June 1, 1943. T. SCHULLSTRÖM 2,320,502

REFRIGERATION

Filed Nov. 6, 1939 2 Sheets-Sheet 1

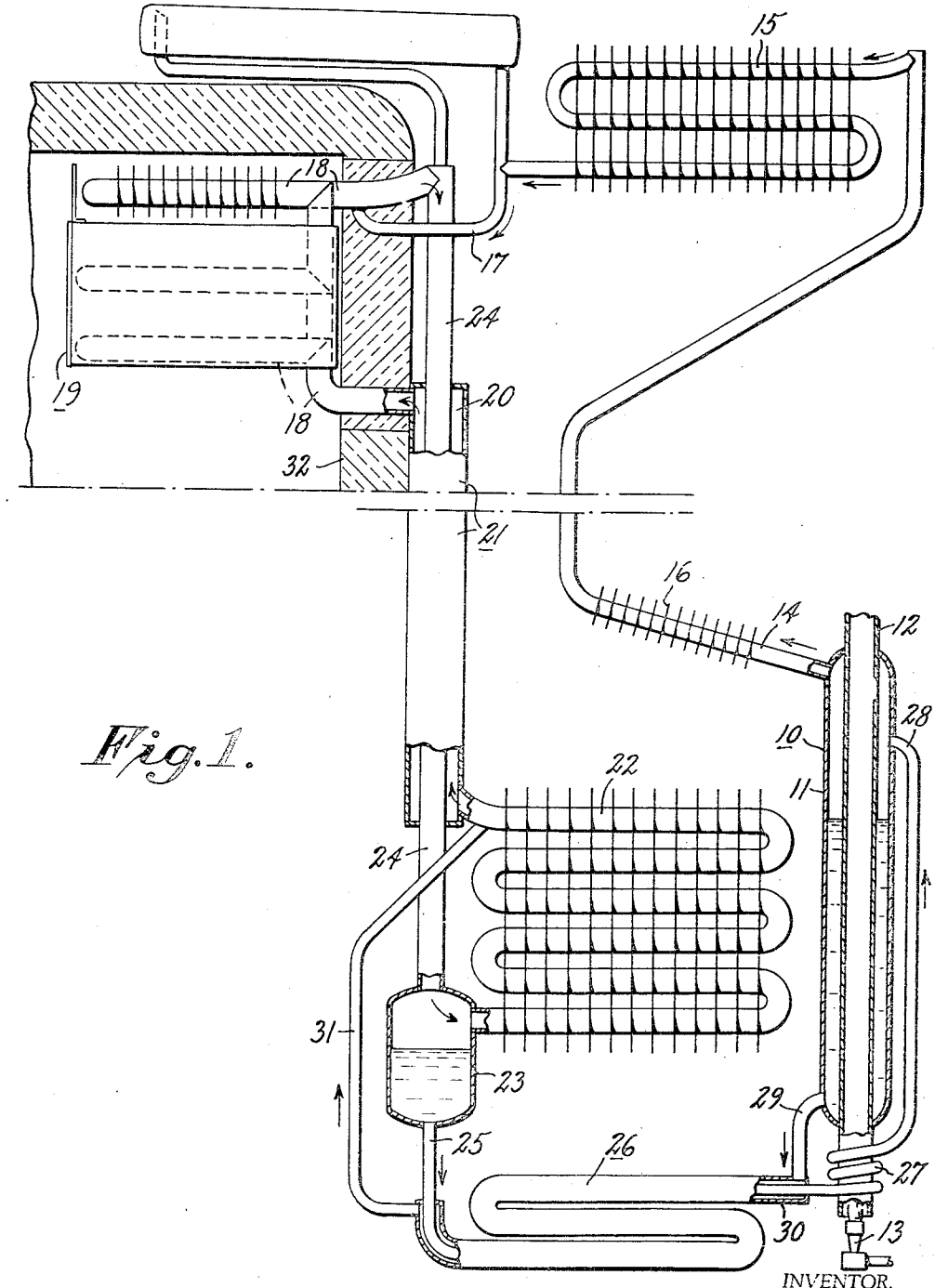


Fig. 1.

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Fig. 2.

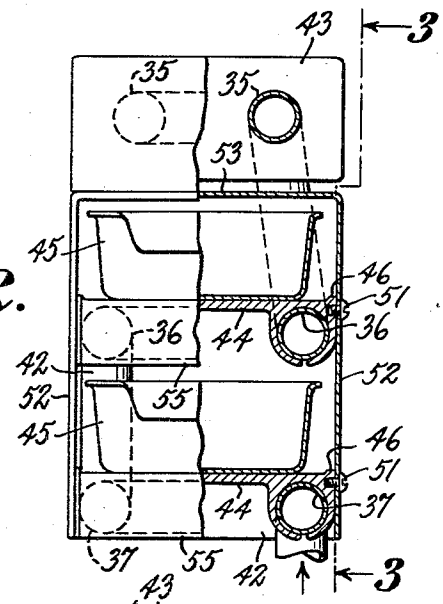


Fig. 3.

