May 23, 1944. C. H. BEANE 2,349,695

EVAPORATOR

Filed June 23, 1942 3 Sheets-Sheet 1

Fig. 1.

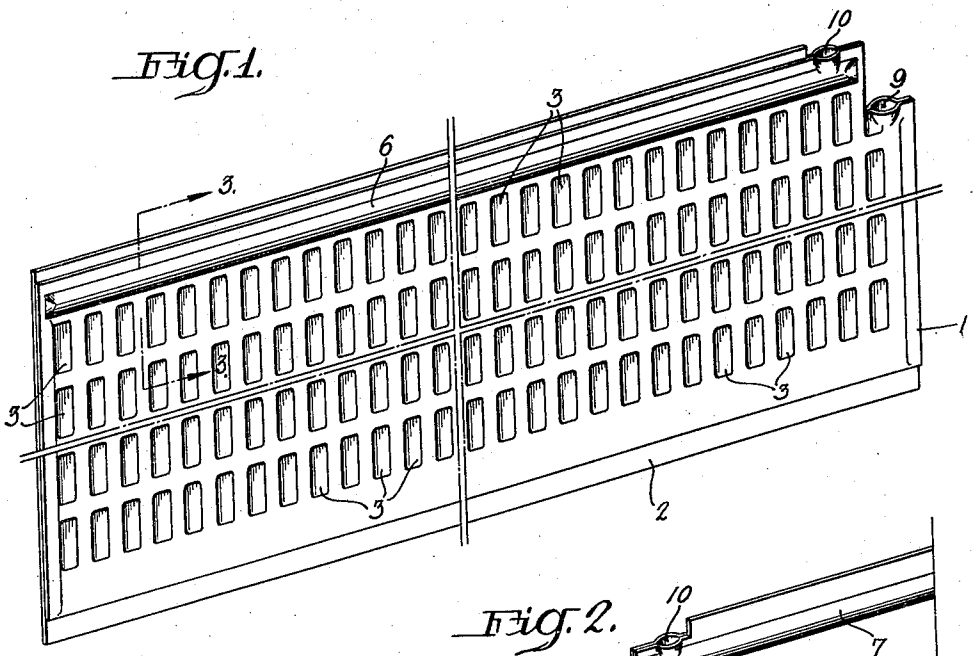


Fig. 2.

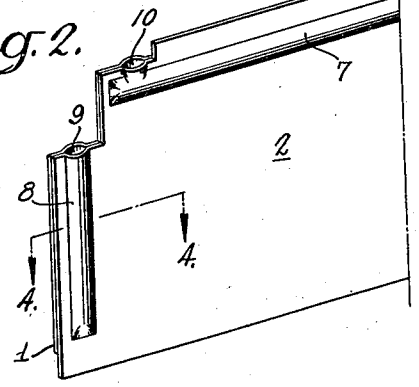


Fig. 3.

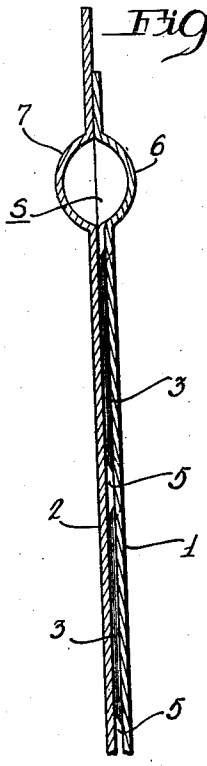
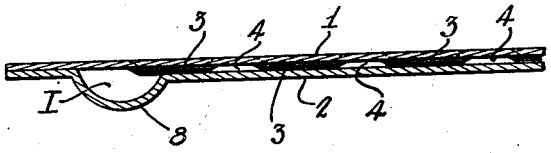


Fig. 4.



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Fig. 5.

