April 18, 1939. L. C. SMITH 2,154,874

REFRIGERATION APPARATUS

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Fig. 1

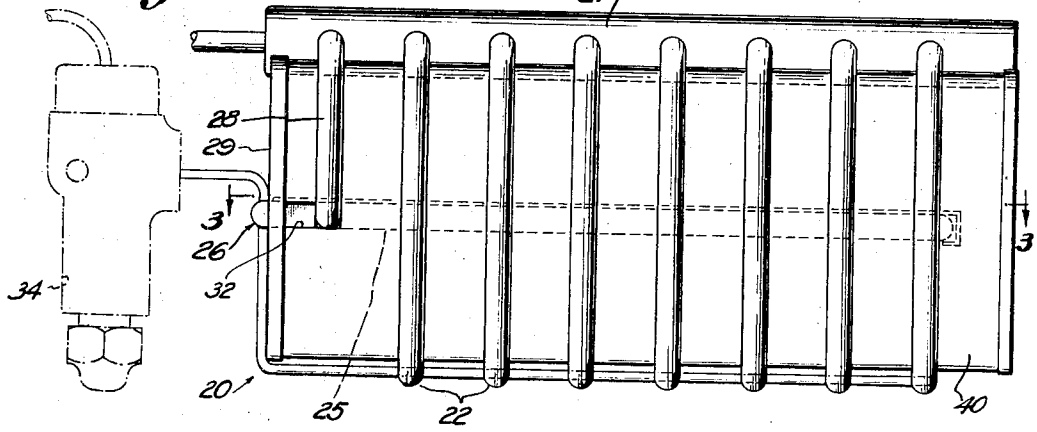


Fig. 3

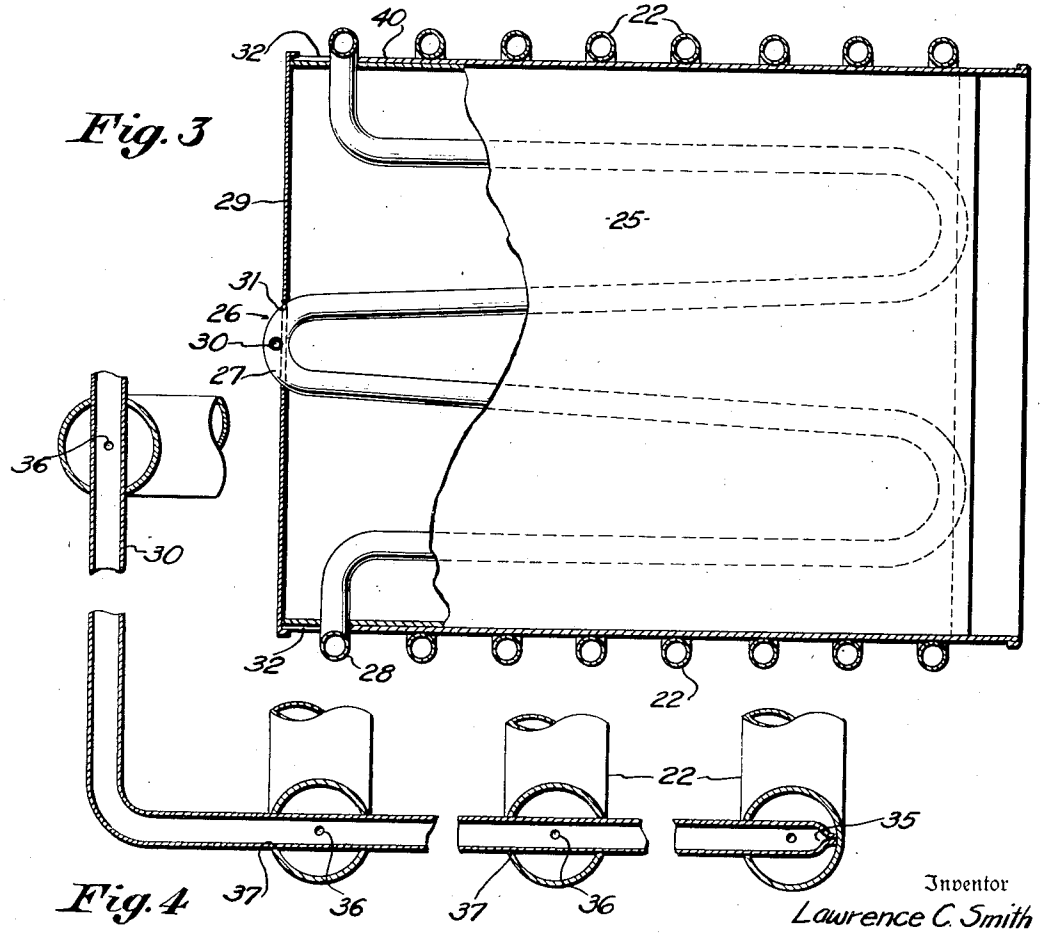


Fig. 4