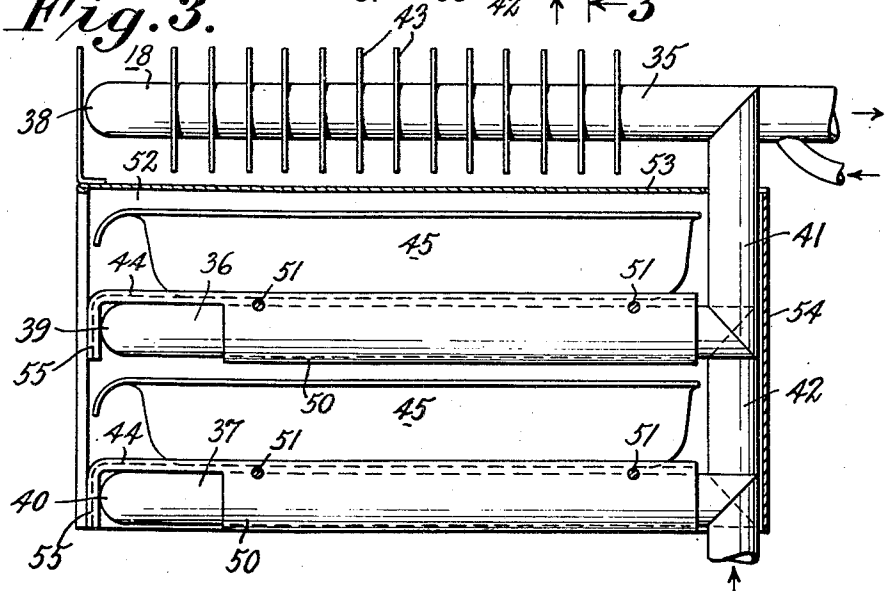


Fig. 4.

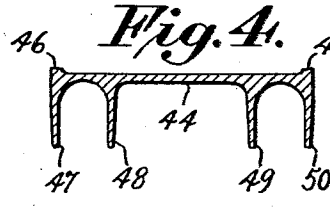
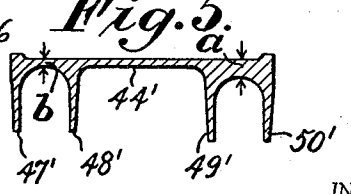


Fig. 5.



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UNITED STATES PATENT OFFICE

2,320,502

REFRIGERATION

Tage Schullström, Stockholm, Sweden, assignor, by mesne assignments, to Servel, Inc., New York, N. Y., a corporation of Delaware

Application November 6, 1939, Serial No. 302,969
In Germany November 7, 1938

4 Claims. (Cl. 62—126)

This invention relates to refrigeration, and more particularly to evaporators or cooling units for refrigeration apparatus.

It is an object of the invention to provide an improved evaporator or cooling unit which is readily fabricated and of simplified construction. This is accomplished by forming a plurality of loop sections from a conduit length, such loop sections having straight portions and connecting bends, and providing horizontal plates or members having vertically extending flanges or ribs which are bent about the straight portions of the loops to provide a good thermal conductive path between the plates or members and the conduit within which a refrigerant is circulated. The plates or members with the ribs or flanges integral therewith may be formed by extruding metal through suitable dies to facilitate the fabrication of the cooling unit or evaporator. A separate shell may be provided to secure the horizontal plates or members together and also form a housing for the cooling unit. If desired, the shell may be formed of a metal, such as steel, for example, having less heat conductivity than the plates or members which may be formed of a metal, such as aluminum, for example.

The above and other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawings, and of which:

Fig. 1 diagrammatically illustrates refrigeration apparatus provided with a cooling unit or evaporator embodying the invention;

Fig. 2 is a front elevation, partly in section, of the cooling unit shown in Fig. 1;

Fig. 3 is a vertical sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a sectional view of one of the horizontal plates or members forming a part of the cooling unit shown in Figs. 1 to 3 inclusive; and

Fig. 5 is a sectional view similar to Fig. 4 illustrating a modification of the invention.

Referring to Fig. 1 the improved cooling unit or evaporator 19 is shown in connection with refrigeration apparatus of a uniform pressure type containing a pressure equalizing gas. A system of this type includes the cooling unit 19, a generator 10, condenser 15, and an absorber 22 which are interconnected in a manner well known in the art and which will briefly be described hereinafter. The system contains a solution of refrigerant in absorption liquid, such as ammonia in water, for example, and also an auxiliary agent or inert gas, such as hydrogen.

