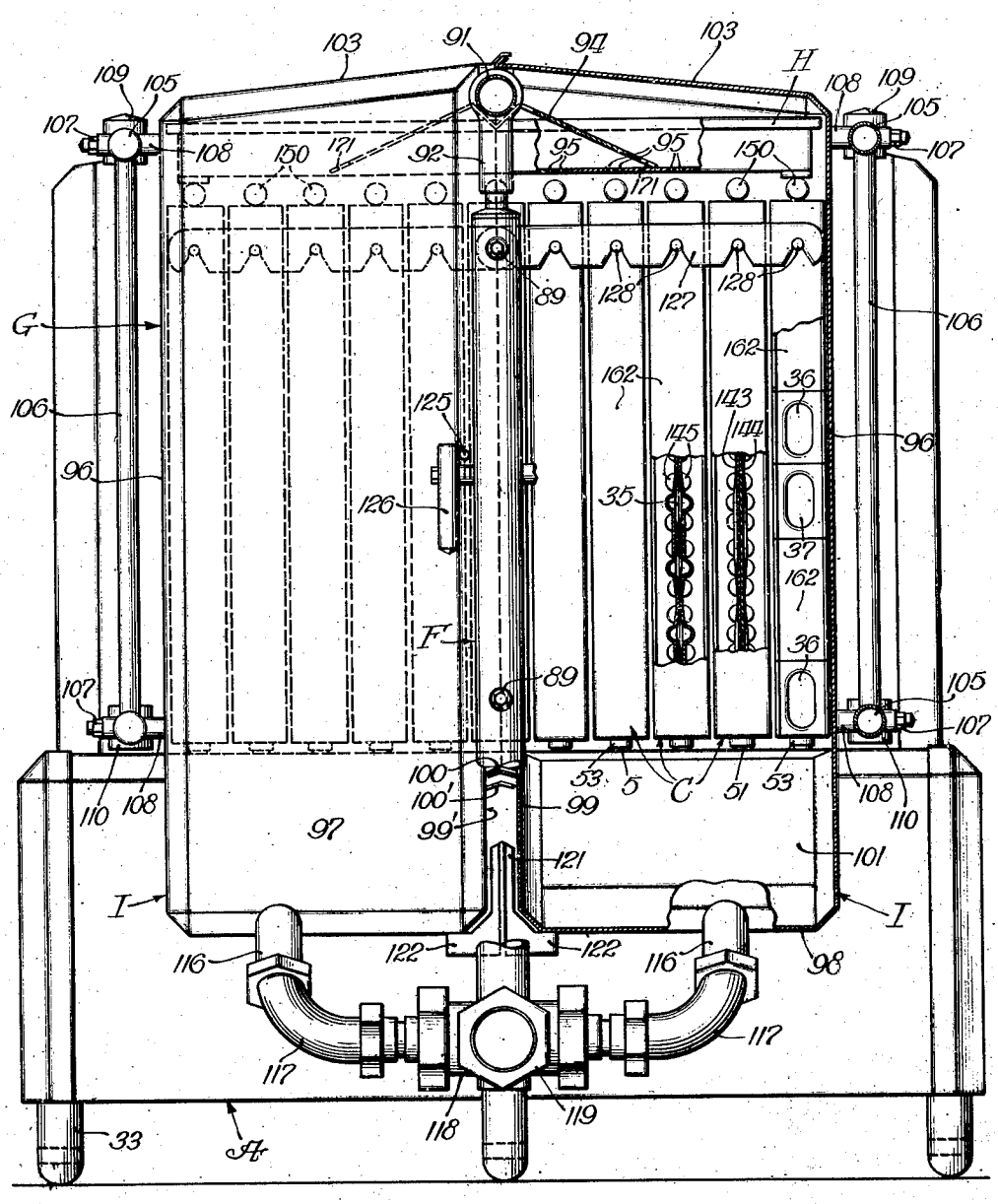
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Aug. 21, 1945. C. B. DALZELL ET AL 2,383,292

HEAT EXCHANGE DEVICE

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Fig. 4.



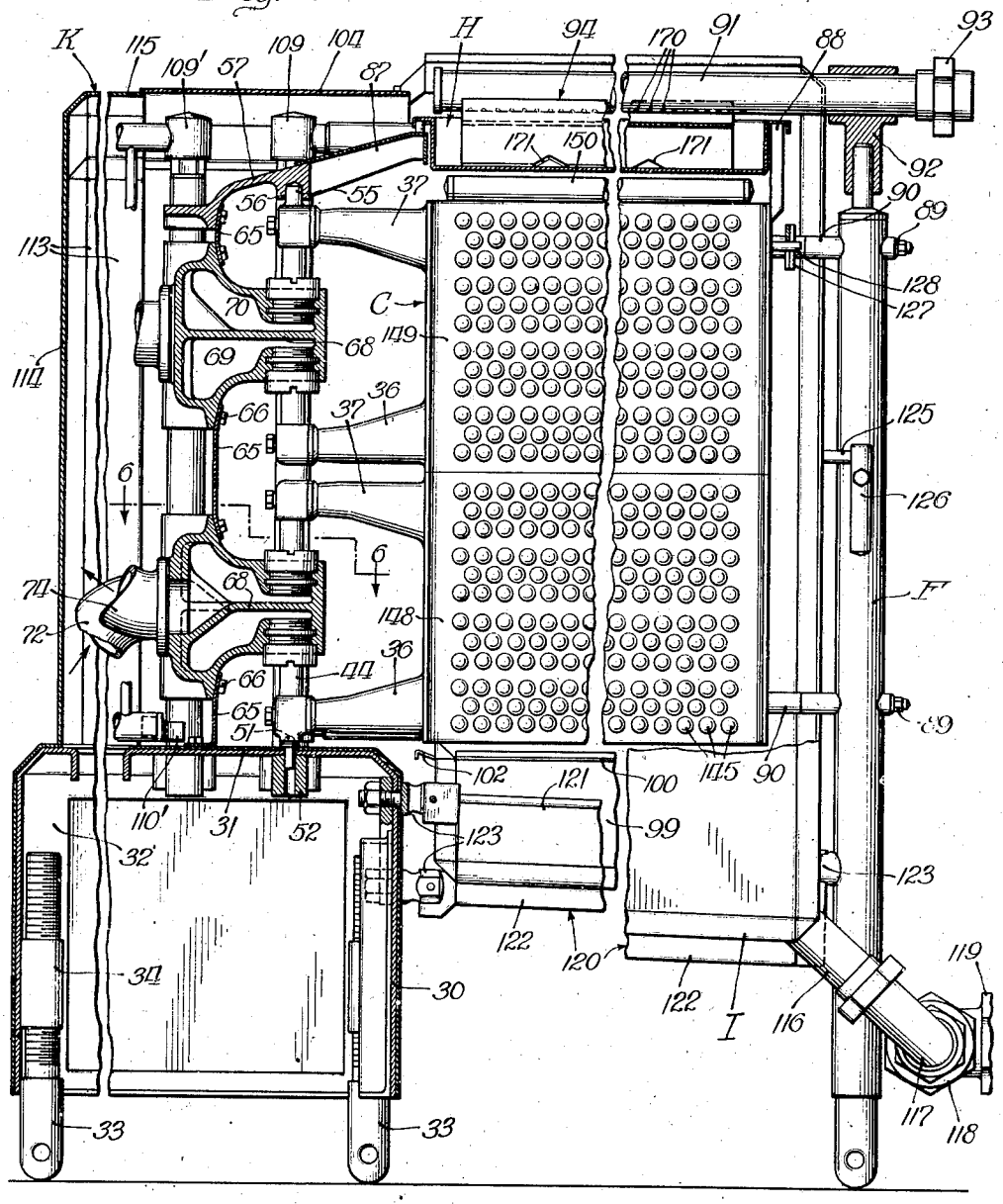
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Aug. 21, 1945. C. B. DALZELL ET AL 2,383,292

HEAT EXCHANGE DEVICE

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Fig. 5.



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Fig. 7.

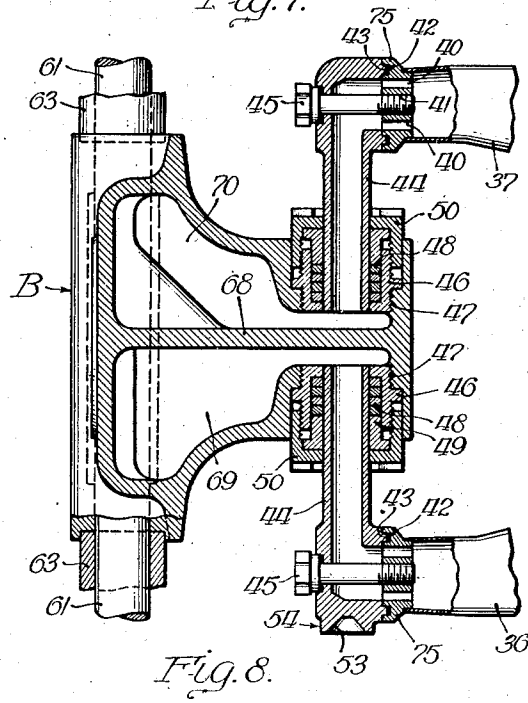


Fig. 6.

