May 10, 1949.

B. C. JOHNSON

2,469,828

EVAPORATOR UNIT

Filed June 15, 1946

2 Sheets-Sheet 1

Fig. 1.

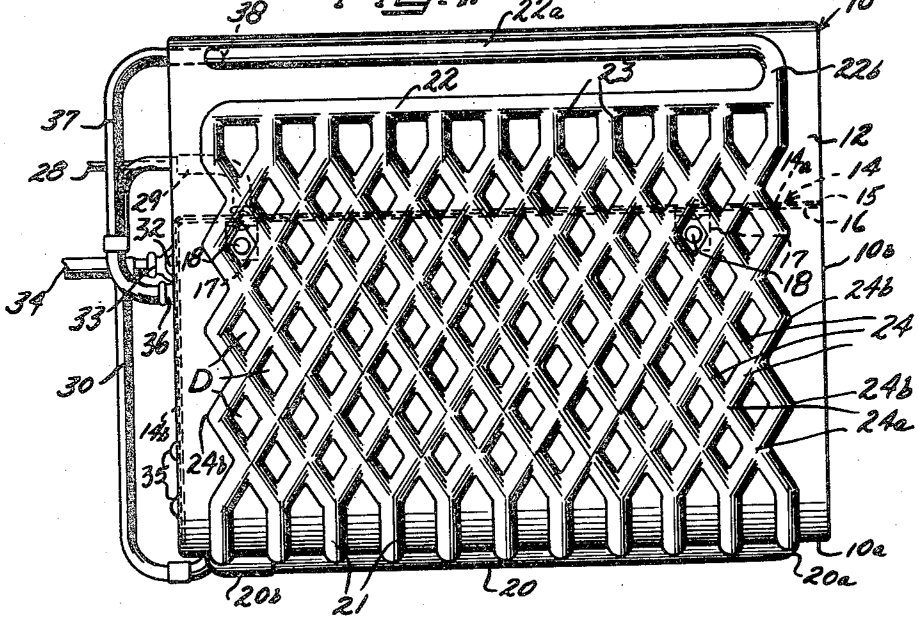
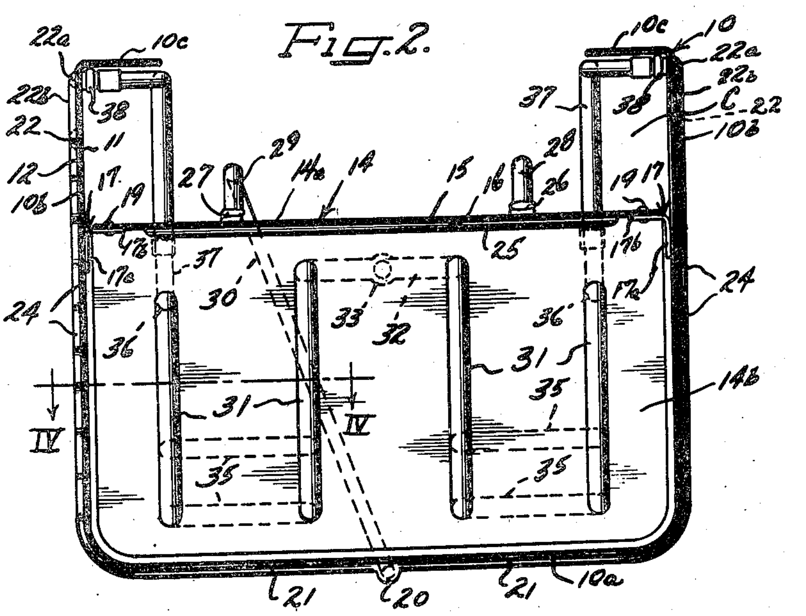


Fig. 2.



Inventor
BERNARD C. JOHNSON

by The Firm of Charles W. Hills Attys.

May 10, 1949. B. C. JOHNSON 2,469,828

EVAPORATOR UNIT

Filed June 15, 1946 2 Sheets-Sheet 2

Fig. 3.