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REFRIGERATION APPARATUS

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Fig. 2

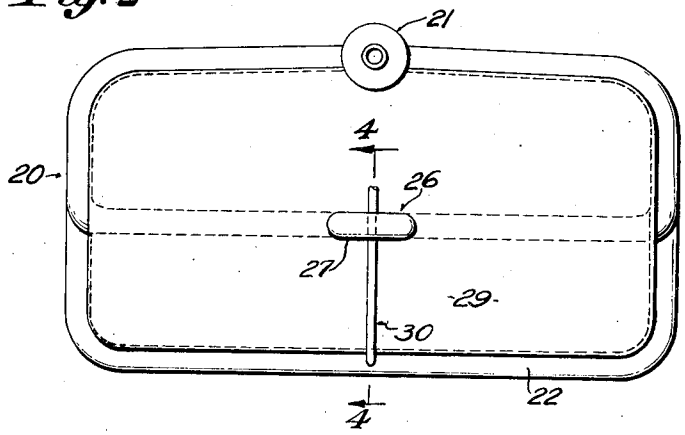


Fig. 5

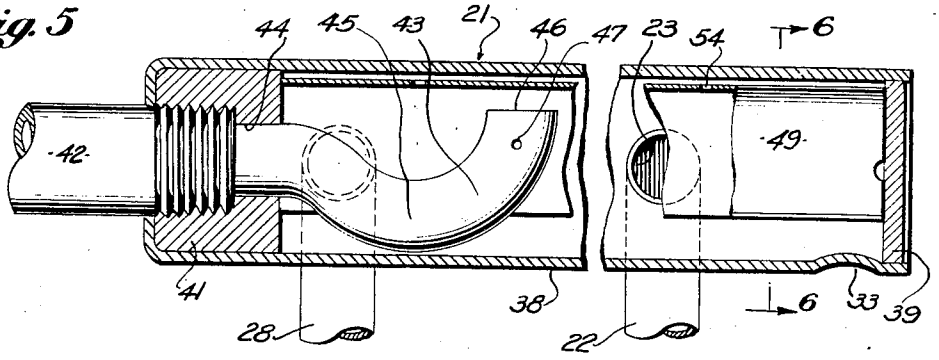
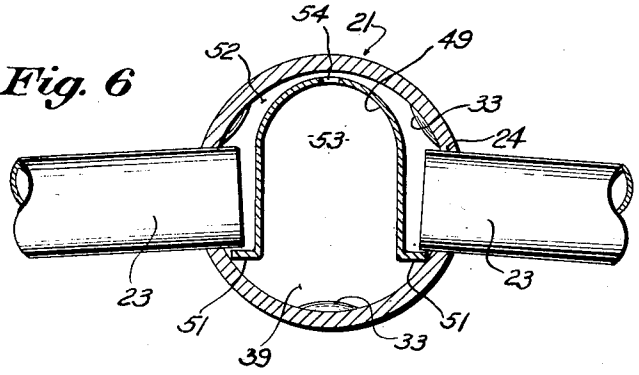