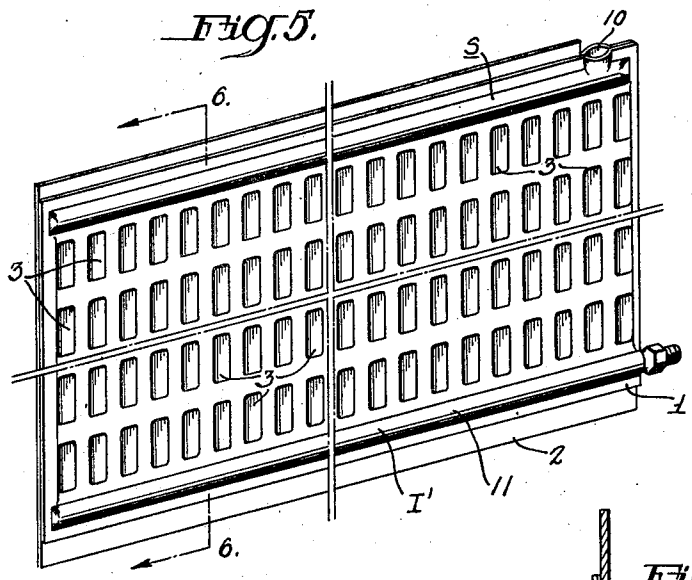


Fig. 6.

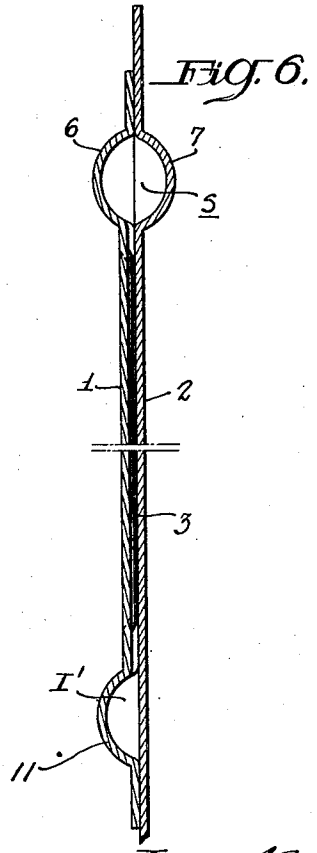


Fig. 7.

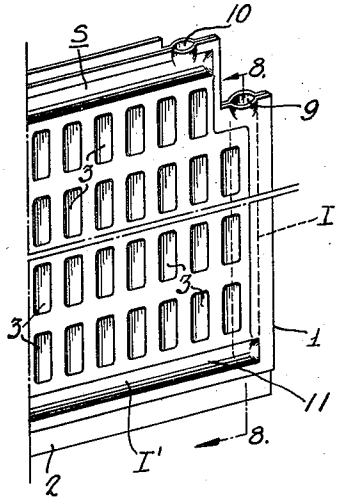
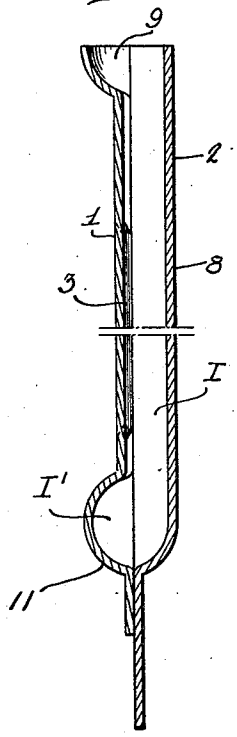


Fig. 8.



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Fig. 10.

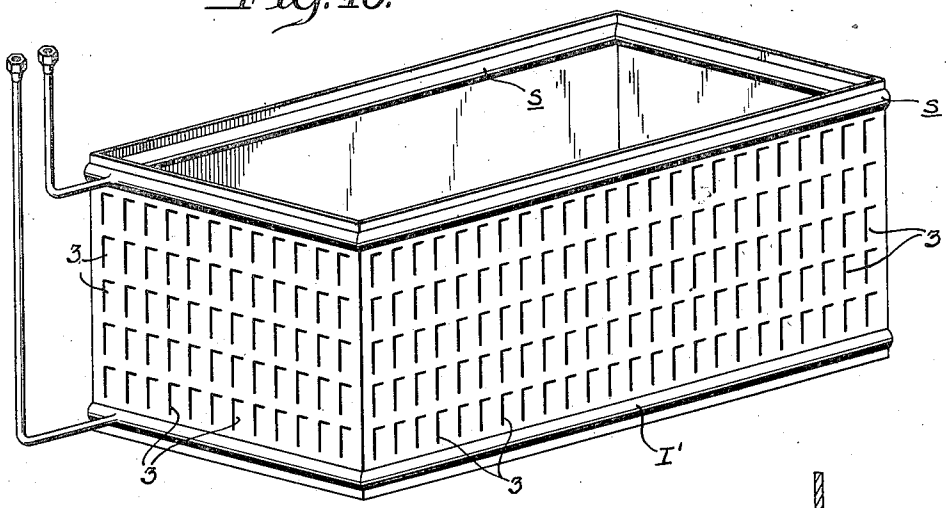


Fig. 9.