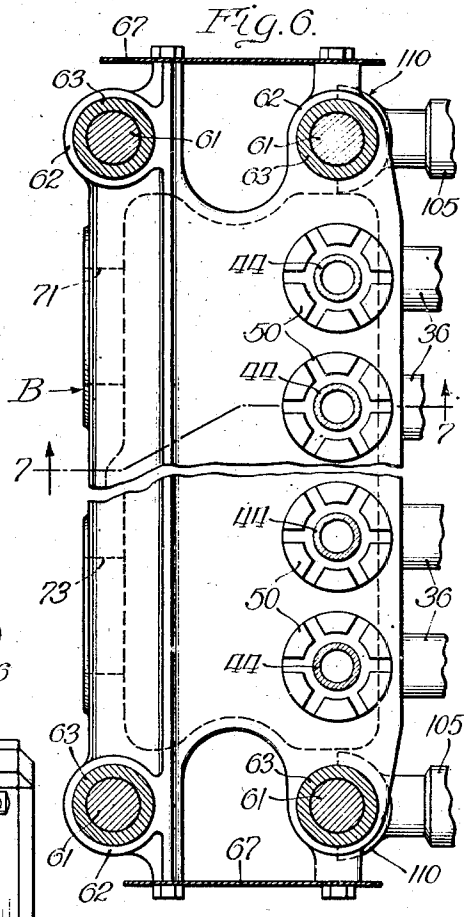


Fig. 8.

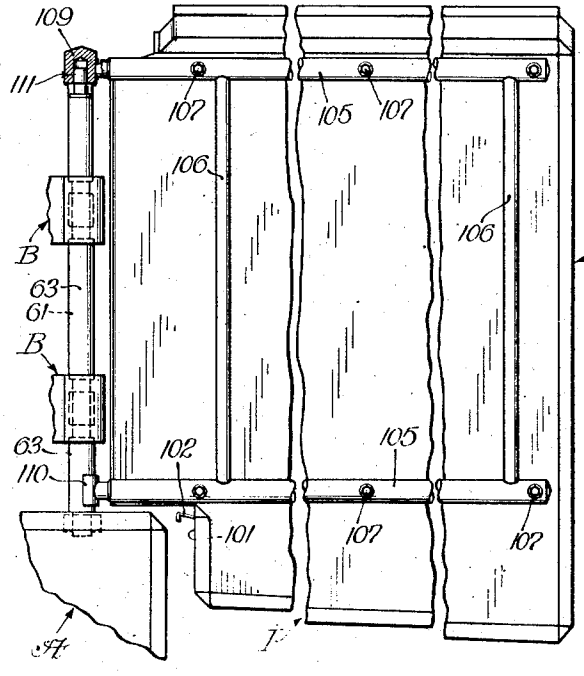
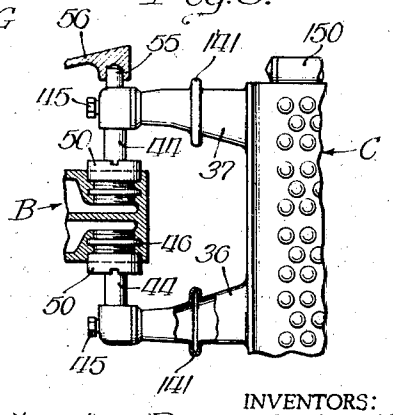


Fig. 9.



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Fig. 10.

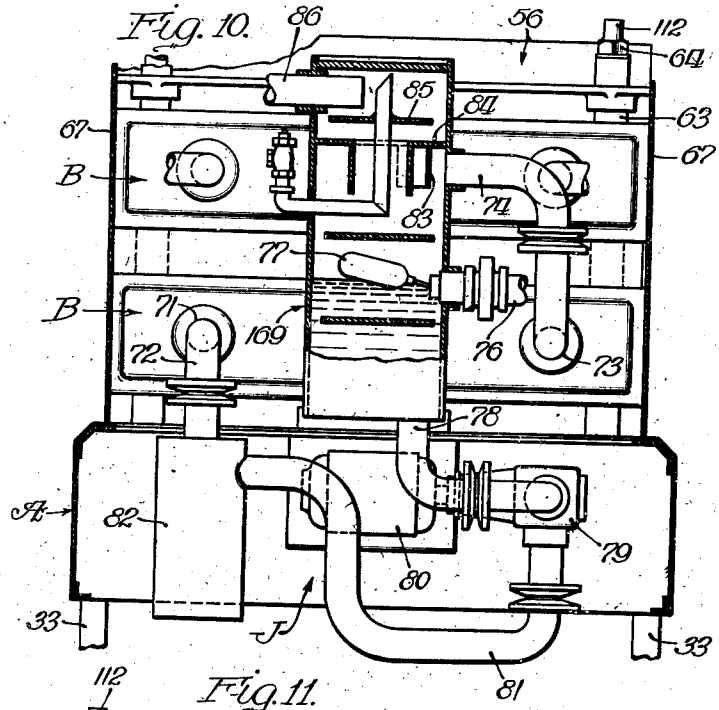


Fig. 12.

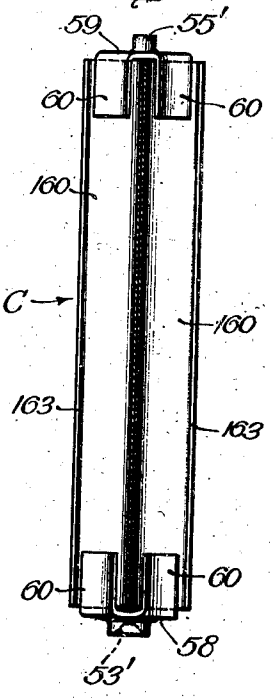


Fig. 11.

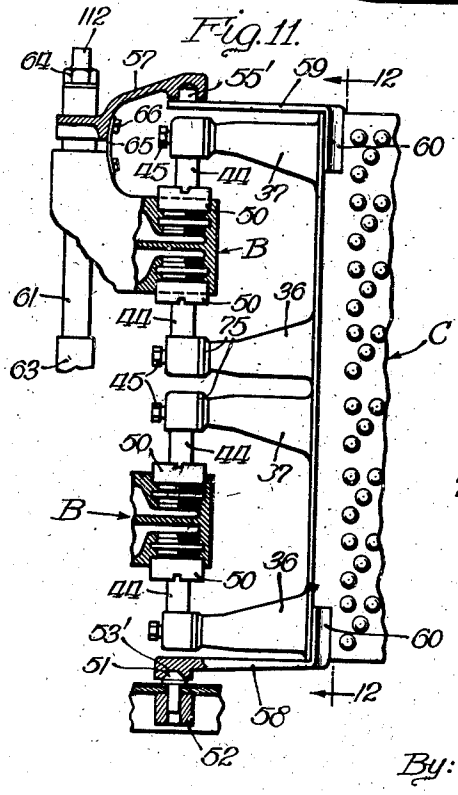
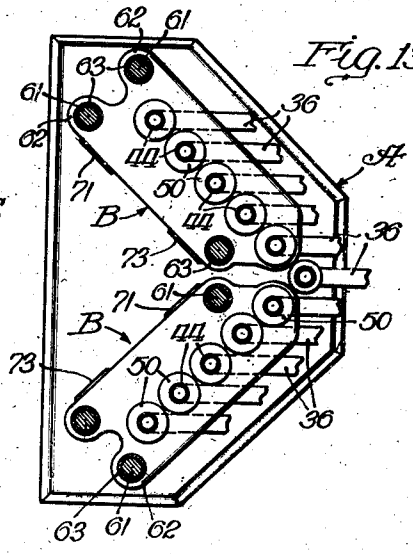


Fig. 13.



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HEAT EXCHANGE DEVICE

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Fig. 14.

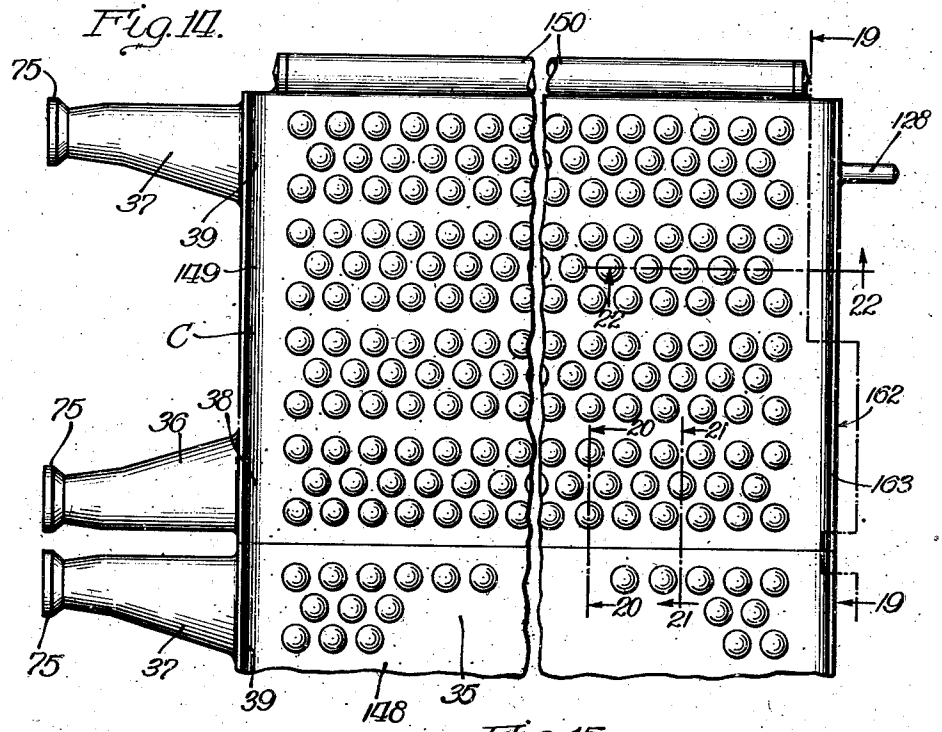


Fig. 15.

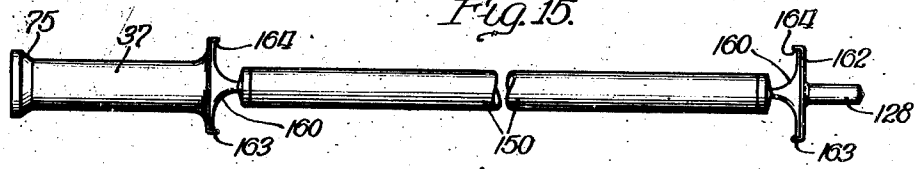


Fig. 16.