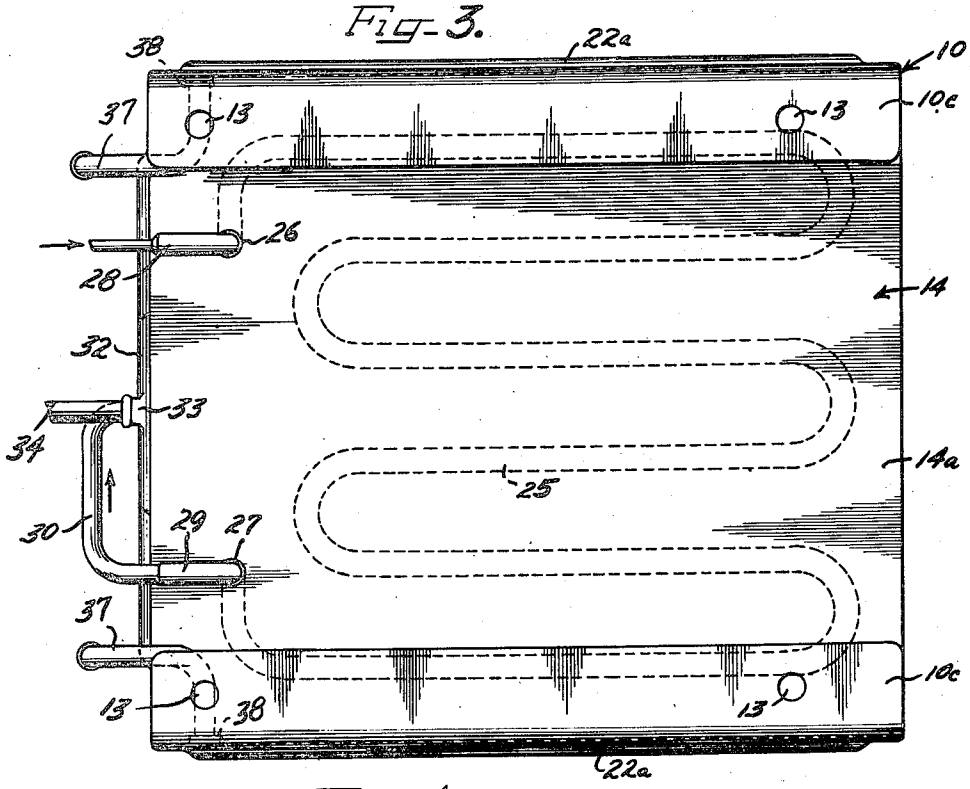
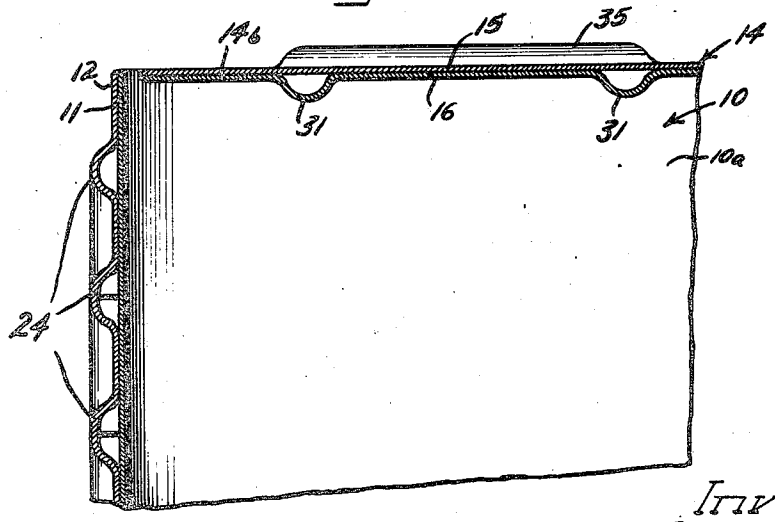


Fig. 4.



Inventor
Bernard C. Johnson

by The Firm of Charles R. Hill Attys.

Patented May 10, 1949 2,469,828

UNITED STATES PATENT OFFICE

2,469,828

EVAPORATOR UNIT

Bernard C. Johnson, Mundelein, Ill., assignor to Houdaille-Hershey Corporation, Detroit, Mich., a corporation of Michigan

Application June 15, 1946, Serial No. 676,939

8 Claims. (Cl. 62—126)

1

This invention relates to heat exchangers having ducts so arranged as to efficiently distribute fluid for heat exchange relation with the surrounding zones. Specifically the invention relates to an evaporator unit construction wherein diagonal ducts are used in intersecting relation to provide a grid-like arrangement which will handle relatively large volumes of refrigerant and avoid the necessity for heretofore used header ducts of relatively large cross sectional area. The invention also includes an arrangement of ducts in an L-shaped plate to provide a refrigerated shelf for the evaporator unit as well as a refrigerated back wall for the unit which will absorb residual cooling capacity of refrigerant leaving the unit to "dry" the refrigerant and prevent frosting of the exhaust tube.