Fig. 6



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Fig. 7

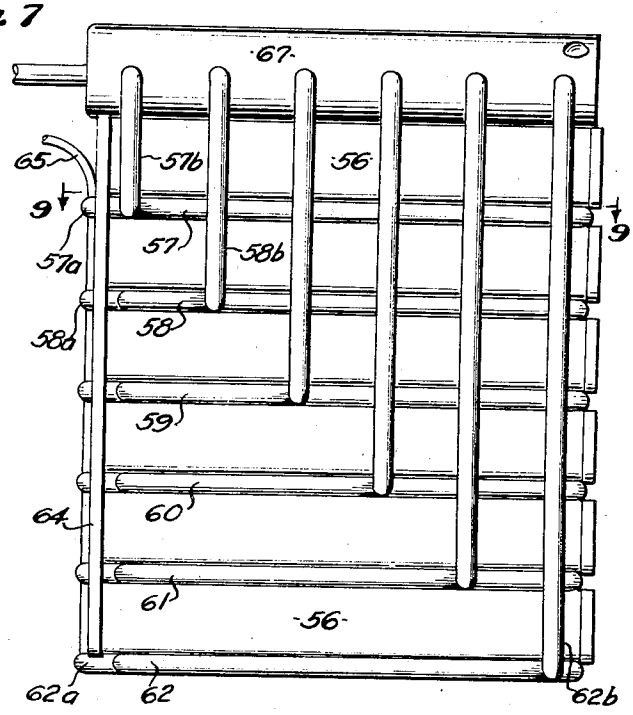


Fig. 10

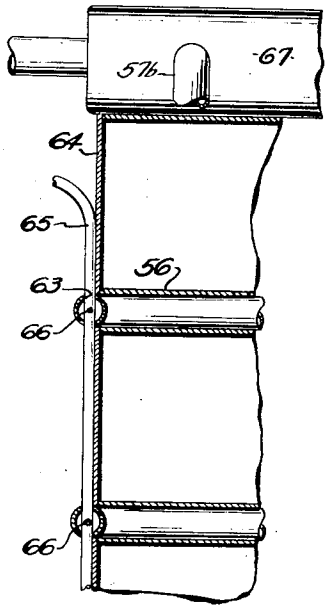
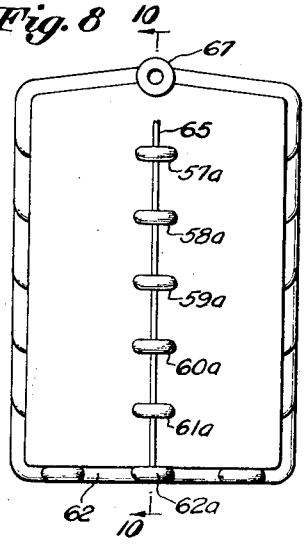


Fig. 8



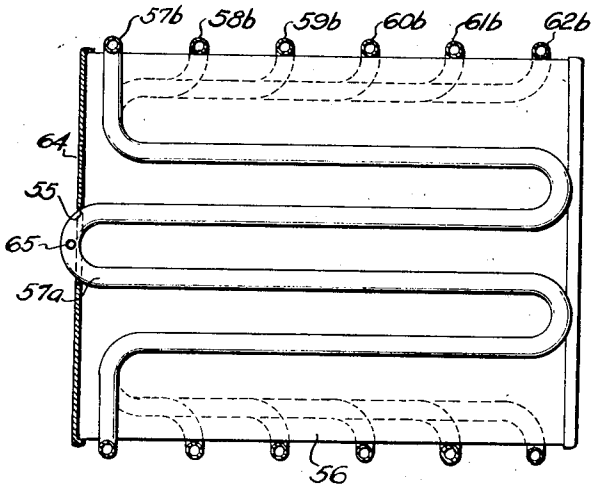


Fig. 9

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REFRIGERATION APPARATUS

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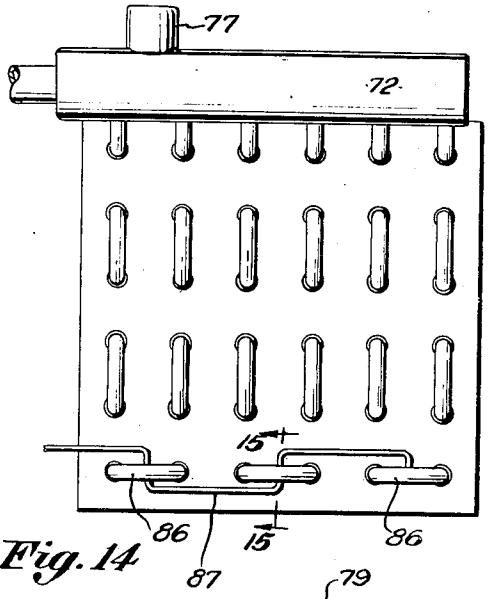