The generator 10 includes an outer shell 11 through which extends a flue 12 which is arranged to be heated in any suitable manner, as for instance by the gas burner 13. A conduit 14 extends from the upper part of the generator to the upper end of a condenser 15. Heat transfer fins 16 are preferably secured to conduit 14 in order to provide an air-cooled rectifier.

The lower end of condenser 15 is connected by a conduit 17 with the upper end of a pipe coil 18 of the cooling unit or evaporator 19, which will presently be described in detail. The lower end of the coil 18 is connected to the upper end of an outer space 20 of a gas heat exchanger 21. The evaporator 19 is disposed within a refrigerator cabinet 32.

The upper end of an absorber 22 is connected to the lower end of space 20, while the lower end of coil 22 communicates with the upper part of a vessel 23. A conduit 24 extends from the upper end of this vessel through heat exchanger 21 and communicates with the upper end of evaporator coil 18.

A conduit 25 extends from the lower part of vessel 23 through a liquid heat exchanger 26 and communicates with the lower end of a coil 27 which is in heat exchange relation with the flue 12. The upper end of this coil is connected by a conduit 28 with the upper end of the generator 10. A conduit 29 connects the lower part of the generator with the outer member 30 of the heat exchanger 26, while a conduit 31 connects the other end of member 30 with the upper part of the absorber coil 22.

Referring more particularly to Figs. 2, 3, and 4, it will be seen that the evaporator coil 18 comprises a plurality of pairs of straight sections 35, 36, and 37. The sections of each pair are disposed in parallel relationship in the same substantially horizontal plane and are connected at their forward ends by U-shaped return bends 38, 39, and 40, respectively. One end of the uppermost pair 35 is connected to the upper end of conduit 24. The opposite end of this pair is connected by a vertical return bend 41 with one end of the intermediate pair 36, while the opposite end of this intermediate pair is connected to the lowermost pair 37 by a vertical return bend 42. The opposite end of the lowermost pair 37 is connected to the chamber 20 of the gas heat exchanger 21.

As shown, heat transfer fins 43 are secured to the sections 35 forming the uppermost pair and serve to transfer heat from the air within the refrigerator cabinet 32.

Secured to each of the intermediate and low-

ermost pairs 36 and 37 are similar horizontally disposed plate members 44 which form shelves adapted to receive ice trays 45. The upper surface of each plate 44 may be formed with an upwardly extending ridge 46 adjacent to each side edge of the plate. Extending downwardly from the plate 44 are flanges or ribs 47, 48, 49 and 50. The flanges or ribs 47 and 48 form a groove or channel adjacent to one side edge of the plate, while the flanges or ribs 49 and 50 form a similar groove or channel adjacent to the other side edge. These plates may be made by extruding metal through a properly shaped die to facilitate the fabrication of the cooling unit, and, as originally formed, the flanges or ribs 47, 48, 49 and 50 are straight, as shown in Fig. 4 and extend the entire length of the plate. The grooves or channels formed between these flanges or ribs are of proper dimension to receive the straight sections of the evaporator coil 18. The flanges are cut off from the forward end of the plate back to the point shown in Fig. 3, whereby the ribs or flanges extend along the straight portions of the horizontally disposed U-shaped loops and the U-bends 39 and 40 at the front of the loops underlie the forward parts of the plates or members 44. After the plates have been placed on the coil with the straight sections received in these channels, the flanges are deformed by a suitable tool so as to closely embrace the pipe, as is shown in Fig. 2. The flanges or ribs are of such length in a vertical direction that, when they are deformed in the manner above described, they substantially completely surround the pipe.

In order to obtain a suitable contact between the flanges and the coil, in order to obtain good heat transfer therebetween, it is preferable that the material of which the pipe is made have a higher coefficient of elasticity than that of the material of the flanges. When the pipe is made of iron and the plates and flanges are made of aluminum and the flanges are deformed from the shape shown in Fig. 4 to that shown in Fig. 2, for example, the pipe may also be deformed slightly. However, when the deforming force is relieved, the pipe will have a greater tendency to spring back to its original shape than will the flanges. In other words, the pipe is expanded within the channel, this producing excellent contact with the flanges.

The forward ends of the plates may be bent downwardly to form transverse flanges 55 in front of the U-bends 39 and 40 and thus serve to conceal the pipe coil when the cooling unit is viewed from the front.

Secured to the side edges of the plates 44 by any suitable means, such as the bolts 51 engaging tapped holes in the plate, are spaced walls 52 and a top wall 53 which connects the upper ends of the opposite side walls 52, as shown most clearly in Fig. 2. A rear wall 54 is also provided and is connected to the top and side walls. The walls 52, 53 and 54 together with the lowermost plate 44 provide an enclosing shell or housing about the sections 36 and 37 which is open at the front for the reception and removal of ice trays. The walls 52, 53, and 54 may be formed of a material having lower heat conductive properties than the plates 44.