The evaporator units of this invention are preferably formed from embossed secured together contiguous metal sheets bent in the shape of a U to define the bottom and side walls of a sharp freezing chamber. The outer sheet is embossed to provide an inlet manifold duct longitudinally along the bottom wall. Distributing or feeding ducts extend at spaced intervals laterally from the manifold duct and thence upwardly into the lower ends of the side walls of the unit. The upper ends of the side walls of the unit each have two superimposed longitudinally extending outlet manifold ducts connected at their front ends. The lower outlet duct of each pair has depending spaced collecting ducts aligned with the upstanding portions of the distributing ducts. Criss-crossed diagonal ducts connect the upper ends of the distributing ducts with the lower ends of the collecting ducts. These diagonal distributing ducts intersect each other to provide a grid-like duct system accommodating large volumes of refrigerant in good heat exchange absorbing relationship with the surrounding zone.

The ducts, because of the large volume capacity afforded by the intersecting grid-defining arrangement need not have large cross-sectional areas to accommodate large volumes of refrigerant and shallow embossments on the outer sheet only are sufficient to define these ducts. As a result, the sharp freezing chamber is free from any protuberances to have increased storage capacity and the outer surfaces of the unit are

2

free from large protuberances to accommodate mounting of the unit close to the walls of a refrigerator cabinet if desired.

The U-shaped unit has an L-shaped wall member composed of embossed secured-together contiguous metal sheets mounted therein to provide a horizontal shelf and a back wall. Refrigerant is supplied through ducts in the horizontal shelf portion to a transfer tube at the rear end of the unit which supplies the inlet manifold duct in the bottom of the unit. The top outlet manifold ducts in the tops of the side walls of the unit discharge through tubes at the back of the unit into ducts provided in the back wall portion of the L-shaped member. These ducts are arranged with sumps so that any remaining heat absorbing capacity of the spent refrigerant is utilized to cool the back wall of the unit before the refrigerant is returned to the compressor and condenser of the refrigerating system. In this manner the back wall acts as a refrigerant "drying" device to prevent frosting of the refrigerant return tube and to increase the efficiency of the unit by causing it to utilize all of the heat absorbing capacity of the refrigerant.

It is then an object of this invention to provide a sheet metal type heat exchanger free from chambers of large cross sectional areas and having an efficient duct system which places substantially all of the heat exchange liquid flowing through the unit in good heat exchange relationship with the walls of the unit.

Another object of this invention is to provide an embossed sheet metal refrigerant evaporator unit free from heretofore used large diameter header ducts and having a duct distributing system which effectively places all of the refrigerant flowing through the unit in extended surface contact with the duct walls to increase the heat absorbing capacity of the refrigerant.

Another object of this invention is to provide a U-shaped sheet metal evaporator unit for mechanical refrigerators wherein the side walls of the unit are embossed to have an arrangement of intersecting diagonally extending shallow ducts defining refrigerant spreading conduits of enhanced capacity.

Another object of the invention is to provide a heat exchanger with a series of intersecting ducts presenting a grid-like appearance and effective

to distribute heat exchange fluid in efficient heat exchange relation with the walls of the unit.

A still further object of the invention is to provide a sheet metal heat exchanger adapted for use as an evaporator unit in a mechanical refrigerator having an L-shaped member mounted therein providing a shelf and a back wall and arranged to receive heat exchange fluid therethrough.

A still further object of the invention is to provide an evaporator unit for mechanical refrigerators wherein contiguous metal sheets form the back wall of the unit and are embossed to define refrigerant "drying" ducts receiving spent refrigerant from the unit.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of a preferred example illustrate one embodiment of the invention.

On the drawings:

Figure 1 is a side elevational view of an evaporator unit according to this invention.

Figure 2 is a front end elevational view of the unit of Fig. 1.