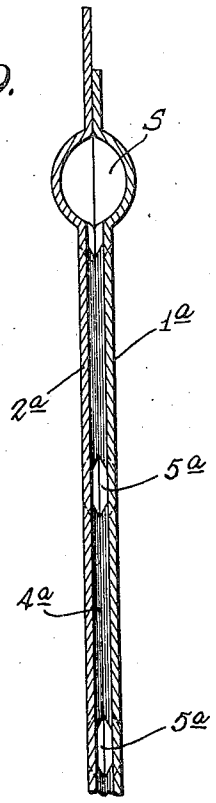
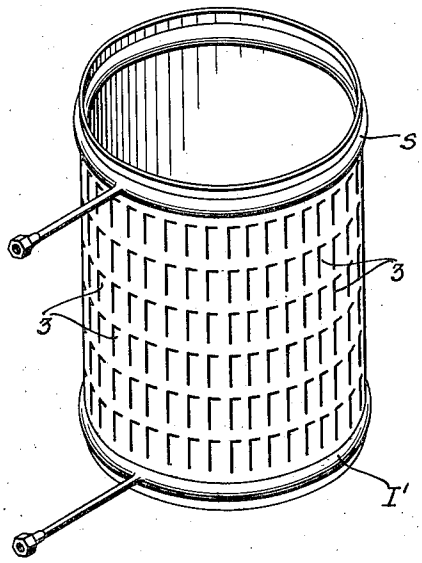


Fig. 11.



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UNITED STATES PATENT OFFICE

2,349,695

EVAPORATOR

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Application June 23, 1942, Serial No. 448,108

4 Claims. (Cl. 62—126)

This invention relates to new and useful improvements in refrigerant evaporators and more particularly to refrigerant evaporators of the so-called plate type such as generally employed in cabinets for the hardening, storage and dispensing of ice cream, frozen foods, etc.

The efficiency of an evaporator, and particularly a plate type evaporator, depends in large part upon the extent to which the evaporator is flooded with refrigerant. This is so for the reason that when some portions of the plate are not supplied with refrigerant, the effective refrigerating area of the plate is correspondingly reduced with the result that there is a proportionate increase in the time required to reduce the evaporator temperature to the desired degree. Furthermore, even in the case of a full flooded plate evaporator, the existence of friction which opposes the flow of refrigerant causes a proportionate drop in the pressure between the inlet and outlet of the evaporator with a resulting decrease in heat absorption.

In addition, continued efficient operation of a plate type evaporator requires that the oil which enters the evaporator along with the refrigerant be forced or carried through the evaporator and returned to the low side of the compressor so that oil is not permitted to settle at the bottom of the evaporator and build up therein to a point where the plate will become "oil-logged."

With the foregoing in mind, the principal object of the present invention is to provide a novel plate evaporator which is constructed and arranged to operate on the full-flooded principle and which has substantially maximum heat-absorption and heat-transfer factors.

Another object of the invention is to provide a plate evaporator of the type described wherein substantially the entire area of the plate constitutes a prime refrigeration surface thereby providing maximum refrigeration within a minimum of surface area and space.

Another object of the invention is to provide a plate evaporator of the character set forth which is constructed and arranged to provide for substantially unrestricted flow of the refrigerant thereby not only substantially eliminating pressure drop across the evaporator but also materially reducing the burden of load upon the compressor.

Still another object of the invention is to provide a plate evaporator of the character set forth which is constructed and arranged so as to eliminate and prevent the existence or occurrence of dead spots therein.

A further object of the invention is to provide a plate evaporator of the stated type which operates to cause oil entering such evaporator to be forced and carried therefrom so that the collection and ultimate oil-logging of the evaporator is eliminated.

A still further object of the invention is to provide a plate evaporator of the stated kind which is constructed and arranged to produce a concentrated and more rapid ebullition of the refrigerant without the use of special or other separate ebullition inducing devices.

These and other objects of the invention and the various features and details of the construction and operation thereof are hereinafter fully set forth and described, and shown in the accompanying drawings, in which:

Figure 1 is a view in perspective of an evaporator plate made according to the invention.