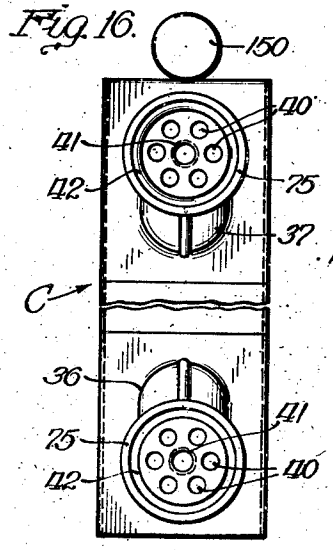


Fig. 18.

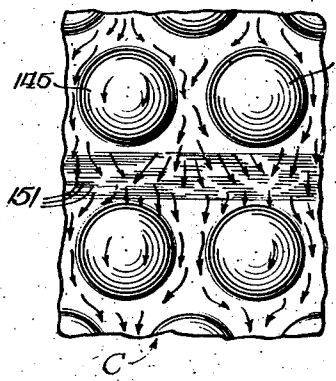
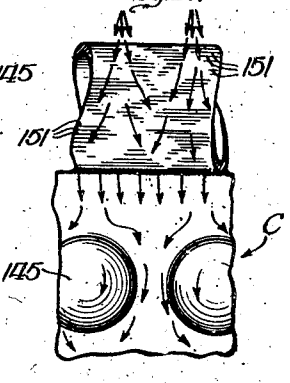


Fig. 17.



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Aug. 21, 1945. C. B. DALZELL ET AL 2,383,292

HEAT EXCHANGE DEVICE

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Fig. 23.

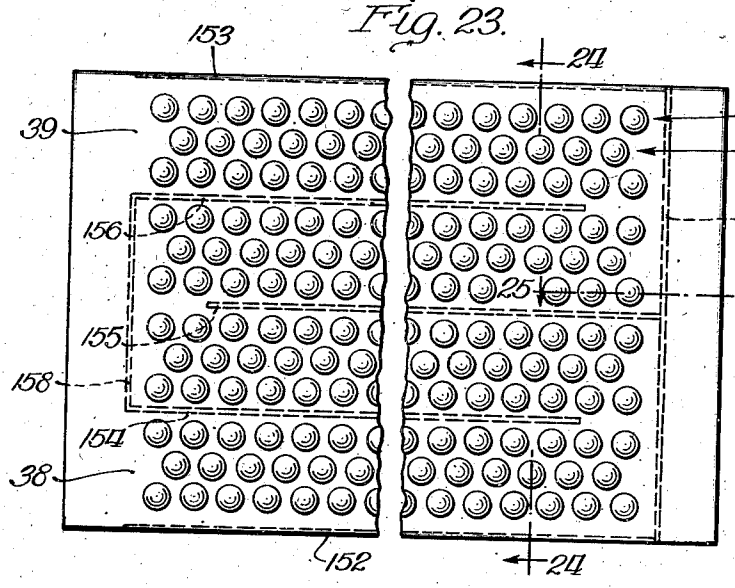


Fig. 24.

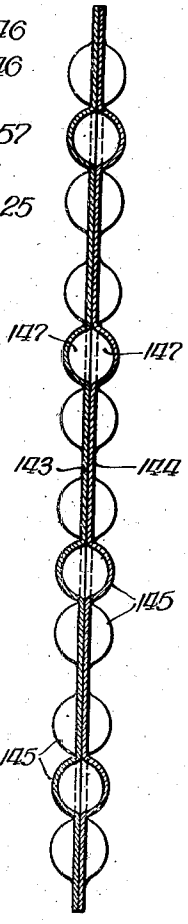


Fig. 19.

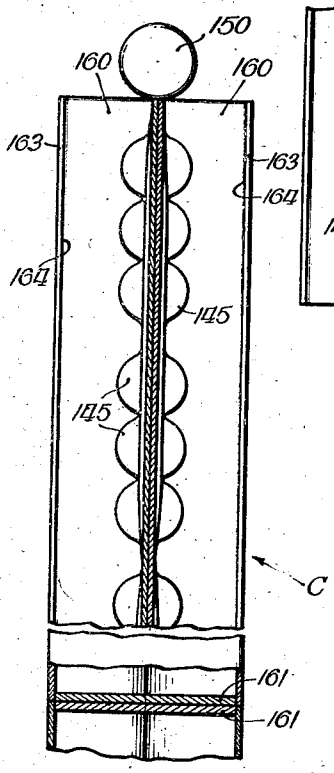


Fig. 20.

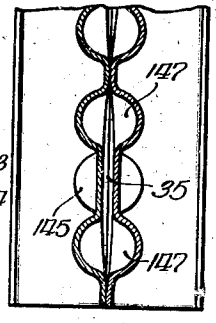


Fig. 21.

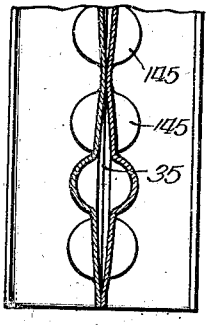
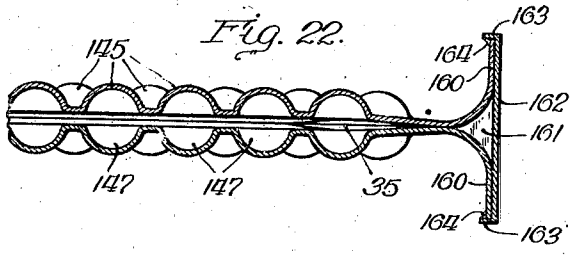


Fig. 22.



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HEAT EXCHANGE DEVICE

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Fig. 27.

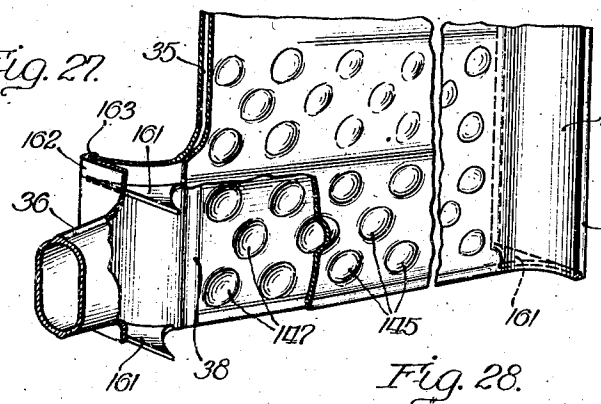


Fig. 28.

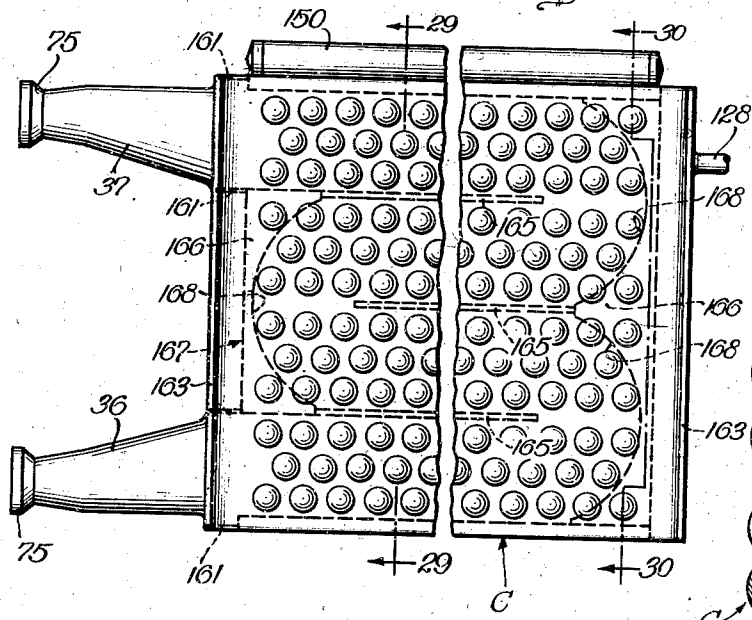


Fig. 29.

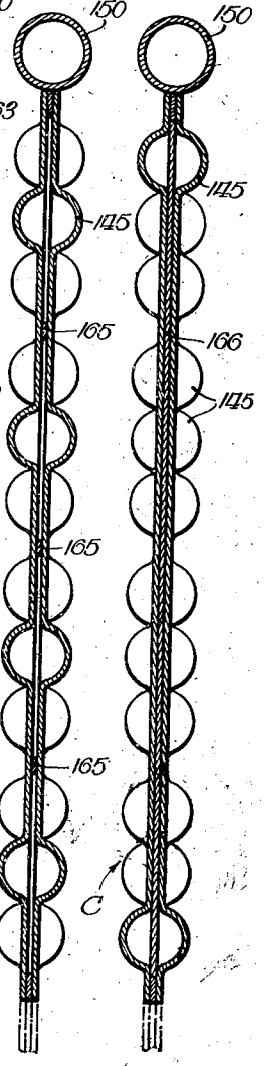


Fig. 30.

Fig. 25.

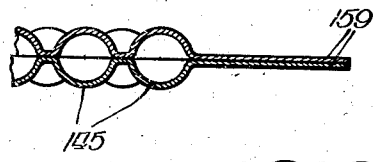
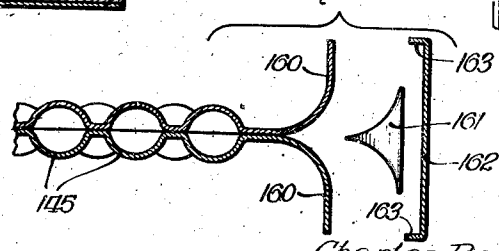


Fig. 26.