Figure 3 is a top plan view of the unit of Figs. 1 and 2.

Figure 4 is an enlarged fragmentary horizontal cross sectional view taken along the line IV—IV of Fig. 2.

As shown on the drawings:

In Figs. 1 to 4 the reference numeral **10** designates generally a sheet metal evaporator unit according to this invention. The unit **10** is composed of embossed brazed or welded together contiguous metal sheets or plates including an inner sheet **11** and an outer sheet **12**. The sheets **11** and **12**, after being secured together, are bent so as to provide a bottom wall portion **10***a*, spaced opposed vertical side wall portions, **10***b*, **10***b*, and inturned horizontal top flanges **10***c*, **10***c* at the upper ends of the side wall portions **10***b*, **10***b*. These flanges **10***c*, **10***c* have apertures **13** therein as best shown in Fig. 3 to receive studs or mounting bolts for suspending the unit **10** in the top portion of a refrigerator cabinet (not shown).

A shelf and back wall unit **14**, composed of contiguous welded together embossed metal sheets or plates **15** and **16** is mounted in the chamber C defined by the unit **10**. The member **14** is bent into the shape of an L and has a horizontal leg **14***a* providing a shelf in the unit **10** together with a vertical leg **14***b* providing a back wall for the unit **10**.

Angle brackets **17** are provided to mount the member **14** in the unit **10**. As best shown in Fig. 2 these brackets have vertical legs **17***a* attached to the side walls **10***c* of the unit **10** near the tops of the side walls, together with horizontal legs **17***b* extending into the chamber C in spaced parallel relation under the flanges **10***c*. Rivets, such as **18**, are provided to connect the legs **17***a* to the side walls **10***b* as best shown in Fig. 1. The horizontal leg **14***a* of the member **14** rests on the horizontal legs **17***b* of the brackets **17** and rivets, such as **19**, are provided to connect the member **14** to the bracket. As shown in Fig. 1 brackets **17** are provided at the front and rear ends of the side wall **10***b*.

As best shown in Figs. 1 and 2, the outer sheet or plate **12** of the unit **10** is embossed to provide an inlet manifold duct **20** along the bottom **10***a* midway between the side walls **10***b*. This duct **20** extends longitudinally from the rear portion

to the front portion of the unit and has a closed end **20***a* in spaced relation from the front edge of the unit, together with an enlarged end **20***b* in spaced relation from the rear edge of the unit.

Feeder ducts **21** are also embossed in the outer plate or sheet **12** and extend laterally outward from the inlet manifold duct **20**. These ducts **21** are in spaced parallel relation and traverse the entire bottom **10***a* of the unit and extend around into the side walls of the unit to levels just above the rounded corners between the side walls and bottom. These feed ducts **21** serve to distribute refrigerant from the inlet manifold **20** to the side wall portions **10***b* of the unit **10** at equally spaced intervals along the length of the side walls.

Embossments are provided in the outer sheet **12** near the tops of the legs or side walls **10***b* to define in each leg or side wall a pair of superimposed longitudinal outlet manifold ducts, including a bottom duct **22** and a top duct **22***a*. The ducts **22** and **22***a* are connected at the front end of the side wall by a duct **22***b*.

The outer sheet **12** is further embossed to provide spaced upstanding collecting ducts **23** depending from the outlet manifold ducts **22** in the upper portions of the side walls **10***b* of the unit. These collecting ducts **23** as best shown in Fig. **1** are aligned with upper ends of the feeder ducts **21**.

The outer sheet **12** is still further embossed in the side wall portions **10***b* thereof to define criss-crossed diagonal or sloping heat exchanger ducts **24** connecting the upper ends of the feeder ducts **21** with the lower ends of the collecting ducts **23**. These sloping ducts **24** are so arranged that two ducts **24** diverge from each duct **21** and **23** except at the end ducts **21** and **23**. The ducts **24** intersect each other at points **24***a* to define a grid-like design in the side walls **10***b* with diamond-shaped flat sheet portions D bounded by duct-defining beads or embossments. The sloping ducts **24** extending from the end ducts **21** and **23** slope diagonally inward and converge with an oppositely sloping duct at their other end. Outwardly sloping ducts **24** which would normally diverge beyond mating relation with the distributing or collecting ducts **21** or **23**, mate with each other at points **24***b* at the front and rear portions of the side walls **10***b*.