Figure 2 is a fragmentary view in perspective of the rear side of the right hand end portion of the evaporator shown in Figure 1.

Figure 3 is an enlarged fragmentary view in section taken on line 3—3, Figure 1.

Figure 4 is an enlarged fragmentary view in section taken on line 4—4, Figure 2.

Figure 5 is a view in perspective of a modified form of evaporator plate according to the invention.

Figure 6 is an enlarged view in section taken on line 6—6, Figure 5.

Figure 7 is a partial view in perspective of still another modified form of evaporator plate embodying the invention.

Figure 8 is an enlarged view in section taken on line 8—8, Figure 7.

Figure 9 is a fragmentary view in section, generally similar to Figure 3, showing a modified arrangement of the invention.

Figure 10 is a view in perspective of an envelope or rectangular evaporator unit embodying plates according to the present invention; and

Figure 11 is a view in perspective of a cylindrical evaporator unit embodying a plate according to the present invention.

The present invention relates generally to an evaporator plate construction comprising two superimposed quadrilateral metal sheets 1 and 2, at least one of which sheets, for example, the sheet 1, is embossed or pressed to provide therein a plurality of recesses or depressions 3 of like size and shape arranged in a predetermined geometric pattern and uniformly spaced over the surface of said sheet 1 so that said recesses or depressions 3 cooperate with one another and

with the other sheet 2 to form two groups of refrigerant passages 4 and 5 respectively which extend in predetermined angular relation with respect to each other so that one group of said passages intersect and intercommunicate with the other group of said passages.

The shape or configuration of the recesses or depressions 3 embossed or pressed in the sheet 1 may be of any desired shape or configuration such as, for example, circular, elliptical or quadrilateral (square, rectangular or diamond shape). I prefer, however, to make the recesses or depressions 3 rectangular in shape or configuration so that the passages 4 and 5 formed thereby in cooperation with the sheet 2 extend vertically and horizontally, respectively, of the evaporator plate as shown in the drawings. Also, I prefer to form these rectangular depressions or recesses 3 with their long axes arranged vertically of the sheet 1 so that the vertical passages 4 are more closely spaced than the horizontal passages 5.

In addition to the embossings 3, the sheet 1 preferably is embossed or pressed to provide a header channel 6 extending adjacent and along the top or upper edge of said sheet in communication with the passages 4 at the upper ends thereof.

The other sheet 2 may be flat except for a header channel 7 and an inlet channel 8 which are embossed or pressed therein (see Figure 2). The channel 7 is arranged and formed in the sheet 2 parallel and adjacent to an edge thereof so that, when the two sheets 1 and 2 are secured together in the relation shown, the channel 7 in said sheet 2 will register with the channel 6 in the sheet 1 and cooperate therewith to form a tubular suction header S of generally cylindrical cross-section shape as shown in Figure 3 of the drawings. The channel 8, on the other hand, extends transversely of the sheet 2 adjacent an end edge thereof and is arranged so that when the two plates 1 and 2 are secured together there will be formed an inlet header I with which the adjacent ends of the second group of passages 5 communicate as shown in Figure 4 of the drawings. An inlet opening or port 9 is provided for the header I, and the suction header S similarly is provided with an outlet opening or port 10.

The two plates 1 and 2 embossed or pressed, as aforesaid, are secured together in the relation shown by welding or otherwise, preferably by spot welding, in the generally rectangular embossed or pressed portions 3. Too, the peripheral edges of the sheet 1 are also embossed or pressed so as to reside in the plane of the embossed recesses 3 and these edge portions are welded to the edge portions of the flat sheet 2 so as to prevent the leakage or escape of the refrigerant from between the sheets 1 and 2.

There is thus formed an evaporator plate wherein there is provided a refrigerant flow network comprising a plurality of intersecting passages 4 and 5 which traverse substantially the entire surface of the plate and serve as an expansion chamber for the liquid or vaporized refrigerant.

The cross-section shape and area of the refrigerant passages 4 and 5 constitutes an important feature of the evaporator of the present invention. Thus the cross-sectional or flow area of the passages 4 and 5 is such that the maximum rate of flow of the refrigerant therethrough, and particularly through the passages 4 leading to the suction header S, preferably does not exceed a rate that will afford a normal rate of overflow maintenance of the plate in a fully flooded condition.