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Patented Aug. 21, 1945

2,383,292

UNITED STATES PATENT OFFICE

2,383,292

HEAT EXCHANGE DEVICE

Charles Brown Dalzell and Ellsworth Wyman, Little Falls, N. Y., assignors to Cherry-Burrell Corporation, Wilmington, Del., a corporation

Application November 30, 1938, Serial No. 243,130

4 Claims. (Cl. 257—180)

The present invention relates to heat exchange devices for cooling or heating liquids, and more particularly to the enclosed sanitary top-feed or trickle-type of film coolers, such as may be used in treating milk, which are of simple compact construction, which comprise a plurality of heat exchange sections positionable in close side by side relation inside a closure when in their operative position and pivoted to swing apart to facilitate cleaning when the closure is opened, which sections are provided with internal passages in which to circulate a cooling or heating medium in heat exchange relation to the liquid flowing over the exterior surface of the sections, and which sections, when in their close side by side position, operate simultaneously on a plurality of streams of liquid thereby forming a compact highly efficient cooler; and to the construction of a closure and method of fabricating a heat exchange section and the regulation of the movement of refrigerant through the heat exchange sections.

The process or method of making the heat exchange sections as disclosed in this application is fully described and claimed in our divisional application Serial No. 250,670, filed January 13, 1939, and entitled "Heat exchange element."

The heat exchange section as disclosed in this application is described and claimed in our divisional application Serial No. 442,750, filed May 13, 1942, and entitled "Heat exchange element."

The refrigeration system as disclosed in this application is described and claimed in our divisional application Serial No. 444,675, filed May 27, 1942, and entitled "Heat exchange device."

In heat exchangers of the sanitary type, such as are used in the processing of milk, it is essential that all parts thereof which contact the milk be easily accessible for frequent cleaning. It is also essential that the mechanism be so constructed that any leakage of cooling medium or refrigerant will be prevented from entering the milk being processed. It is also desirable to have all of the functioning elements, particularly the heat exchange sections, enclosed when in their operative position and to this end, in addition to various other features, the present invention embodies a closure which is so constructed that it must first be closed before the mechanism can be operated. The accompanying drawings illustrate the invention in a heat exchanger of the type referred to.

The objects of this invention are to provide a sanitary, efficient, compact heat exchanger of novel construction in which a plurality of heat exchange sections are pivoted to swing about vertical axes to and from operative position in which they stand close together side by side to positions in which they are freely accessible for cleaning; in which the sections are provided with spacing and bracing elements which maintain the sections in alignment while in their operative position but which elements are substantially devoid of heat exchange relation with the cooling medium or refrigerant passing through the sections; in which the individual sections are provided with a novel liquid film distributing means along their upper edge, which distributing means also constitutes a bracing element for the individual heat exchange section; in which the heat exchange medium is supplied to the heat exchange sections through freely pivoting hollow hinges or swivel joints constructed to prevent leakage of refrigerant onto the sections and aligned with the pivots supporting the cantilever or eccentrically mounted sections, which hinges establish liquid communicating passages between the interior of the heat exchange sections and the heat exchange medium supply and discharge manifolds.

Another object of this invention is to provide a milk supply holder which, together with the individual distributing element carried at the top edge of each heat exchange section, as well as the distributing baffle within the milk supply holder or chamber, will assure the proper distribution and application of the milk to each individual section.

A further object is to pivot or swingably support the eccentrically mounted, unitary heat exchange sections having one or more independent heat exchange medium passages, and to construct and arrange the pivots and hollow hinges in a manner which will prevent the application of the eccentrically mounted weight of the heat exchange sections to the packing glands of the hollow hinges constituting the refrigerant medium supply connections individually connecting the independent passages to separate supply headers permitting individual control and operation; and which will enable the removal of any sections from its connecting hollow hinges and pivots without disturbing the arrangement of the adjustment of the pivot elements or the packing glands in the swiveled joints of the hollow hinges whereby the desired adjustment of the pivot elements and the packing glands in the swiveled liquid connections is readily maintained.

A further object of the present invention is to provide a novel closure and collecting basin in which the collecting basin constitutes an inte-

gral part of the closure thereby necessitating the closing of the heat exchanger before commencing the operation of the mechanism.

Another object of the present invention is to provide a means and method whereby the flow of liquid refrigerant through a heat exchange section may be readily controlled and regulated to facilitate the rapid commencement and discontinuance of the refrigerating action.

Further objects of this invention are to provide an embossed sheet metal heat absorbing section of cheap construction, together with a simple method of constructing the same, in which the embossed sheets are arranged face to face and sealed along predetermined lines thus providing sealed liquid passages intermediate the metal sheets.

A still further object of the invention comprises the construction of a heat exchange section of improved efficiency and augmented heat transfer surface which is provided on its liquid contacting surfaces with means to obstruct the uniform, laminar flow of a film of liquid, and to secure the dispersion and distribution of the liquid upon the heat exchange surface in such a manner as to cause a difference in the speed of different portions of the liquid as they travel over and around the obstructions on the surface of the section, resulting in a more efficient heat transfer between the liquids inside and outside of the sections.

As one important feature of the present invention the supporting framework for the heat exchange sections and the liquid distributing trough comprises the use of the refrigerant supply and discharge manifolds and a central heat exchange section as integral and active elements in the framework of the entire mechanism.

It is also important to note that in the construction of the present machine, the refrigerant supply and discharge manifolds are both constructed or housed in the same manifold unit. This construction lends itself particularly well to the fabrication of a heat exchanger in which the individual heat exchange sections are provided with different zones of individual passages for heat exchange medium to which different controlling fluids or heat exchange media can be supplied at will.

Other important features of the invention will be apparent upon examination of the details of construction and arrangement of the heat exchanger parts and their various combinations as disclosed in the figures and description, including the hinged or swiveled supports or hangers for the sectional cabinet closure elements by which the common unsanitary seams along the lines of affixation to large strong hinges are avoided and sufficient strength is achieved to enable the proper support of the collecting basin which forms an integral part of the closure, as well as the unique clamping mechanism which maintains the individual heat exchange sections in proper alignment with the liquid supply and distributing means when the sections are in operative position, all of which will be first fully described and then be specifically pointed out in the appended claims, reference being made to the accompanying drawings in which:

Figure 1 is a perspective view of a heat exchanger arranged and constructed in accordance with the present invention, in which the chamber for distributing liquid over the various sections has been removed and the heat exchanger has been opened as if for cleaning purposes.

Figure 2 is a perspective view of a modification of the heat exchanger shown in Figure 1, and shows the chamber for distributing liquid to the sections swingably mounted above the sections and the chamber for collecting liquid from the sections swingably mounted below the sections. The collecting chamber in the modification shown in Figure 2 is independent of the covers for the heat exchanger.

Figure 3 is an elevation partly in section of the bracket and hinge arm arrangement used in the support of the distributing chamber as shown in Figure 2.

Figure 4 is an end view, partially in section and partially broken away, of the heat exchanger embodying the preferred arrangement of this invention.

Figure 5 is a view showing the heat exchanger partially in longitudinal section elevation.

Figure 6 is a transverse section plan on an enlarged scale taken along line 6—6 of Figure 5.

Figure 7 is a longitudinal section elevation of the refrigerant supply and discharge manifold and the hinged fluid couplings for the heat exchange sections taken along line 7—7 of Figure 6.

Figure 8 is a longitudinal elevation view of the cabinet-like closure for the heat exchanger.

Figure 9 is a longitudinal elevation, partially broken away and partially in section, of a modification of the liquid couplings or hinge arms joining the heat exchange sections with the hollow hinge elements communicating with the refrigerant supply and discharge manifolds.

Figure 10 is a rear view elevation of the heat exchanger partially in broken away section and with the enclosure removed showing the refrigerant supply and return mechanism and the refrigerant circulating pumps and connections.

Figure 11 is a longitudinal elevation partially in broken away section of a modification of the hinges or pivot elements swingably supporting the heat exchange sections and the swiveled liquid connections communicating between the refrigerant supply and discharge manifolds and the heat exchange sections.

Figure 12 is a transverse elevation taken along line 12—12 of Figure 11.

Figure 13 is a further embodiment of this invention showing a plan view of the arrangement of refrigerant supply and return manifolds and the swiveled connections through which the refrigerant medium circulates from the manifolds to the heat exchange sections.

Figure 14 is a longitudinal elevation of the heat exchange sections embodied in this invention shown in the perspective view in Figure 1.

Figure 15 is a plan view of the heat exchange section shown in Figure 14.

Figure 16 is an end elevation of the heat exchange section of Figure 14 showing the liquid couplings of the section which are joined to the hollow swiveled hinges in the refrigerant supply and return manifolds.

Figure 17 is an elevational view of a portion of the liquid distributing and heat exchange reinforcing element 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 element before reaching the heat exchange section.

Figure 18 is a longitudinal elevation of a portion of the heat exchange section provided with novel surfacing at spaced positions along the path of travel of the liquid being treated to dis-

perse and more uniformly distribute the liquid on the heat exchanger surface.

Figure 19 is a transverse section elevation, and partially in broken away section, of the heat exchanger embodying this invention, taken along the line 19—19 of Figure 14.

Figure 20 is a transverse section elevation of the heat exchanger embodying this invention, taken along the line 20—20 of Figure 14.

Figure 21 is a transverse section elevation taken along the line 21—21 of Figure 14.

Figure 22 is a longitudinal section plan taken along the line 22—22 of Figure 14.

Figure 23 is a longitudinal elevation view of the juxtapositioned metal stampings used in the construction of the heat exchange sections showing the line of welding before the liquid passages have been shaped or the ends flared.

Figure 24 is a transverse section elevation taken along line 24—24 of Figure 23.

Figure 25 is a transverse section plan taken along line 25—25 of Figure 23.

Figure 26 is a section plan of an end portion of a partially fabricated section showing the end plates for sealing the ends of the sections in relative order of assembly.

Figure 27 is a perspective view partially in broken away section of a portion of the heat exchanger embodying this invention with its liquid connections.