Fig. 14

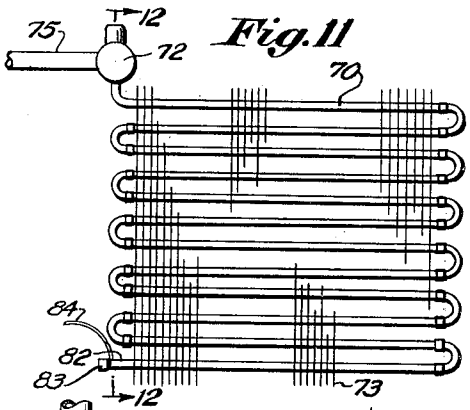


Fig. 11

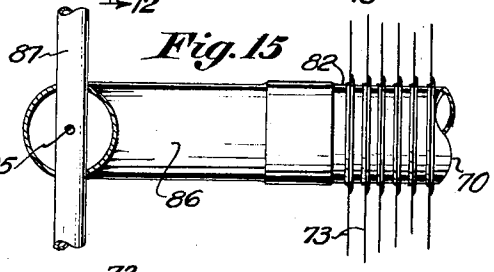


Fig. 15

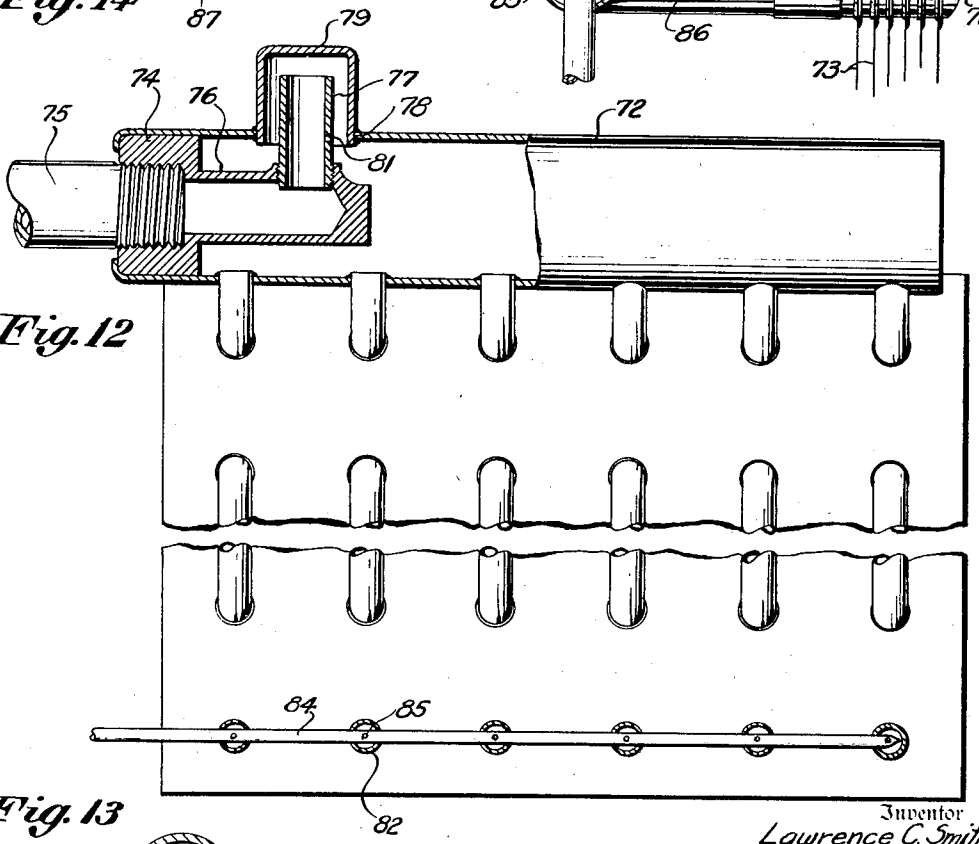


Fig. 12

Fig. 13

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UNITED STATES PATENT OFFICE

2,154,874

REFRIGERATION APPARATUS

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Application October 2, 1936, Serial No. 103,700