In addition, the cross-sectional shape of the refrigerant flow passages 4 and 5 formed by the embossings 3 is such that the said passages at their side edge portions are of diminishing thickness or tapered outwardly (see Figures 3 and 4), and this arrangement, due to the diminishing thickness of the refrigerant along the sides of the passages and consequent proportionately greater heat exchange or transfer per unit volume of refrigerant in the region of the converging or tapered side portions of the passages, results in more rapid boiling of the refrigerant at the sides of the passages and therefore more rapid and increased ebullition is afforded with resulting increased refrigeration efficiency. Too, this more rapid and increased ebullition, together with the relatively small flow area of the passages, serves also to carry and force through and out of the evaporator oil which is discharged into the evaporator along with the refrigerant. It will be observed, in the case of the rectangular shaped embossings 3 embodied in the form of the invention illustrated, that the refrigerant flow passages 4 and 5 are of generally trapezoidal shape in cross-section.

In operation, the refrigerant such as, for example, Freon, or the like, is introduced through the inlet 9 to the header I from which it flows laterally into and through the communicating and interconnecting passages 4 and 5 in the plate to completely flood the expansion chamber. Ebullition rapidly takes place due to the converging or tapered sides of the evaporator passages and as vaporized refrigerant rises in the passages, liquid refrigerant continues to drop down until it begins to boil and vaporize and pass upwardly to the suction header S to be returned to the compressor for recompression and recirculation through the plate. The construction and arrangement of the passages 4 and 5 causes the chamber or evaporator to become flooded very rapidly and operates to eliminate entirely the occurrence of dead spaces in the circulatory system of the plate. Too, this particular intersecting arrangement of passages provides just about a maximum of refrigeration surface for a given evaporator surface, and the time required to pull the evaporator down to the desired temperature is materially reduced. Furthermore, the provision of the interconnecting horizontal or cross-passages 5 operates to prevent oil-logging of any particular section or portion of the plate since said passages 5 tend to equalize the liquid flow and level in said plate.

While, of course, it is generally essential that the suction header S be located at the top or upper portion of the evaporator, the disposition of the inlet header is susceptible of some variation. Thus, in lieu of the vertical endwise arrangement of the inlet header I, as shown in Figures 2 and 4 of the drawings, an inlet header may be formed by embossing a channel 11 along the bottom or lower edge of sheet 1 of the evaporator parallel to the suction header S to form an inlet header as shown at I' in Figures 5 and 6 or, in addition to said vertically arranged endwise inlet header I, the evaporator may be formed to provide an inlet header which embodies both vertical and horizontal courses I and I' connected in series and arranged, for example, as shown in Figures 7 and 8 of the drawings.

In certain refrigeration installations, and particularly those in which there is a requirement

for large capacity and low temperature, it may be desirable to emboss both of the sheets 1 and 2 instead of only one of them as previously described. Such a construction is shown in Figure 9 of the drawings wherein each of the sheets 1*a* and 2*a* is embossed as herein described to provide registering recesses or depressions which cooperate with one another to form passages 4*a* and 5*a* arranged in the manner hereinabove set forth, and in this case also it will be observed that the passages at their side edges are of diminishing thickness of refrigerant along the sides or marginal portions of said passages with resultant increased heat exchange or transfer per unit volume of refrigerant as aforesaid.

The plate evaporator may be used in the flat sheet-like form shown in Figures 1, 5 and 7, individually or in multiple. Thus one of the more commonly used arrangements of plate type evaporators is the so-called envelope refrigeration unit employed in cabinets and the like and which consists of a rectangular disposition of four plate evaporators serially and endlessly joined together, for example, as shown in Figure 10 of the drawings. Another of the more important commercial applications of the plate type evaporator is its embodiment into the cylindrical form shown in Figure 11 for use in the refrigeration of goods in cylindrical containers such as milk and ice cream cans, etc., or for the cooling of water.

From the foregoing, it will be seen that the present invention provides a plate evaporator of novel construction which operates on the full-flooded principle and affords maximum heat absorption and transfer. Also, an evaporator constructed according hereto is characterized by its more rapid and speed ebullition resulting in increased efficiency and in the forcing and carrying through and out of the evaporator oil which enters said evaporator with the refrigerant. Too, the present construction eliminates dead spots in the evaporator while providing maximum refrigerating surface within a minimum evaporator area, and practically eliminating pressure drop across the evaporator and reducing the burden or load on the refrigerant compressor.