Figure 28 is a longitudinal elevation of a modification of the heat exchange section embodying this invention.

Figure 29 is a transverse section elevation taken along the line 29—29 of Figure 28.

Figure 30 is a transverse section elevation taken along the line 30—30 of Figure 28.

Referring to the drawings, the principal parts of this invention in a heat exchange device include a base A, a series of refrigerant or heat exchange medium supply manifolds B fixedly positioned in vertical alignment upon the base A to constitute a vertical frame as well as refrigerant supply source, a plurality of hollow, zoned heat exchange sections or units C through which the refrigerant is circulated, associated hinges or pivots D for swingably supporting the units C upon the base A and manifold frame, hollow, swiveled liquid connections E communicating with the hollow heat exchange sections or units C and manifolds B for supplying the heat exchange medium to the interior of units C, an upright or standard F fixed to the normally free end of one of the sections C thereby forming a frame with the base A through the section C and manifolds B for supporting the weight of the sections C and box-like or cabinet covers G which overhang the base A, a liquid supply and distributing chamber H supported on the manifold frame B and the upright F from which chamber the liquid to be treated is passed over the sections C, a collecting basin I below the sections C for collecting the liquid which has been passed down over the sections C, and refrigerant storage and circulation mechanism J mounted on the base A and housed in a separate cabinet K.

The base A consists of a substantially rectangular sheet metal construction with vertical walls 30 and top cover 31, all supported on a skeleton box-like framework 32 provided with adjustable legs 33 which are threaded into collars 34 affixed to the frame 32. The preferable construction of the framework and sheet metal covering is a welded construction.

The heat exchanger illustrated in Figures 1, 4, 5, 6, 7, 8, 9 and 10 as one practical adaptation of this invention, comprises a plurality of multi-zoned heat exchange sections C, which when in operative position stand close together side by side within an enclosed cabinet G. The specific details of the construction of the sections C will be described in detail later, but, as illustrated, each section comprises a series of superposed zones of independent heat exchange medium passages 35 for the circulation of the medium through the interior of the sections.

The multi-zoned sections C are each provided at one end with aligned hollow hinge arms 36 and 37 which are permanently affixed to the section, each communicating with an inlet end 38 or outlet end 39 respectively of the liquid passages 35. The hollow hinge arms 36 and 37 are each provided at their free end with a union element 75 having liquid passages 40, a tapped central opening 41, and an annular recessed gasket seat 42 in its face which, when provided with a gasket 43, is seated over a complementary annular flange on the free end of a hollow journaled hinge element 44 to which it is releasably secured by means of a screw 45 passing through the hinge element 44 and threaded into the tapped opening 41 of union 75. By this arrangement a section C may be removed without disturbing the hinge elements 44.

Each of the hinge elements 44 associated with a section C is in axial vertical alignment and at their free ends communicate with the interiors of the manifolds B through liquid sealing glands. In the embodiment of this invention specifically illustrated in Figure 5 the hinge elements 44 are also in transverse alignment perpendicular to the plane of sections C. However, if it is desired to make a heat exchanger which is yet more compact and in which the sections can be freely pivoted away from operative position, the hinge elements 44 may be arranged at an angle to the plane of the sections C as shown in Figure 13 (preferably a 45° angle) which will permit of free pivoting of the sections C through approximately an angle of 90°.

The liquid sealing glands, through which the hollow hinge element 44 communicates with the interior of the manifolds B, consist of a ferrule 46 threaded into a partially tapped opening 47 of the manifold B. An annular flange on the outer periphery of the union 46 is drawn into sealing engagement with a counter sunk shoulder in the opening 47. The interior of the union 46 with its inwardly turned flange at its free end also constitutes the retaining chamber for the laminar packing element 48 which is compressed into sealing engagement with the hollow hinge element by means of compression element 49 pressed against the packing element 48 by means of nut 50 screwed onto the outer end of union 46.

The heat exchange sections C are each swingably supported on lower and upper vertically aligned hinges or pivots whereby the various sections may be swung outwardly on their hinges from an operative position in which the sections stand close together face to face to positions in which the sections are readily accessible for cleaning. The lower hinge element or pivot comprises a conical pivot point 51 mounted in a socketed boss 52 affixed to the framework 32 of the base A, which pivot point engages in a central socket 53 in an axially aligned boss 54 forming an integral part of the lowermost hinge ele-

ment 44 at the lowermost extremity thereof. The upper hinge element or pivot comprises a cylindrical axially aligned boss 55 formed integral with and at the top end of the uppermost hinge element 44. Boss 55 engages a socket 56 in a bridge plate 57 affixed to the top of and forming a part of the vertical manifold framework B fixed to the base A. The pivot point 51, socket 53, boss 55 and socket 56 are all in vertical axial alignment with the hollow liquid hinge elements 44, whereby the cantilever or eccentrically mounted weight of the section C is all carried by the upper and lower hinges and the application of eccentric pressure to the sealing glands is prevented resulting in their increased efficiency and life.

In Figure 11 is illustrated a modification of the upper and lower hinge arrangement for the support of sections C. In the modification shown in Figure 11 the socket 53 and the boss 55 are not associated with the lowermost and uppermost hollow hinge elements 44, but they are associated with rigid bracket arms 58 and 59 respectively which are provided with socket 53' and boss 55' respectively, and which bracket arms are permanently fixed to the section C. Various methods of affixing bracket arms 58 and 59 to the sections C may be devised and in Figure 12 is shown a transverse elevation through one section depicting inwardly turned lugs 60 at the section end of the bracket arms 58 and 59, welded to the section C on either side of the heat exchange surface.

The manifolds B and bridge plate 57 are mounted on base A by four vertically extending lag bolts 61 rigidly fixed to the base A and passing through ported bosses 62 at the several corners of the manifold and bridge plate 57. The necessary vertical spacing of the manifolds and bridge plate is secured by spacer elements 63 telescoped over bolts 61 intermediate the several manifolds and bridge plate. The spacing elements 63 are accurately machined and their ends fit into counter sunk recesses at the ends of the tie bolt ports in the bosses 62. The manifold and bridge plate assembly is held in rigid position by compressing the assembly by tightening the end caps 64 on bolts 61. Closure plates 65 are attached as by screws 66 to the adjacent horizontal edges of the manifolds B and bridge plate 57 and between the lowermost manifold and the base A, to form with the manifolds a vertical wall adjacent the swiveled hinges 44. Vertical closure plates 67 are attached as by bolt screw 66 to the outer ends of the manifolds B, and together with the manifolds B, closure plates 65 and end plates of the sections C constitute a substantial enclosure of the swiveled liquid hinges 44.

Each manifold B includes an internal division plate or web 68 which divides the manifold into a lower supply header 69 and an upper return header 70. Supply header 69 is provided in its rear wall with a refrigerant supply port 71 which is in communication with a refrigerant supply conduit 72. Return header 70 is provided in its rear wall with a refrigerant return port 73 communicating with a refrigerant return conduit 74. In the upper and lower wall of the manifold B and adjacent the front edge a series of partially tapped openings 47 are provided for the hinge elements 44. These openings are in transverse alignment one with another and vertically aligned in pairs, each pair constituting the refrigerant supply and return connection for the associated zone of a section C. It is important to note that due to the unique design of the manifold B to act both as supply and return headers, it has been possible to construct the compound manifold, together with the liquid hinge elements associated with a respective zone of a section C, of lesser vertical extent than the zone in a multi-zoned heat exchange section C to which the liquid is being supplied.

In the operation of the heat exchanger embodying this invention various types of heat exchange media may be used in the sections C. It may be desired to use brine, fresh cold water, hot water or some type of direct expansion refrigerant such as liquid ammonia. It may also be desired to use the combination of several of such heat exchange media, for example, cold water and liquid ammonia, in different zones of the heat exchange sections and in such instance it is desirable to use the cold water in the upper zones of the sections C and the liquid ammonia in the lower zone. With this thought in mind the Figure 10 illustrates refrigerant connections only to the lower manifold B and therefore only to the lower zone 35 of sections C. However, any other desired arrangement of connections to the zones of sections C may be used within the scope of this invention.

Liquid heat exchange medium, such as a refrigerant, is supplied to the heat exchange device by conduit 76, to a float valve 77 through which it enters an accumulator 169. The accumulator 169 is of an operative capacity in excess of the capacity of the combined zones of sections C which are supplied with refrigerant from the accumulator 169, whereby an excessive supply of liquid refrigerant is always available for prompt and efficient operation of the heat exchanger. The accumulator 169 is rigidly mounted on the frame 32 of base A immediately to the rear of the manifolds B. From the lower portions of the accumulator 169 liquid refrigerant is withdrawn through conduit 78 which supplies the positive acting or other satisfactory type of ammonia circulating pump 79 driven by motor 80. From pump 79 the refrigerant is forced through conduit 81 into an oil separator 82 from whence it passes through conduit 72, through the manifold supply header port 71, into the supply header 69. After the refrigerant has circulated from the supply header 69 through the lower hinged elements 44 and one of the zones 35 of section C, it is returned to the return header 70 from which it passes through return port 73 to return conduit 74 into the upper gas portion of accumulator 169. It may be desirable, however, to interchange the refrigerant conduits 72 and 74 in their connections to manifolds 69 and 70 to thereby produce a downward flow of refrigerant through the sections C. The refrigerant gas and unevaporated refrigerant thus returned through conduit 74 is impinged against an angular deflecting plate 83 causing the return refrigerant to momentarily travel about a circular path during which time the liquid refrigerant precipitates from the gas and settles to the bottom of the accumulator from whence it may be again circulated through sections C. The gaseous refrigerant, however, is withdrawn into the uppermost compartment of accumulator 169 which is divided from the main compartment by ported diaphragm 84, past a further separation baffle 85, after which it is discharged from the accumulator in a substantially dry state through conduit 86 returning

the refrigerant gas to a compression unit not shown in the figures.