12 Claims. (Cl. 62—126)

This invention relates to refrigeration evaporators applicable in compressor-condenser-expander systems, and it has particular reference to the provision of refrigerant evaporators having a suction manifold and a plurality of tube loops connected thereto, together with inlet means for each of the separate tubes for admitting the refrigerant thereto.

In the devising of refrigerant expanders or evaporators, there has been proposed the so-called dry coil, which essentially is a length of continuous tubing through which refrigerant may flow and evaporate, and also the flooded header type, in which a reservoir of liquid refrigerant may flow down into a number of spaced tubes where evaporation occurs,—the gases forcing their way up through the liquid. In flooded evaporators, the valve or control mechanism may be either within the reservoir, to give the "low side" type of operation, or in an adjacent vessel, to give the so-called "high side float" type of control. All of these basic systems are well known and have been used, and improvements therein have been directed toward the devising of suitable arrangements of the necessary parts to increase efficiency of operation or reduction of cost of the equipment.

According to the present invention, it is proposed to effect concurrently an increase in thermal efficiency while effecting savings in cost, by forming the evaporator with a suction header or manifold, from which expanded refrigerant may be withdrawn, and connecting thereto a number of separate refrigerant evaporation loops or ducts, the feed of refrigerant to each of these ducts being into the bottom thereof.

The principles of the invention may be readily applied to various types of evaporators, such as are especially adapted for domestic refrigerators, ice-makers, air or room coolers, and the like, and hence they may be herein illustrated by reference to a number of typical examples. As the description thereof proceeds, it will also be made apparent that these various evaporators themselves possess numerous points of novelty and advantage, which will be recognized by those skilled in the art.

In the drawings:

Fig. 1 is a side elevation of one embodiment of the invention particularly adapted for a domestic refrigerator;

Fig. 2 is a rear elevation thereof;

Fig. 3 is a section on the line 3—3 of Fig. 1, particularly showing details of the refrigerated shelf;

Fig. 4 is an enlarged section on the line 4—4 of Fig. 2, showing the duct and feed tube arrangement;

Fig. 5 is an enlarged longitudinal section through the header;

Fig. 6 is an enlarged cross section on the line 6—6 of Fig. 5;

Fig. 7 is a side elevation of a further embodiment showing the invention applied to an evaporator of the ice making type;

Fig. 8 is a rear view thereof, drawn on a reduced scale;

Fig. 9 is a section on the line 9—9 of Fig. 7;

Fig. 10 is an enlarged section on the line 10—10 of Fig. 8;

Fig. 11 is a front view of a further embodiment of the invention as applied to a cooling coil;

Fig. 12 is an enlarged section on the line 12—12 thereof;

Fig. 13 is a similar but further enlarged section;

Fig. 14 is a side view of an air cooling coil similar to that of Fig. 11, but provided with a slightly different feed arrangement;

Fig. 15 is an enlarged section on the line 15—15 of Fig. 14.

In the first embodiment of the invention (Figs. 1–6) an evaporator 20 is formed with a cylindrical outlet header 21 and ducts 22 which are bent to enclose a rectilinear ice tray housing or sleeve 40. The ends 23 of the ducts 22 are inserted through holes 24 of the header and secured thereto, as shown in Fig. 6.

The sleeve is divided into two ice tray compartments by a horizontal shelf 25 which is soldered in place and which contains a refrigerant duct 26. This duct is formed into several loops, the central loop 27 thereof projecting beyond the rear end of the sleeve 22 (Fig. 3), and the terminal portions 28 of the remaining loops being bent upward and inserted in the header 21. A cap 29 covers the back of the sleeve and it contains an opening 31 through which a portion of the central loop 27 projects. The sleeve is formed with two opposed slots 32 in its side walls which permit the duct 26 to be inserted through the rear of the sleeve during the assembling operation.

