March 17, 1959 J. A. McLEAN, JR 2,877,631

REFRIGERATION APPARATUS

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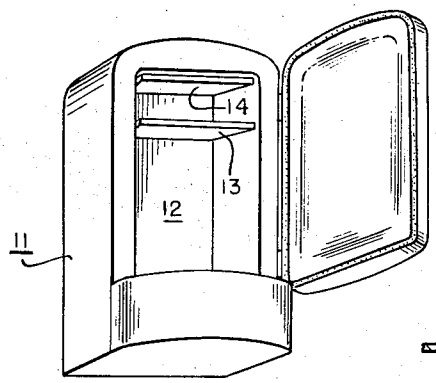


FIG. 1.

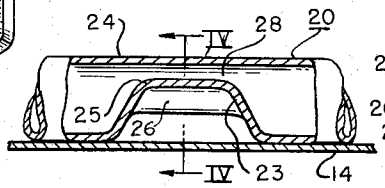


FIG. 3.

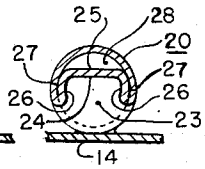


FIG. 4

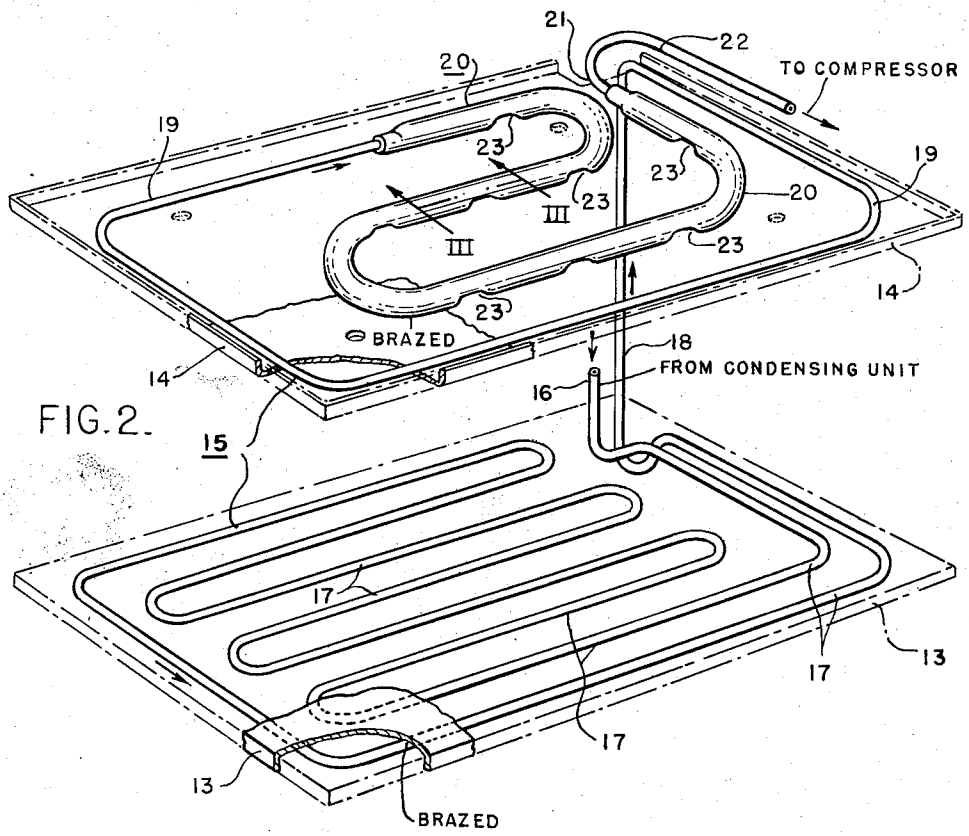


FIG. 2.

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REFRIGERATION APPARATUS

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This invention relates to refrigeration apparatus and more particularly to refrigerant evaporators.

It is an object of this invention to provide a refrigerant evaporator which occupies a minimum of space within the refrigerated chamber.

Most refrigerating systems of the compression-expansion type employ a surge tank or header at the outlet of the evaporator to trap and prevent the return of liquid refrigerant to the compressor. This header must have sufficient volume to retain all excess liquid refrigerant flowing from the evaporator. Since, under certain conditions of operation, the header is required to trap considerable quantities of refrigerant liquid, the headers have been large and bulky and occupied considerable space.

In this invention a tubular surge header is employed to trap refrigerant liquid flowing from the evaporator passages and permit only gaseous refrigerant to return to the compressor. Comparatively small diameter tubing is employed in the header to reduce the depth of the space occupied by the header and the necessary storage volume is given the header by making it longer than headers heretofore employed. To prevent liquid refrigerant from being carried or blown through the header by the gaseous refrigerant passing therethrough, the header tube is deformed or indented from its under side at spaced intervals to provide dams which trap the refrigerant liquid.