The heat exchange sections C when in operative position are supplied with liquid to be treated from a distributing chamber H, which in the preferred embodiment of this invention, is mounted above the sections C in alignment therewith and supported at its rear wall by a bracket 87 extending forwardly and upwardly from the forward outer corners of the bridge plate 57 to which it is rigidly affixed as by welding. Adjacent its front wall the distributing chamber H is supported in aligned and spaced relation relative to the sections C by an upright 88 fixed to the upper front corner of the fixed central section C which is rigidly fixed to the standard F as by bolts 89 and spacer elements 90 thereby forming a forward framework for the heat exchange device to cooperate with the base A and manifold B. Liquid, such as milk, is supplied to the distributing chamber by supply pipe 91 removably supported in a fitting 92 swivelled on the top of standard F. Pipe 91 is provided with any conventional sanitary coupling 93 at its inlet end and is capped at its far end and extends centrally over the chamber H. A series of perforations 170 are provided along the lower portion of pipe 91 above the chamber H through which perforations liquid to be treated is discharged into the trough of an inverted W-shaped horizontal distributing baffle 94. From this trough 94 liquid spills over the inclined legs or fins constituting the remaining portions of the W-shaped baffle plate in the supply chamber H. The liquid spills onto the perforated bottom of chamber H midway between the outer walls and the central portion of the chamber. Notches or cut-away sections 171 are provided along the edges of the W-shaped baffle where it contacts the bottom of chamber H, to permit the ready and uniform distribution of the liquid over the entire bottom of the supply chamber H. From chamber H the liquid is discharged onto sections C through a series of double rows of perforations 95 extending longitudinally across the bottom of chamber H and in alignment with the section C. A double row of perforations 95 supplying any one section C is in alignment therewith and equally spaced on either side of the central vertical plane of the section C, thereby assuring distribution of liquid from the chamber H to both sides of section C.

The liquid distributed onto the sections C from chamber H, after passing over the sections, is collected in chambers I below the sections C. The chambers I are formed integral with the two sectional cabinet-like covers for the heat exchanger. The lower portions of the outer wall panel 96 and end panel 97 of each half of the sectional cabinet closure G are also used at the corresponding walls of the collecting chamber I. To complete the collecting chamber I for each half of the sectional closure G, a forwardly inclined bottom plate 98 is provided which also constitutes the bottom closure for the sectional cabinet G, and there is also provided an inner wall 99 with outwardly turned flange 100, as well as a rear end wall 101 with outwardly turned flange 102 to complete the chamber I, both of which walls 99 and 101 are of the desired depth of the chamber I. In the other half of the sectional cabinet closure G the inner wall 99' is of slightly lesser height than the wall 99 so that upon closing the sections of cabinet G the outwardly extending flange 100 will overlap flange 100', thereby forming a complete closure below the sections C, assuring the collecting of all the liquid passing from the surface of the sections. It is of course essential that the length of chamber I be sufficient to accommodate the liquid flow from sections C.

The sectional halves of the cabinet-like closures G also include a cover plate 103 downwardly and outwardly inclined from its inner edge toward the upper edge of the cabinet wall panel 96. Rear wall panels for the sections of closure G are not necessary as the cabinet closure is swingably supported on the front two manifold frame tie bolts 61 with its side wall panels 96 and top panels 103 abutting up against and cooperating with the manifold housing side panels 67 and top panel 104 of the manifold closure to complete the cabinet.

The sectional cabinet type closure G is swingably supported on a hinged pipe framework including two parallel horizontal pipe reaches 105 joined adjacent either end by two parallel vertical pipe reaches 106, all of which pipes are joined by any desired conventional manner such as T unions or by welding. The closure sections G are affixed to the pipes 105 and 106 by bolts 107 and spacer elements 108 in any conventional manner. At the rear end of the pipes 105 hinges 109 and 110 are provided to swingably support the pipe framework for the cabinet closure section G upon the two front tie bolts 61. Hinge element 109, affixed to the rear portion of the upper reach of the pipes 105, is provided with a socket 111 as shown in Figure 8, and is pivoted on the bolt caps 64 which are formed with a pivot boss 112 at their upper end. The hinge element 110 is affixed to the rear portion of the lower pipe reach 105 and consists of a semicircular yoke element which abuts up against and pivots upon a manifold spacer element 63 mounted on tie bolt 61. By this arrangement of a pipe framework for swingably supporting the sheet metal cabinet closure section G, the sections are substantially stabilized and strengthened to support the excess weight of the collecting chambers I. A further advantage of the unique hinges 109 and 110 is that the entire sections of the cabinet-like closure G, as well as the collecting chamber I, can be removed from the heat exchange device by lifting the top hinge 109 from its pivot 112. It is also important to note that the outwardly turned flanges 100 and 102, in addition to their function of completing the closure, also accomplish the additional function of strengthening the otherwise easily bendable sheet metal construction due to their angular relation to the plane of the panels of which they form a part, thereby strengthening and bracing the same.

The closure cabinet also includes the refrigerant accumulator and pump unit sectional casing K, which is positioned on base A on the opposite side of the manifold frame B from the closure sections G, and includes vertical wall panels 113, end panels 114 and top panel 115. The sections of cabinet K are removably hinged as by hinge elements 109' and 110' as shown in Figure 5, to the two rear posts or manifold tie bolts 61 in the same manner as the sections of cabinet G are removably hinged to the two front tie bolts 61 by hinges 109 and 110. The wall panels 113 and top panels 115 cooperate with the wall plates 67 and cover plate 104 of the manifold housing to complete the enclosure for the ammonia system J.

At the forward and lower free end of the sectional collecting chamber I each section is provided with a discharge connection 116, together with the necessary elbows 117, which communicate with a compound union 118 provided with the conventional coupling means 119 to connect to a discharge line not shown.

To further brace the upright standard F, a tie beam 120 is provided between the standard F and the base A. The tie beam 120 is comprised of a vertical fin 121 and a transverse fin 122, and is affixed at either end to the base A and standard F in any conventional manner such as by bolts 123. The tie beam 120 is positioned in vertical alignment with the fixed center section C of the heat exchange device and inclined forwardly relative to the horizontal at the same angle as the bottom panel 98 of collecting chamber I, and positioned at the necessary elevation so that the inner edges of panel 98 of chamber I rests upon the transverse fin 122 when the sections G of the cabinet are closed.

The inner edges of vertical front end panels 97 of the cabinet closure sections G are provided with a flange 124 at an angle to the plane of the panels 97 to brace the panel, and to complete the closure of the sectional cabinet for the heat exchange device.

Each of the sections G of the cabinet-like closure is provided with a catch element 125 on its front end panel 97 adjacent the inner edge thereof to coact with a latch 126 carried upon the upright standard F.

In the operation of the heat exchanger it is essential that the several sections C be positioned accurately below the double row of perforations 95 associated with each separate section to assure the distribution of liquid on both sides of the sections C. To this end we provide compound latch elements 127 hinged on a spacer element 90 to coact with catch elements 128 affixed to the upper portion of the free end of the pivoted sections C thereby maintaining the sections C accurately positioned below the distributing chamber H.

In the modification of the heat exchange device shown in Figure 2, the distributing chamber H, instead of being supported on a bracket 87 and upright 88, is swingably supported on hinge arm 129 fixed to the pivot element 130 pivoting in socket 131 of boss 132 formed on top of the bridge plate 57 adjacent the center of its front edge, as shown clearly in Figure 3. A notched latch element 133 is affixed to the front wall of chamber H and coacts with upright 88 fixed to the center section C to support the free end of chamber H when in its operative position and accurately position it with respect to the sections C.

The modification of the collecting chamber I shown in Figure 2 comprises a unitary collecting chamber 134 swingably supported by hinge arms 135 hinged to the frame 32 of base A by pivot 136. The bottom 137 of the chamber 134 is inclined downwardly and forwardly and is provided at its lowest point with a conventional discharge connection 138. A notched latch element 139 is fixed centrally to the front vertical wall of the swingably mounted chamber 134 to coact with the tie rod 140 to support and position the free end of the chamber 134.

In Figure 9 is shown a modified construction of the hollow hinge arms 36 and 37 which are provided with an annular outwardly protruding corrugation 141 which enables slight distortion of the hollow welded sheet metal hinge arms 36 and 37. Such slight distortion of the hinge arms facilitates the assembly of the hinged heat exchange section C which assembly necessitates the vertical alignment of all the swiveled hinge elements 44. The corrugations 141 will also function as deflectors of liquid draining over the hinge arms 36 and 37.

A further important feature of the invention illustrated in Figure 2 involves the use of the portless end plate 142 mounted on the vertically aligned series of hinge arms 36 and 37 normally associated with the ends of the liquid passages 35 in the several zones of each section C normally carried by the hinge arms. The end plate 142 serves the purpose of forming a dividing wall between the sections C and the hinges 44, which wall is normally formed by the ends of sections C. The end plate 142 is of the same width as the ends of section C and therefore when in close side by side relation, cooperates with the ends of the mounted sections C to constitute a front closure for the chamber housing the manifolds B. However, due to the fact that the end plates 142 are mounted on the hinge arms 36 and 37 (which for this purpose are sealed to prevent the escape of refrigerant medium) they are capable of swinging movement and therefore facilitate the lateral movement of the sections C.

Figure 13 shows a modification of the manifold B and the relative arrangement of the hollow swivel elements 44, the lower pivots 51 and the upper pivot receiving socket 56 with respect to the plane of the sections C when in operative position. Each manifold B in the modification of Figure 13 is divided into two separate halves each half only supplying sections C on one side of the fixed central section C. The general arrangement of the mounting on the base A is the same as described for the preferred construction shown in Figure 5. In the modified construction of Figure 13 the hinge elements 44 and pivot elements 57 and 56 are arranged in close side by side alignment on the modified manifolds B at an angle (preferably 45°) to the vertical plane of the fixed center section C. This angular arrangement of swiveling elements permits the free swinging of the several sections C through about an angle of 90° without binding one upon another. The refrigerant for the fixed central sections is supplied by separate means, not shown, but which may be any conventional conduit connection.