Refrigerant is accurately metered to each duct through a manifold or feed tube 30 which leads to a feed control element such as a high side float or expansion valve 34. The feed tube 30 is a simple tube of small diameter closed at one end, as indicated by the numeral 35 (Fig. 4), and provided with spaced ports 36. Each duct 22 is drilled through, as indicated by the numeral 37, and the manifold tube is threaded therethrough, so that each port or pair of ports 36 in the tube 30 is dis-

posed within a duct. The tube is finally soldered to the ducts to provide a fluid-tight assembly.

It will be observed that the feed tube enters each duct at a central point therein, so that a symmetrical feed effect is obtained in each duct from the central inlet to the dual outlets. To insure an equalized feed to each duct, I prefer to maintain a back pressure condition in the tube **30**, which effect is obtained by proportioning the total area of the ports so that it is slightly smaller than the cross sectional area of the tube **30**.

The header **21** is formed of a tubular body **38** having internal beads **33** disposed at one end to provide a mounting shoulder for a head disc **39** which is soldered in place. The remaining end of the body is closed by a head **41** which is tapped to receive a suction conduit **42** leading to the compressor or suction side of the refrigeration system (not shown). An oil return device **43** is secured in a drilled hole **44** in the head **41**, and it communicates with the suction conduit **42**. This member is formed of a tube provided with a depending loop or trap portion **45** and a vertical gas intake terminal **46** disposed adjacent the top portion of the header. A small oil inlet hole **47** is provided in the return device at a high point in the terminal **46**. This arrangement permits the gaseous products of evaporation to be withdrawn at a high point in the header above the liquid level, while the oil hole **47** is disposed at a point at the liquid level where it permits the slow passage of oil into the trap portion **45**.

The gas intake **46** is protected from direct association with the relatively violent discharge action at the duct terminals by a shield or baffle **49**. This member is in the form of an inverted casing having marginal flanges **51** which engage under the projecting duct extremities and thus serve as securing means. The ends of the baffle **49** abut the heads **39** and **41**. This arrangement permits the ebullient fluid emerging from the ducts to expend its energy in the upper chamber **52**, thus formed, while the liquid in the inner or quiet chamber **53** will be retained in a relatively tranquil state, so that oil separation and subsequent removal by the device **43** may be efficiently accomplished.

Holes **54** are formed in the top of the baffle to permit the passage of gas from the chamber **52** to the upper portion of chamber **53**, whence it is directed into the gas intake **46**.

In Figs. 7–10 the invention is utilized in an evaporator which is formed for the purpose of producing ice cubes in large quantities. The evaporator includes a large ice tray housing formed of a plurality of superimposed ice tray containers or sleeves **56**. Beneath each sleeve or shelf portion of this structure, a duct is secured in intimate thermal contact, the ducts being indicated by the numerals **57**, **58**, **59**, **60**, **61**, and **62**. The ducts are formed with central loops **57***a*, **58***a*, etc., which project beyond the rear of the sleeves **56**, and which are each vertically drilled through as indicated by the numeral **63**. A plate or cap **64** is secured to the rear of the sleeve structure and it is formed with spaced slots **55** through which the central loops project.

A feed tube **65** is threaded through the loops and soldered in position, and it contains ports **66** which may be identical in disposal and function to the ports of the tube **30** of Fig. 1. The ducts are each symmetrically disposed from the feed portion thereof, and they terminate in external legs **57***b*, **58***b*, etc., which extend about the assembled sleeves and enter a suction header **67** at equally spaced intervals. The header may be formed in a similar manner to the header of Fig. 1.

It will be observed that each sleeve is in intimate thermal contact with approximately the same lineal length of duct tubing as a result of the terminal disposal of successive ducts. The uppermost sleeves, for example, contacts four legs of duct tubing, compared to the six legs in contact with the bottom tray (compare Figs. 7 and 9). However, the former is supplied with twelve compensating lengths of vertical tubing formed by the duct extremities, while the latter is furnished with but two.