A more specific object of this invention is the provision of an improved surge header for refrigerant evaporators.

These and other objects are effected by this invention as will be apparent from the following description taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a perspective view of a refrigerator employing an evaporator embodying this invention;

Fig. 2 is a perspective view of the evaporator with portions thereof broken away to show the refrigerant carrying tubes more clearly;

Fig. 3 is an enlarged longitudinal sectional view of a portion of the surge header of this invention and taken as indicated by the arrows III—III of Fig. 2; and

Fig. 4 is a cross sectional view of the header taken along the line IV—IV of Fig. 3.

Referring to the drawings and more especially to Fig. 1, numeral 11 designates generally an insulated cabinet for a domestic refrigerator or freezer having a refrigerated storage space 12 therein. Disposed within the upper portion of the refrigerated chamber 12 is the cooling unit of a refrigeration system, which in the illustrated embodiment comprises two vertically spaced horizontal refrigerated plates 13 and 14.

The refrigerated plates 13 and 14 are preferably made of metal or other good heat conducting material and serve to support the refrigerant carrying tubular evaporator structure 15 illustrated in Fig. 2. The evaporator 15 is preferably constructed of metal tubing such as copper or aluminum. Liquid refrigerant is supplied to the evaporator 15 at the inlet end 16 thereof by a refrigerant compressing and condensing unit (not shown). The refrigerant liquid enters a first portion 17 of the tubular evaporator 15, which portion is shaped in serpentine fashion and attached, by grazing or other suitable means, to the under surface of plate 13. This first tubular portion 17 of the evaporator tube is of comparatively small internal diameter such as to cause the liquid refrigerant therein to be carried along with the gas produced by vaporization of a portion of the refrigerant. This mixture of liquid and gaseous refrigerant passes through a vertical portion 18 of the evaporator tube 15 to an intermediate length of tubing 19 secured to the upper plate 14. Further vaporization of the refrigerant liquid takes place in this intermediate portion 19 as the refrigerant is conveyed therethrough to an enlarged section of evaporator tubing constituting a surge header 20. This surge header 20 traps liquid refrigerant not vaporized in the other portions of the evaporator tubing and permits only gaseous refrigerant to flow from the outlet 21 of the evaporator into a suction conduit 22 for return to the compressing and condensing unit.

In accordance with this invention, the tubing portion forming the surge header 20 has a larger internal diameter than the tubing making up the other portions of the evaporator so as to permit the separation of liquid and gaseous refrigerant therein, but is considerably smaller in diameter than refrigerant headers heretofore employed. The header tube 20 is elongated to give it sufficient internal volume to retain the excess refrigerant liquid flowing through the evaporator under any operating conditions which may be encountered in the use of the refrigerator. Refrigerant evaporators have geen constructed in accordance with this invention embodying a surge header formed from approximately 50 inches of ⅝ inch outside diameter aluminum tubing having a wall thickness of .050 inch. The other evaporator tubing had a 5/16 inch outside diameter and approximately the same wall thickness. These dimensions are illustrative only as it is obvious that the exact size of the header for one refrigerating system will not be the same as that employed in another system. As shown, the header 20 has a serpentine configuration and it is secured to the upper surface of plate 14 by brazing.

To prevent refrigerant liquid from being carried through the header 20 by the flow of gaseous refrigerant therethrough, the under side of the header tube is deformed or indented upwardly at spaced intervals along its length as indicated at 23. One of these indentations is illustrated more clearly in Figs. 3 and 4. As can be seen in these figures, in forming the indentations 23, a bottom section of the header wall 24 is deformed upwardly to partially collapse the tube 20 and form a dam 25 across the tube bore. As the bottom section of the tube wall 24 is deformed upwardly, contiguous sections 26 of the sides of tube wall 24 are folded inwardly and upwardly and pressed tightly against undeformed sections of the tube wall at 27 to prevent flow around either side of dam 25. Dam 25 preferably extends more than half way across the tube bore to confine the refrigerant flow through the tube in the vicinity of each indentation 23 to an upper region 28. This upper region 28 of the header 20 preferably has a flow area larger than the flow area of the upstream portions 17, 18 and 19 of the evaporator tube. In the practical embodiments of the invention referred to previously a satisfactory flow area 28 was obtained when the top of the dam 25 was positioned approximately ⅛ inch beneath the middle of the top inner surface of tube wall 24.