Referring now more particularly to the embodiment of the invention as it relates to the heat exchange sections C and the method of making these sections, each section C, as illustrated, includes several zones or units of independent flow passages 35. These independent zones or units are all identical with the exception of the topmost unit 149 of each section which is provided at its top edge with a cylindrical bracing and liquid dispersing element 150 substantially devoid of heat exchange relation with the rest of the section C of which unit 149 forms a part. The flow passages in each zone or unit consist of outwardly bulged cooperative portions of the two rectangular sheet metal stampings 143 and 144 intermediate a series of two sets of continuous weld lines joining the stampings and defining the flow passages in between the two stampings 143 and 144. The two ends of the passage 35 are located, in this preferred embodiment of the invention, at the lower and upper left hand corners of the unit and are respectively the inlet port 38 and discharge port 39. However, it should be evident that the passage 35 could be so arranged and con-

structed that the ends thereof would be located at opposite ends of the unit or zone.

The passage **35** consists of a series of horizontal lengths of passages between the stampings **143** and **144** with appropriate bulged vertical passages so joining the ends of the horizontal elements of the passages as to constitute a zigzag line of travel for liquid passing therethrough.

The stampings **143** and **144** consist of substantially co-planar metal sheets (preferably non-corrosive metal, such as stainless steel) provided with a series of horizontal tiers of staggered rows **146** of outwardly directed, hollow, preferably semi-spherical protuberances **145** extending substantially across the stampings leaving only a vertical margin **159** at each end unstamped. The rows **146** are usually three deep and the size of the protuberance is such as to effectively block the space intermediate two adjoining protuberances in an adjacent row **146** thereby effectively diverting any liquid which may flow through between the protuberances in the adjoining row. The depth, however, of the protuberances is not sufficient to cause a rupture of the liquid layer as it flows downwardly over the heat exchange sections. The vertical margins at either end are flared outwardly forming flanges **160**. End plates **162** with inwardly directed flanges **163** are affixed to the free edges of flanges **160** by weldings **164** between **160** and **163** with the exception of that portion of the flanges **160** immediately adjacent the inlet and outlet ports **38** and **39** for the passage **35**. Triangular web or partition elements **161** are affixed intermediate the flanges **160** at each end of each end plate **162** thereby sealing the vertical space intermediate the flanges **160** and end plates **162**, which space and defining elements **160**, **161** and **162** are substantially devoid of heat exchange relation with the passages **35** and the refrigerant which may flow through the passages. Each unit or zone is provided with an inlet and outlet hinge arm **36** and **37** respectively, which arms are joined to the unit at the inlet and outlet ports **38** and **39** respectively. These ports are defined by the portion of the flared flange **160** intermediate two triangular partition elements **161** adjacent the two ends of the passage **35** of the unit. The ends of the hinges **36** and **37** are welded on or otherwise satisfactorily affixed to the outer edges of the flange **160** and partition **161**, which define the inlet and outlet ports **38** and **39**. The two rectangular stampings **143** and **144** are in face to face contact with each other and the oppositely directed corresponding protuberances **145** are in exact transverse alignment. It should, however, also be remembered that satisfactory sections can be made by arranging the transversely opposed protuberances in staggered or other relation one to another. On the interior of each stamping the inner surface of the hollow semi-spherical protuberance **145** presents a cavity **147** which has an agitating effect on the refrigerant as it is speedily passed through the flow passage **35** when the sections are in operation.

In the past, heat exchange sections constructed for comparable use have been of the type employing superposed lengths of tubing connected at its ends by suitable headers 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 sides of the sections, has been an undisturbed flow. The liquid flowing over the outer surface of those types of sections has been in the form of a uniform film smoothly sliding over the wetted surface of the section. Such a flow generally assured or rather necessitated a type of laminar flow of the liquid film in which the outer particles of the liquid film would travel faster than the inner 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 section embodied in this invention, as illustrated in Figure 14, results from the turbulent flow of the liquid as it passes down over the sections and engages the protuberances **145**, 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 **143** and **144** not been provided with protuberances **145**. Such deflection of the particles of liquid in the thin liquid layer by the protuberances **145** 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 plates **143** and **144**. Such separation and rejoining of the liquid particles result in active turbulence within the liquid layer itself as it passes downwardly thereby increasing the heat transfer between the liquid layer and the heat exchange section. Active turbulence is further induced by the inherent physical result of the liquid layer flowing downwardly over a series of staggered rows of protuberances which are so arranged that the space between any two protuberances in one row is completely blocked by a protuberance in an adjoining row, whereby the liquid is forced to follow zigzag courses in its flow. 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 protuberances over which the liquid flows. However, the flow over the protuberances is in a much thinner layer than the flow over the flat spaces between the protuberances. Due to the fact that the adjacent rows of protuberances are in staggered relation, that portion of the liquid layer which flowed through between two adjacent protuberances in one row will engage a protuberance in the next adjoining row and therefore part of it will be diverted toward one or the other side of the 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 heat exchange section embodied in this invention is greatly increased.

The flow of the heat exchange medium or refrigerant passing through between the plates **143** and **144** is also turbulent due to the effect upon the flow of the medium as it passes over the cavities **147** which line the walls of the flow passages **35**. Such turbulence induced in the heat exchange medium or refrigerant will greatly increase the efficiency of the heat transfer between the plates **143** and **144** of the heat exchange section C and the refrigerant passing

through the liquid passage 35 on the inside of the sections C.

In the construction of a multi-zoned heat exchange sections C, several separate individual units or zones 148 and 149 with only one liquid passage each are welded together along their adjoining edges in superposed order as shown by Figure 14. Each zone is provided with separate liquid inlet connections in the form of a hollow hinge arm 36 and a separate discharge connection in the form of a hollow hinge arm 37. The spacing of the horizontal lengths of the flow passages 35 in each zone or unit which are combined to form a section C is such that when two sections are joined in superposed order, the separate adjacent horizontal elements of the flow passages 35 of the adjoining sections are spaced equal to any two adjacent horizontal elements of a flow passage in a separate zone or section. Such construction facilitates the fabrication of multi-zoned sections from single zoned units.

The multiple zoned section is desirable in that it shortens the flow of any portion of heat exchange medium through the sections. A multiple section is also easily adapted to the use of a plurality of heat exchange media in that any one or more of the units or zones of the sections can be supplied with one type of heat exchange medium while the remaining units of each section may be supplied with another type of heat exchange medium depending on the result to be accomplised on the liquid being treated.

Each top unit or zone in a heat exchange section next adjacent to the distributing chamber H is provided along its upper edge with a horizontal, longitudinally extending cylindrical stiffening element 150 which is welded to the top edge of the section C with the center line of the element 150 in a horizontal plane and in vertical alignment with the vertical plane of the section C. By this arrangement the liquid supplied to the section C from the chamber H through the double row of perforations 95, which rows are on opposed sides of the vertical projection of the center line of the cylindrical element 150, will be directed against opposite sides of the element 150, thereby assuring uniform liquid supply to each side of the section. To secure uniform distribution over the sides of section C of the liquid supplied to either side of element 150, the element is provided with a grained finish as shown in Figure 17 in which the grains 151 extend in a direction crosswise to the path of the flow of liquid passing downwardly over the section. As the liquid elements contact the counter-directional grains 151 of the finish one element 150, their flow is hindered tending to cause a lateral dispersion of the liquid. By this procedure a complete uniform distribution throughout the entire length of element 150 is obtained before the liquid which is passed onto the upper surface of element 150, in small rivulets, passes off of the lower portion of element 150 onto the top portion of the upper zone of the associated section C. A similar finish with horizontal grains 151 is provided on the outer surfaces or walls 143 and 144 of the sections C intermediate the horizontal elements of the flow passages 35 as shown in Figure 18. This also aids in securing and maintaining more uniform distribution of the liquid passing down over the walls 143 and 144. However, after the liquid once passes onto the surfaces provided with the staggered rows 146 of the protuberances 145, it is maintained in substantially uniform distribution and active turbulence as it passes downwardly over the surface of the sections C. In the fabrication of each unit or zone 148 of the heat exchange section C, it is preferable to use two sheet metal stampings 143 and 144 provided with tiers of rows 146 of protuberances 145. 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 24 and 25. The stampings 143 and 144 have in substance the plane of the sheets of metal from which they were stamped, and the peripheral unstamped marginal edges 159 of the juxtapositioned plates are co-planar as shown by Figure 23. The sheets are then welded together at their upper and lower edges along the weld lines 152 and 153 as shown in Figure 23, which weld lines extend along the edges over to the vertical unstamped portion of the end margins. The internal horizontal flow spaces 35 of the sections C are then laid out and their edges sealed by seam welding the stampings along horizontal lines 154, 155 and 156 intermediate the tiers of superposed staggered rows 146 of protuberances 145. The joining of the corresponding ends of one group of alternate weld lines including the lines 152 and 153 along their right hand end as shown in Figure 23 by line 157, and joining the remaining lines at their corresponding opposite end by weld line 158, as also shown in Figure 23, defines the flow passage 35. In each instance the horizontal weld lines and their joining lines are no closer to the remaining horizontal weld lines and their joining lines than the width of a tier of rows 146 of protuberances 145. This arrangement of vertical and horizontal weld lines defines a zigzag flow passage 35 with its open ends 38 and 39 at the lower and upper left hand corners of the stampings.