Although the described similar lineal characteristics of the coils are not an absolute necessity in a structure of this type, it is to be preferred, since it provides equal freezing characteristics for the ice trays, and simplifies the feed tube port structure to the extent that the ports thereof may be all of equal size.

In commercial evaporator coils used for air conditioning and the like, a comparatively higher operating temperature is maintained than in the types of evaporators heretofore described. However, a similar feed structure may be utilized with several useful results. The coils of Figs. 11 and 14 are identical in structure, with the exception of the feed connection, and they consist of a plurality of serpentine ducts **70** disposed in parallelism and having outlet extremities **71** entering a large header **72**. The usual cross fin structures **73** are applied to the ducts.

The header **72** receives the upper extremities of the ducts, and it is provided with a head **74** which is tapped to receive a suction conduit **75**, and which is formed with an axial projection **76** tapped to receive a vertical gas inlet pipe **77**. The pipe projects vertically through an opening **78** in the header wall, which is sealed with a cap **79**. A small hole **81** is drilled in the pipe **77** to provide an oil return passage.

In Figs. 11–13, the lower terminals **82** of the ducts are closed by caps **83**, and each duct is drilled to receive a feed tube **84** which leads to the refrigerant control means (not shown). Ports **85**, drilled in the feed tube, communicate with each duct (Fig. 12).

In Figs. 14 and 15, pairs of lower terminals **82** are connected by loops **86** which are drilled to receive the feed tube **87**. Thus each pair of ducts receives refrigerant from a common supply. This disposal may be varied according to the dimensional or thermal characteristics of the coil, as obviously any desired group of ducts may be supplied in this manner.

In the operation of the coils, it is usual to place them in an air duct or tunnel, with the air flowing parallel to the fins thereon. As is well understood in the art, a preferential heat exchange condition occurs under these circumstances in which the heat transfer from the ducts to the moving air stream progressively diminishes in succeeding ducts as the result of reduction of air velocity and the progressive reduction of temperature differential. The first duct to the left in Fig. 14, for example, may easily bear thirty per cent of the total heat transfer load of the coil, while the last duct may perform but five per cent of the work.

With the feed and header system of the present invention, each duct is continuously retained in flooded condition, even though the demands of each duct are incommensurate with the feed

characteristics of the feed tube ports; that is, the first duct may not receive enough refrigerant from its port, while the last duct may receive an excess supply. In this event, the excess refrigerant is introduced into the header 72 to act as a supply or reserve for gravitationally feeding the ducts in which more refrigerant is demanded.

From the foregoing it will be appreciated that the valve or other refrigerant control means may be set to provide for the partial flooding of the header 72, whereupon the duct supply system will be automatically self-compensating without further attention or recourse to the intricate individual duct controls which have previously been deemed necessary.

I claim:

1. An evaporator comprising a suction header, an ice tray housing member disposed beneath said header, horizontal shelves in the housing, a looped duct beneath each shelf having terminal portions extending upward into said header, and a feed tube extending transversely through central portions of all of said ducts, said tube being formed with a plurality of outlet ports, each port being disposed in a portion of said tube within a duct.

2. An evaporator comprising a suction header, an ice tray housing member disposed beneath said header, a shelf in said member, a plurality of ducts extending about the exterior of said member and having terminal portions communicating with the header, a duct secured beneath said shelf and having a central loop portion projecting beyond one end of said member and terminal portions communicating with the header, and a feed tube extending transversely through the loop of said last named duct and central portions of the remaining ducts, said tube being formed with a plurality of outlet ports, each outlet port being disposed in a portion of said tube within a duct.

3. An evaporator comprising a suction header, a plurality of superimposed sleeves forming an ice tray housing, a duct disposed beneath each sleeve and having a central looped portion projecting beyond one end of the overlying sleeve, each duct having terminal portions bent upward against the sides of overlying sleeves and entering said header, and a feed tube extending transversely through the looped portions of said duct, said tube being formed with a plurality of outlet ports, each outlet port being disposed in a portion of said tube within a duct.