Refrigerant from the feeder ducts **21** is distributed throughout substantially the entire faces of the side walls **10***b* of the unit by the grid-like arrangement of sloping ducts **24** and at the same time the ducts **24** only have semi-cylindrical cross sectional areas as best shown in Fig. 4. The labyrinth passages provided by the ducts afford ample capacity for relatively large volumes of refrigerant without collecting the refrigerant in any chamber of large cross sectional area. As a result the refrigerant is maintained in excellent heat exchange relation with the sheets **11** and **12**.

Since the ducts **20** to **24** are all defined by embossments in the outer sheet **12**, the chamber C enclosed by the unit **10** is free from inwardly protruding embossed portions and will have increased storage space.

The shelf portion **14***a* of the member **14** has the bottom sheet **16** thereof embossed, as shown in Fig. 3, to provide a serpentine duct **25** which extends from an upstanding inlet collar **26** formed on the upper sheet **14***a* at the rear end of the shelf forwardly and rearwardly in a series of coil-like turns to an upstanding outlet flange **27** trans-

versely aligned with the collar 26. An inlet tube or fitting 28 is brazed in the flange 26 to supply refrigerant to the duct 25. An outlet tube or fitting 29 is brazed or otherwise secured in the flange 27 and is connected by means of a tube 30 with the enlarged portion 20b of the inlet manifold duct 20. Refrigerant thus is introduced through the shelf portion 14a to the rear end of the manifold 20.

The serpentine duct 25 is formed entirely by embossments on the bottom sheet 16 and the top surface of the shelf portion 14a is thereby unobstructed. The inlet and outlet fittings 28 and 29 are equipped with upstanding leg portions which afford stops for ice trays or the like (not shown) supported on the shelf portion 14a. These upstanding legs are at the rear end of the shelf.

The back wall-defining portion or vertical leg 14b of the member 14 has the inner sheet 16 thereof embossed to define spaced parallel vertical ducts 31 as best shown in Fig. 2. The top ends of the two innermost ducts 31 are connected by a horizontal duct 32 embossed in the outer or back sheet 15 of the leg 14b. The duct 32 has an outwardly extending cylindrical flange portion 33 embossed thereon and receiving an outlet tube or fitting 34. This flange 33 is midway between the ends of the duct 32.

The lower ends of adjacent ducts 31 are connected by a pair of superimposed parallel ducts 35 embossed in the outer or rear sheet 15 of the member 14 near the bottom of the back wall 14b. The lower ducts 35 of each pair provide collecting sumps for unspent refrigerant while the flow of spent refrigerant is unimpeded through the upper ducts 35. The unspent refrigerant in the lower ducts 35 soon becomes exhausted since it is in excellent heat transfer relation with the refrigerated space surrounding the unit and, when exhausted, it is drawn upwardly into the duct 32 through the innermost ducts 31.

The top ends of the outer ducts 31 have rearwardly extending cylindrical flanges 36 receiving tubes or fittings 37 connected at their upper ends to cylindrical flanges 38 extending inwardly from the rear ends of the outlet manifold ducts 22a.

Refrigerant is thus collected from the outlet ducts 22a by the tubes 37 and flows in a serpentine path through the ducts 31 and 35 to the center of the back wall 14b. These ducts 31 and 35 provide a "drying tube" and "sumps" for the refrigerant to afford additional heat-absorbing surfaces through which the spent refrigerant from the outlet manifold 22 must pass before it reaches the exhaust tube 34.

From the above description it should be understood that the heat exchanger or evaporator unit of this invention is free from enlarged header chambers and has a drying circuit made as a part of the back wall of the unit in a member supported by the unit and also providing a shelf in the unit. The criss-crossed diagonal or sloping distributing ducts are formed by shallow embossments on the outer surfaces only of the unit but due to their intersecting grid-defining arrangement, have large capacity without at any time collecting the refrigerant in a chamber of large cross-sectional area. This arrangement maintains the refrigerant in relatively small diameter flowing columns to have increased heat exchange relationship with the walls of the unit. The elimination of headers which heretofore projected into the storage space C of U-shaped refrigerator units creates increased storage space for ice trays and the like in the units of this invention. The superimposed outlet manifold ducts 22 and 22a are connected at their front ends and the top duct is exhausted out of its rear end so that refrigerant being removed from the unit must traverse the entire length of the unit. This arrangement prevents any "short circuiting" possibilities which might produce warm or defrost areas on the unit especially at the upper front corners of the unit.