Having the sections 143 and 144 welded together along the weld lines referred to above, the vertical edges 159 are then flared outwardly to become flanges 160 as clearly shown in Figure 26. Triangular web or partition elements 161 are provided at the ends of the vertical spaces intermediate the outwardly turned flanges 160 at the ends of the units 148 of the sections C, as shown in Figure 27, and in the vertical space intermediate the flanges 160 at the left end of the sections C immediately above and below the inlet 38 and outlet 39 communicating with the zigzag liquid passage 35, as also shown in Figure 27. Each unit is then provided at its inlet and outlet openings 38 and 39 with inlet and outlet hollow hinge arms 36 and 37 respectively, which are welded to the free edges of flanges 160 at the lower and upper left hand corners of unit 148 and also to the free edge of the triangular partitions 161 defining the entrance 38 to the liquid passage 35 and communicating therewith. End plates 162 with inwardly turned flanges 163 are then provided to complete the enclosure of the vertical space intermediate the outwardly turned flanges 160 at either end of the unit or zone 148 of sections C and the triangular end partitions 161. End plates 162 are fixed to the flanges 160 by a welding 164 between the flange 163 and the outer free edge of flanges 160, as shown in Figure 22.

Each unit 149 of sections C is also provided with a cylindrical, horizontally grained, section bracing element 150 welded to its top edge as shown in Figure 14. Bracing element 150 extends across the section C intermediate the outwardly turned flanges 160. The horizontal grain

lines 151 of element 150 provide liquid dispersing means to act on the liquid supplied to the section in rivulets from chamber H to uniformly distribute it before the liquid passes downwardly over the section C. Similar grain lines 151 are provided on the surface of stampings 143 and 144 between the tiers of rows of protuberances. To complete the sections, each section is provided on its front end plate 162 near the upper portion thereof with a latch catch 128 to cooperate with a positioning latch when the section is assembled in a heat exchange device embodying this invention.

To provide the zones of the multi-zoned sections C with internal flow passages 35, the outlet hinge arms 37 of the completed multi-zoned section are each sealed and the inlet hinge arms 36 are each connected to a source of fluid pressure, such as hydraulic pressure. The pressure is adjusted until the portions of the plates 143 and 144 intermediate the weld lines defining the liquid passages 35 have been bulged out to the desired shape as shown by sectional drawings, Figures 20, 21, 22 and 27, depicting internal views and Figures 19 and 27 depicting the bulged effect on the liquid passage boundary portions of stampings 143 and 144. However, the stampings 143 and 144 may be stamped originally with the bulged portions to form the flow passages 35, and in such instance the hydraulic pressure could be dispensed with.

In Figure 28 is shown a modified form of heat exchanger section C which differs only from the previously described section by using spacing elements between the stampings 143 and 144 along the weld lines which define the liquid passages 35. The spacing elements 165 used along the horizontal weld lines comprise straight, narrow, metallic strips of a thickness equal to the desired thickness of the heat exchange medium passages 35. The spacing elements 166 along the vertical weld lines defining liquid passage 35 are straight along their outer edges 167 but are curved along the inner edges 168 to facilitate the passage of liquid through the liquid passage 35. The spacer elements 166 are also of a thickness equal to the desired thickness of liquid passage 35. The only other difference in the sections C shown in Figures 28, 29 and 30 and the previously described section is in the final shaping or bulging operation performed on the sections which do not have the spacer elements 165 and 166. In the modified type, a bulging operation is not necessary as the passages 35 are open due to the thickness of the spacer strips 165 and 166.

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, and the entire mechanism incorporates many essential sanitary features to make it satisfactory for such purpose. However, the heat exchanger is also well adapted for use in the heating or cooling of liquids which do not necessarily require sanitary handling but in which heating or cooling operation it is desired to use a compact highly efficient heat exchanger. The improved unit is simple and unique in construction, in which construction various novel features are resorted to, as well as novel methods of fabricating respective elements of the device. The plurality of heat exchange sections provided with staggered protuberances on their outer surfaces assures turbulent flow and uniform distribution over the outer walls of the sections resulting in an increased efficiency and desired uniformity of heat exchange rate over the entire section. The uniquely finished, cylindrical stiffening element affixed to the upper portion of each section, which element is substantially devoid of heat exchange relation with the heat exchange medium passing through the interior of the section, also tends to brace the section longitudinally as well as receive the liquid from the distributing chamber and distribute it over the section, all of which features, combined with the protuberances on the section surfaces, assure uniform distribution of the liquid over the surface of the heat exchange section. 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 took place, would prevent the satisfactory operation of the heat exchanger.

Each of the heat exchange sections is also provided at both of its ends with a transverse bracing element or end plate affixed to the outwardly flared ends of the stampings constituting the walls of the heat exchange section. The outwardly flared ends of the stampings, as well as the end plates or bracing members, 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 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 surfaces of the outwardly flared flanges at the ends of the sections or on the bracing end plates, thereby aiding in the satisfactory operation of the machine. However, the transverse bracing end plates of the respective sections will contact the edges of the adjacent bracing end plates of adjacent sections when the plurality of swingably mounted sections are placed in close side by side relation within the cabinet for operative position. This assures the desired spacing of the sections relative to one another and also forms a substantial enclosure of the spacing between the outer surfaces of adjacent sections through which the liquid being treated flows downwardly over the section to the collecting chamber for treated liquid. Such a substantial enclosure tends to prevent contamination of the liquid by foreign matter which may otherwise enter into the space between the sections. A further advantage of the use of the transverse end plate bracing elements at the ends of the heat exchange sections adjacent the hinged elements and refrigerant medium connections, consists of the substantial enclosure or wall comprised of adjacent abutting end pieces of adjacent heat exchange sections immediately ahead of the swiveled hinges, whereby the possible spattering of the liquid flowing down over the outer surfaces of the sections onto the hinged elements is prevented, as well as the prevention of foreign material entering into the liquid treating spaces intermediate adjacent sections from the space adjacent the swiveled ends of the sections.

It is also important to again refer to the unique construction of the treated liquid collecting chamber which during the operation of the machine occupies a position immediately below the heat exchange sections to collect the liquid flowing

over the outer surface of the sections. These unique collecting chambers are formed integral with the closure cabinet at the lower extremity of the wall and end panels, and the bottom plate of the collecting chamber also constitutes the bottom plate of the closure cabinet. Being formed integral with the closure cabinet, it is of course necessary to discontinue the operation of the machine before the cabinet can be opened, and it is also necessary to close the cabinet before the operation thereof can be commenced. By virtue of this unique construction and the necessary procedure before commencing or discontinuing the operation of the machine, it is of course apparent that a closure has been provided for the heat exchange device which assures its complete enclosure while it is in operation.

It is of course also apparent that a further unique feature of construction involves the incorporation of the refrigerant circulating system within the same cabinet which houses the heat exchange device. The relative capacity of the refrigerant storage chamber with respect to the capacity of the refrigerant evaporating passages in the heat exchange section, together with the use of a positive-acting large capacity refrigerant circulating pump, assures the prompt and desirable control of the refrigerating effect obtainable in this heat exchange device. The efficiency of the heat exchange sections as an evaporator is of course greatly enhanced by the use of heat exchange sections in which the flow spaces are lined with outwardly extending hollow semi-spherical protuberances, which provide cavities on the inner surface of the stampings defining the flow spaces between welded lines joining the stampings. The cavities increase turbulence in the refrigerating medium as it is speedily passed over the cavities surrounding the heat exchange medium passages.

It is also common in the operation of heat exchange devices from time to time to observe defects which have developed in one or more of the plurality of heat exchange sections. The unique construction of the present invention which enables the removal of the individual heat exchange sections without disturbing the pivot element and hinged liquid supply and return connections, which are associated with the respective sections, is a further particular advantage of this invention. At times when all the sections are not in the machine the use of blank end plates affixed to the normally operative swiveled liquid supply and return connections, enables the provision of a substantial enclosure for the compartment in which the liquid is being treated as divided from the compartment housing the swiveled liquid supply and return connections for the refrigerant medium. These blank end plates, though swingably mounted, will, however, not interfere with the lateral movement of the heat exchange sections.

Various changes in materials and detail arrangements 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 exchanger for liquids, a base, a plurality of heat exchange sections mounted at one end upon said base and extending outwardly therefrom, a standard adjacent the free ends of one of said sections, a tie beam fixed intermediate said base and said standard, a sectional cabinet-like closure for said heat exchange sections, means for supplying liquid to be treated to said heat exchange sections, and means formed integrally with the sections of said cabinet-like closure for collecting treated liquid, said collecting means being so constructed and arranged as to rest at its lower edge upon said tie beam when the sections of the cabinet-like closure are in operative position enclosing said heat exchange sections.

2. In a device of the class described, heat exchange means mounted on a support, liquid supply means mounted above said heat exchange means, a sectional closure for said device having an inwardly extending, upwardly opening chamber-like compartment formed integrally with the lower portion of each section, and outwardly extending flanges carried by the free edges of the sections of said closure to cooperate one with another in overlapping relation when the sections of the closure are brought together, whereby the device is completely enclosed, said closure being substantially braced by its overlapping flanges and a collecting chamber being formed below said heat exchange means when said closure sections are brought together.

3. A heat exchange device of the class described comprising the combination of a plurality of heat exchange sections hinged to a support at corresponding ends to swing laterally relative to one another from operative position in which they stand close together side by side to positions in which they are freely accessible for cleaning, means for supplying a heat exchange medium to the several sections and operable to permit said swinging movement of said sections, a sectional cabinet-like closure for said device, and end plates formed on the hinged ends of said sections and out of heat exchange relation with the heat exchange medium supplied to said sections and adapted to cooperate one with another and with the cabinet-like closure to form a substantial partition between said sections and said means for supplying heat exchange medium to said sections.

4. A heat exchange device according to claim 3, wherein the means for supplying heat exchange medium to the several sections are swiveled hollow hinges, some of which are sealed at their outer ends, and unported end plates sealed to said hinges which are sealed at their outer ends, said end plates being of the same size as the ends of said sections, whereby the substantial partition intermediate said sections and said hinges is formed when said unported end plates and complementary plates on said sections are pivoted into side by side relation.

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