4. An evaporator comprising a suction header, an ice tray housing disposed beneath said header and having a plurality of horizontal shelves forming ice tray compartments therein, a looped duct formed of tubing and disposed beneath each shelf, said ducts being of progressively greater lineal length from the lower to the upper of said shelves, each duct having a pair of terminal portions extending upward against sides of said housing, said pairs of terminal portions progressively contacting a greater number of ice tray compartments from the uppermost to the lowermost duct, whereby each compartment is contacted by a substantially equal lineal length of duct tubing, and a feed tube extending transversely through central portions of all of said ducts, said tube being formed with a plurality of outlet ports, each outlet port being disposed in a portion of said tube within a duct.

5. An evaporator comprising a suction header, a plurality of spaced sleeves each forming an ice tray compartment disposed in superimposed relation beneath said header, a plurality of spaced continuous refrigerant ducts depending from said header, said ducts each having terminal portions connected to said header, each of said ducts extending downward in contact with the side walls of a sleeve and into the space between a pair of adjacent sleeves and in contact with the surfaces of said sleeves, the length of each duct being substantially equal to the length of the other ducts, the length of each duct disposed between any pair of adjacent sleeves plus the length of all ducts in contact with the side walls of any sleeve being substantially constant.

6. An evaporator comprising a suction header, a plurality of ducts having one end communicating with the header and remaining ends closed, and a feed tube extending transversely through all of said ducts at the closed ends thereof, said tube being formed with a plurality of spaced outlet ports, each outlet port being disposed in a portion of said tube within a duct.

7. An evaporator comprising a suction header, an ice tray housing disposed beneath said header and having an open front and a back wall formed with a plurality of vertically spaced slots, said housing being formed with a plurality of spaced shelves disposed adjacent to said slots, a duct secured beneath each shelf and having terminal portions extending upward into said header, each duct having a central loop portion projecting through a slot in the back wall of the cabinet, and a feed tube extending transversely through the loop portions of said ducts, said tube being formed with a plurality of outlet ports, each outlet port being disposed in a portion of said tube within a duct.

8. An evaporator comprising a suction header, a plurality of ducts of tubular formation communicating with said header, said ducts being each formed with transversely aligned holes, an independent feed tube passed through the holes of the ducts, means for sealing the tube to each of the ducts at the points of entry and exit through the holes, and a plurality of ports in said tube, each of said ports being disposed to lie within the confines of the bore of one of the ducts.

9. An evaporator comprising a suction header, a plurality of ducts of tubular formation having terminal portions communicating with said header, said ducts being each formed with transversely aligned holes at substantially central points therein relative to the terminal portions, an independent feed tube passed through the holes of the ducts, means for sealing the tube to each of the ducts at the points of entry and exit through the holes, and a plurality of ports in said tube, each of said ports being disposed to lie within the confines of the bore of one of the ducts.

10. An evaporator comprising a suction header, an ice tray housing member disposed beneath said header, a plurality of ducts extending about the exterior of said member and having terminal portions communicating with the header, each duct being formed with transversely aligned holes located in the portions of the ducts which are beneath said member, a feed tube passed through the holes of the ducts, means for sealing the tube to each of the ducts at the points of entry and exit through the holes thereof, and a plurality of ports in said tube, each of said ports being disposed to lie within the confines of the bore of one of the ducts.

11. An evaporator comprising a suction header, a plurality of ducts having terminal portions

communicating with said header and depending therefrom, said ducts being each formed with transversely aligned holes, a feed tube passed through the holes of the ducts, means for sealing the tube to each of the ducts at the points of entry and exit through the holes thereof, a plurality of ports in said tube, each of said ports being disposed to lie within the confines of the bore of one of the ducts, said header being disposed horizontally to provide a liquid reservoir in communication with all of the terminal portions of the ducts.

12. An evaporator comprising a suction header, a plurality of ducts communicating with said header, said ducts being each formed with transversely aligned holes, a feed tube passed through the holes of the ducts, means for sealing the tube to each of the ducts at the points of entry and exit through the holes thereof, a plurality of ports in the tube, each of said ports being disposed to lie within the confines of the bore of one of the ducts, said ports being proportioned so that the sum of their areas is less than the effective cross sectional area of the tube.

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