The use of shallow embossments only on the outer faces of the unit accommodates mounting the unit close to the walls of a refrigerator cabinet, thereby conserving cabinet space. The units of this invention are especially satisfactory for mounting in an upper corner of the storage space of a refrigerator cabinet.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A heat exchanger comprising contiguous secured together U-shaped metal sheets forming the bottom and side walls of a chamber, at least one of said sheets being embossed to define a longitudinal inlet manifold duct along the bottom, feeding ducts extending laterally from the manifold duct and thence upwardly into the lower ends of the side walls, oppositely sloping ducts extending upwardly from the upper ends of the feeding ducts and the oppositely sloping ducts extending from one of said feeding ducts each intersecting with a plurality of the other sloping ducts to form a grid-like pattern on the side walls, upstanding collecting ducts at the upper ends of the oppositely sloping ducts, and longitudinal outlet ducts at the upper ends of the collecting ducts, contiguous secured together L-shaped metal sheets mounted in said chamber to provide a shelf and a back wall and having a shelf duct and a back wall duct, means for introducing fluid into the shelf duct, a tube connecting said shelf duct and the inlet manifold duct, tubes connecting the longitudinal outlet ducts with the back wall duct, and an outlet tube for exhausting said back wall duct.

2. A heat exchanger comprising inner and outer contiguous metal sheets secured together along contacting faces thereof and bent into U-shape to provide the bottom and side walls of an enclosed space, said outer sheet being embossed to define a longitudinally extending inlet duct along the bottom, a plurality of spaced feeding ducts extending laterally outward from the inlet duct along the bottom and thence upwardly into the lower portions of the side walls, longitudinally extending outlet ducts in the upper ends of the side walls having a plurality of depending collecting ducts and criss cross oppositely inclined diagonal ducts in a grid-like arrangement in the side walls communicating at their lower ends with the upper ends of the feeding ducts and at their upper ends with the depending collecting ducts of said outlet ducts whereby heat exchange fluid introduced into the inlet manifold will be distributed in a plurality of individual ducts to the lower ends of the side walls of the heat exchanger and will thence flow in a multitude of criss crossed paths to the upper ends of the side walls for removal through said outlet ducts.

3. An evaporator unit for mechanical refrigerators or the like which comprises contiguous secured together embossed metal sheets bent to define a sharp freezing chamber and embossed to define a single inlet manifold duct, a plurality of feeding ducts extending in spaced relation from opposite sides of the inlet manifold duct and a plurality of oppositely inclined distributing ducts communicating with the feeding ducts and arranged in a grid-like pattern to distribute refrigerant along a labyrinth arrangement of paths each of relatively small cross sectional area to enhance heat transfer from the refrigerant to the walls of the unit, and an outlet manifold duct communicating with the upper ends of the distributing ducts.

4. An evaporator unit comprising contiguous secured-together embossed metal sheets bent into U-shape to provide bottom and side walls for defining a sharp freezing chamber, at least one of said sheets being embossed to define an inlet manifold duct extending longitudinally along the central portion of said bottom from the front to the rear of the unit, a plurality of laterally extending feeding ducts in spaced relation along the bottom of the unit and continuing around the bottom corners of the unit into the side walls of the unit, criss-crossed oppositely sloping sets of refrigerant-spreading ducts in said side walls diverging from the upper ends of the feeding ducts, spaced parallel upstanding collecting ducts at the converging upper ends of the diagonal ducts to receive refrigerant therefrom, lower longitudinally extending outlet manifold ducts receiving the upper ends of the collecting ducts and upper longitudinally extending manifold ducts spaced above said lower manifold ducts and connected therewith at the front ends of the side walls, an L-shaped member composed of embossed contiguous secured-together metal sheets in said sharp freezing chamber carried by the side walls of said unit to provide a shelf and a back wall for the unit, said shelf portion of the member having a duct for refrigerating the shelf, a refrigerant inlet connected to one end of said shelf refrigerating duct together with a refrigerant outlet at the end of the duct remote from the inlet end thereof, a tube connecting said outlet with said inlet manifold of the unit, said back wall portion of the member having refrigerant ducts therein with an outlet at the central portion thereof and with inlets at the outer end portions thereof, said back wall refrigerant ducts having bottom sump ducts between the inlets and outlet, and tubes connecting the rear ends of the upper outlet manifold ducts of the unit with the upper outer end portions of the refrigerant ducts in said back wall portion.