The dams 25 formed by the indentations 23 hold back the refrigerant liquid flowing through the header tube 20

while permitting the refrigerant gas to flow thereover. In the illustrated embodiment, a plurality of these indentations 23 are shown and it will be understood that, during the operation of this apparatus, refrigerant liquid will collect ahead of the first dam which it encounters and as the space ahead of this dam is filled, will flow thereover and into the space ahead of the next dam and so on until all of the excess refrigerant liquid entering the header 20 is trapped therein.

The unique, elongated nature of the surge header 20 of this invention offers several advantages in evaporator construction not available from header configurations previously employed. The principal advantage lies in the reduction in depth of space occupied by the header. This reduction in space requirement is effected by using smaller diameter tubing for the header than was heretofore possible. This, in turn, permits the evaporator to be made in thin, plate-like fashion as illustrated in the drawings.

The header of this invention, because of its elongated nature, also is a more efficient refrigerating element of the evaporator. The refrigerant liquid trapped in the header 20 is distributed over a larger area than the liquid would be in a header having a large cross-sectional area. Hence, a greater portion of the liquid refrigerant is in close proximity to the medium being cooled and more efficient heat transfer is possible. In the embodiment disclosed, the header 20 is actually utilized to refrigerate a major portion of the upper plate 14 and articles stored in the vicinity of plate 14.

It should also be pointed out that the header of this invention need not necessarily have its entire length disposed in a single horizontal plane. It can be employed in other evaporator arrangements, such as, for example, an arrangement wherein the header is supported by a vertical plate. Under such conditions, the header would have one or more horizontal passes in which the indentations described previously would be impressed into the underside thereof. The horizontal tube length between indentations would hold liquid refrigerant in the same manner as if the entire header were horizontally arranged.

From the foregoing, it will be apparent that this invention provides an improved evaporator structure which, because of the novel surge header employed, occupies a minimum of space.

While the invention has been shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What is claimed is:

1. A tubular refrigerant evaporator having an inlet for receiving liquid refrigerant and an outlet for discharging vaporous refrigerant and comprising two serially connected tubes, the first tube being at the inlet of the evaporator and having a comparatively small internal diameter whereby liquid refrigerant therein is carried along by vaporous refrigerant passing therethrough, the second tube being at the outlet of the evaporator and having a larger internal diameter than said first tube, said second tube having at least a portion thereof lying in a substantially horizontal plane and having a plurality of indentations in the under side thereof at spaced intervals along its length, said indentations providing regions in the second tube in which refrigerant flow is restricted to the upper portions of the tube whereby all of the refrigerant liquid entering said second tube is trapped therein and prevented from being carried therethrough to the outlet of the evaporator.

2. A refrigerant evaporator including a sheet of good heat conducting material and first and second refrigerant carrying tubes intimately attached to said sheet throughout their length, said tubes being serially connected with the outlet of the first communicating with the inlet of the second, said first tube being of comparatively small internal diameter whereby liquid refrigerant therein is carried along by vaporous refrigerant passing therethrough, said second tube being larger in internal diameter than said first tube and having a plurality of longitudinally spaced indentations in the under side thereof for confining refrigerant flow to the upper portion of said second tube at each indentation whereby all of the liquid refrigerant entering said second tube is trapped between said indentations and prevented from being carried through the outlet of the second tube.

3. A tubular refrigerant evaporator having an inlet for receiving liquid refrigerant and an outlet for discharging vaporous refrigerant and comprising two serially connected tubes, the first tube being at the inlet of the evaporator and having a comparatively small internal diameter whereby liquid refrigerant therein is carried along by vaporous refrigerant passing therethrough, the second tube being at the outlet of the evaporator and having a larger internal diameter than said first tube, said second tube being arranged in serpentine fashion in a single horizontal plane and having a plurality of indentations in the under side thereof at spaced intervals along its length, said indentations providing regions in the second tube in which refrigerant flow is restricted to the upper portions of the tube whereby all of the refrigerant liquid entering said second tube is trapped therein and prevented from being carried therethrough to the outlet of the evaporator.

4. In a refrigerant evaporator, first and second sheets of good heat conducting material, said sheets being disposed substantially horizontally and in vertical spaced relation to one another, first and second refrigerant carrying tubes having horizontally arranged serpentine portions thereof attached respectively to said first and second sheets, said tubes being serially connected with the outlet of the first tube communicating with the inlet of the second tube, said first tube being of comparatively small internal diameter whereby liquid refrigerant therein is carried along by vaporous refrigerant passing therethrough, said second tube being larger in internal diameter than said first tube and having a plurality of longitudinally spaced indentations in the under side thereof for confining refrigerant flow to the upper portion of said second tube at each indentation whereby all of the liquid refrigerant entering said second tube is trapped between said indentations and prevented from being carried through the outlet of the second tube.

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