It will be obvious, of course, instead of forming the suction header S of the evaporator by the complementary channels 6 and 7 embossed in both of the sheets 1 and 2, that the said suction header may be formed by a single channel of sufficient size formed in either one or the other of said sheets 1 and 2. Similarly, the channel 8 may be formed in the sheet 1 or the channel 11 formed in sheet 2, or both of them may be formed in either of the sheets, as desired, or as a particular installation may require.

While certain embodiments of the invention have been herein illustrated and described, it is not intended that the invention be limited to such disclosure but that changes and modifications may be made and incorporated therein within the scope of the claims.

I claim:

1. A plate evaporator comprising two quadrilateral flat metal sheets secured together in face to face relation, at least one of said sheets being embossed to provide a suction header between said sheets extending adjacent and along one edge of said evaporator, and at least one of said sheets being embossed to provide between the sheets a first group of relatively narrow elongated straight refrigerant passages extending in spaced parallel relation substantially perpendicular to the said suction header and communicating therewith and a second group of relatively narrow elongated straight refrigerant passages extending in spaced parallel relation substantially parallel to said suction header and intersecting the passages of said first group, the cross-sectional contour of each passage of both groups having its greatest dimension in a longitudinal median plane of the passage and diminishing at opposite sides of said plane toward opposite edges respectively of the passage and the cross-sectional areas of said passages being substantially less than the cross-sectional area of said suction header, and a refrigerant inlet to said passages independent of the suction header.

2. A plate evaporator comprising two quadrilateral flat metal sheets secured together in face to face relation, at least one of said sheets being embossed to provide a suction header between said sheets extending adjacent and along one edge of the evaporator and an inlet header between said sheets extending adjacent and along an adjacent edge thereof at right angles to said suction header, and at least one of said sheets being embossed to provide between the sheets a first group of narrow elongated straight refrigerant passages extending in spaced parallel relation substantially perpendicular to said suction header and communicating therewith and a second group of narrow elongated straight refrigerant passages extending in spaced parallel relation substantially parallel to the suction header and intersecting the passages of said first group, certain of the passages of said second group communicating with said inlet header and the cross-sectional contour of each passage of both groups having its greatest dimension in a longitudinal median plane of the passage and diminishing at opposite sides of said plane toward opposite edges respectively of the passage, said headers each having a cross-sectional area greater than the cross-sectional areas of the passages.

3. A plate evaporator comprising two quadrilateral flat metal sheets secured together in face to face relation, at least one of said sheets being embossed to provide a suction header between said sheets extending adjacent and along one edge of the evaporator and an inlet header between said sheets extending adjacent and along the opposite edge thereof parallel to said suction header, and at least one of said sheets being embossed to provide between the sheets a first group of narrow elongated straight refrigerant passages extending in spaced parallel relation substantially perpendicular to said suction and inlet headers and communicating with each thereof and a second group of narrow elongated straight refrigerant passages extending in spaced parallel relation substantially parallel to the suction header and intersecting the passages of said first group, the cross-sectional contour of each passage of both groups having its greatest dimension in a longitudinal median plane of the passage and diminishing at opposite sides of said plane toward opposite edges respectively of the passage, and said suction and inlet headers each having a cross-sectional area greater than the cross-sectional areas of the passages.

4. A plate evaporator comprising two quadrilateral flat metal sheets secured together in face to face relation, at least one of said sheets being embossed to provide a suction header between said sheets extending adjacent and along one edge of the evaporator and an inlet header between said sheets extending adjacent and along the opposite

and adjacent edges thereof, and at least one of said sheets being embossed to provide between the sheets a first group of narrow elongated straight refrigerant passages extending in spaced parallel relation substantially perpendicular to said suction header and the opposite edge portion of said inlet header and communicating with both thereof and a second group of narrow elongated straight refrigerant passages extending in spaced parallel relation substantially parallel to the suction header and intersecting the passages of said first group, certain of the passages of said second group communicating with the adjacent edge portion of said inlet header and the cross-sectional contour of each passage of both groups having its greatest dimension in a longitudinal median plane of the passage and diminishing at opposite sides of said plane toward opposite edges respectively of the passage, and said suction and inlet headers each having a cross-sectional area greater than the cross-sectional areas of the passages.

CARSON H. BEANE.