5. A sheet metal evaporator for mechanical refrigerators comprising a U-shaped unit having duct containing side walls and a duct containing bottom, an L-shaped duct defining member mounted in said U-shaped unit to define a horizontal shelf with a first set of ducts and a vertical back wall with a second set of ducts, means for introducing refrigerant into the first set of ducts, a tube connecting said first set of ducts with the ducts in said bottom, and tubes connecting the ducts in said side walls with the second set of ducts to dry refrigerant exhausted from the unit in said vertical back wall before the refrigerant leaves the evaporator.

6. An evaporator unit comprising a U-shaped member defining a sharp freezing space and having refrigerant-distributing ducts in the walls thereof with outlets at the upper ends of the side legs, an L-shaped member in said U-shaped unit having a horizontal leg providing a shelf in the sharp freezing space enclosed by the unit and a vertical leg depending from said horizontal leg forming a back wall for the unit, said vertical leg having ducts therein with upstanding portions connected at their lower ends by spaced superimposed horizontal ducts, and transfer tubes connecting the outlets of the ducts in the unit with the ducts in the back wall of the L-shaped member.

7. An evaporator unit comprising contiguous secured-together embossed metal sheets bent into U-shape to provide a bottom wall and side walls for defining a sharp freezing chamber, at least one of said sheets being embossed to define an inlet manifold duct extending longitudinally along the central portion of said bottom from the front to the rear of the unit, refrigerant-spreading ducts in at least one side wall, means providing communication between said refrigerant-spreading ducts and said inlet manifold duct, a longitudinally extending outlet manifold duct in at least one side wall, means providing communication between said refrigerant-spreading ducts and said outlet manifold duct, an L-shaped member composed of embossed contiguous secured-together metal sheets in said sharp freezing chamber carried by the side walls of said unit to provide a shelf and a back wall for the unit, said shelf portion of the member having a duct for refrigerating the shelf, a refrigerant inlet at one end of said shelf-refrigerating duct, a refrigerant outlet at the other end of said duct remote from the inlet end thereof, means connecting said refrigerant outlet with said inlet manifold duct of the unit, said back wall portion of the member having refrigerant ducts therein with at least one inlet and outlet, said back wall refrigerant ducts having bottom sump ducts between the inlet and outlet, and means connecting the rear end of the outlet manifold duct of the unit with the inlet of said refrigerant ducts in said back wall portion, whereby refrigerant circulates through said shelf-refrigerating duct, through said inlet manifold duct, through said refrigerant-spreading ducts in said side wall, through said outlet manifold duct, and into the refrigerant ducts in said back wall portions, through the bottom sump ducts, and through the outlet of said refrigerant ducts in said back wall portion.

8. An evaporator unit comprising contiguous secured-together embossed metal sheets bent into U-shape and having an embossed longitudinally extending duct in at least one of the upper ends of the side legs, a back wall on said unit composed of embossed secured-together metal sheets having a first duct therein with an upper inlet end adjacent said one side leg, a second duct having an upper outlet end remote from said one side leg, superimposed parallel ducts at the bottom of said back wall, one end of each parallel duct being connected with said first duct, the other end of each parallel duct being connected with said second duct, an outlet tube communicating with the outlet end of said second duct in the back wall, and a transfer tube connecting the rear end of the upper longitudinally extending duct in said one side leg of the unit with the inlet end of the first duct in said back wall.

BERNARD C. JOHNSON.

(References on following page)

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,067,208	Schweller	Jan. 12, 1937
2,136,249	Newman	Nov. 8, 1938
2,157,127	Heath	May 9, 1939
2,162,586	Newman	June 13, 1939
2,234,713	Steenstrup	Mar. 11, 1941
2,244,475	Raskin	June 3, 1941
2,349,695	Beane	May 23, 1944
2,386,613	Johnson	Oct. 9, 1945

FOREIGN PATENTS

Number	Country	Date
2,535	Great Britain	June 21, 1906