The ridges 46 not only provide more material in the regions of the tapped holes for receiving the bolts 51, but they also serve to prevent liquid, which may have been spilled from the ice trays 45, from running down between the plates 44 and the side walls 52. If such liquid found its way between the plates and the walls it would freeze and the resulting expansion would be apt to deform the side walls.

The operation of the above described apparatus is as follows: The generator 10 is filled up to about the level indicated with a solution of refrigerant, such as ammonia, dissolved in an absorbent, such as water. The application of heat to this solution causes expulsion of refrigerant vapor therefrom which flows through the conduit 14 to the upper end of the condenser 15. The refrigerant vapor is liquefied in the condenser 14 and flows through the conduit 17 to the upper end of the pipe coil 18 of the evaporator. Inert gas weak in refrigerant flows into the lower end of the coil 18 from the space 20 of the heat exchanger 21. The liquid and gas are in counterflow and liquid evaporates and diffuses into the gas with consequent absorption of heat from the cooling unit 19 and its surroundings. The rich gas mixture of the refrigerant and inert gas formed in the evaporator 19 flows out through the upper end of the coil 18 into the conduit 24, from whence it passes through the upper part of the vessel 23 to the lower end of the absorber 22.

In the absorber 22 the rich gas mixture is brought into intimate contact with absorption liquid weak in refrigerant and which is introduced into the upper part of the absorber through the conduit 31. The absorption liquid absorbs refrigerant from the inert gas and the latter flows from the absorber 22 through space 20 of gas heat exchanger 21 to the lower end of the evaporator coil 18.

The rich absorption solution formed in the absorber 22 flows therefrom into the vessel 23 and thence through the conduit 25 to the lower end of the coil 27. The application of heat to this coil raises liquid through the conduit 28 by thermosiphon action to the upper part of the generator 10. Within the generator further heat is supplied to the solution which results in expulsion of refrigerant vapor from solution, as previously explained. Absorption solution weak in refrigerant flows by gravity through the conduits 29, 30 and 31 to the upper part of the absorber coil 22.

Due to the evaporation of liquid refrigerant which takes place within the evaporator coil 18, the temperature of the fins 43 is reduced with the result that heat flows to these fins from the air within the refrigerator cabinet 32 and consequently the interior of the cabinet is cooled. Likewise, heat flows from the contents of trays 45 through the plates 44 and flanges thereon to the sections 36 and 37. Since the flanges or ribs are in good heat transfer relation with these sections, the flow of heat is rapid. Further, since the walls 52, 53 and 54 may be made of material having a comparatively low coefficient of heat conduction, the flow of heat from the air within the cabinet to the ice trays may be greatly reduced and rapid freezing of the contents of the trays obtained.

In Fig. 5 is illustrated a plate 44' similar to that shown in Fig. 4, with the exception that the flanges 49' and 50' on one side are longer than the flanges 47' and 48' on the other side and the thickness a of the material between the bottom of the channel formed by the flanges 49' and 50' and the upper surface of the plate is greater than the thickness b at the opposite side of the plate. With this arrangement it is possible to use such plates with pipe coils in which the straight sections of each pair are at slightly

different elevations, whereby the connecting U-bends are slightly inclined. Thus, the upper surface of the plate 44' will be level, although the supporting pipe sections are not in exactly the same horizontal plane.

If desired, the bent ribs or flanges wrapped about the pipe sections may be galvanized or tinned, or an aluminum paste may be employed to fill any spaces which may result when these parts are secured together. The enclosing housing may be formed of iron or steel, or of a suitable synthetic plastic material.

Due to the fact that the pipe sections to which the plates 44 are secured are located underneath the plates, practically the entire upper surface of each plate is available for receiving an ice tray. In other words, it is not necessary that the ice trays fit between the straight sections of each pair. Hence, either wider ice trays or a narrower evaporator may be used with the invention than is possible where the coil sections are above the plates. As pointed out above, the particular shape of these plates makes it possible to manufacture them by an extrusion process.

While I have shown and described several embodiments of the invention, such variations and modifications are contemplated as fall within the true spirit and scope of the invention, as pointed out in the following claims.

What is claimed is:

1. A cooling unit or evaporator including a pipe having a plurality of vertically spaced pairs of substantially straight parallel horizontally extending sections, the sections of each pair being connected together at their forward ends by return bends disposed in different substantially horizontal planes and adjacent pairs being connected by return bends disposed in substantially vertical planes, plate members supported on said pairs of sections and provided with vertically extending flanges or ribs along the sides thereof, said flanges or ribs being formed to embrace said straight sections to provide for heat transfer therebetween, and a lip extending downwardly at the forward end of each plate in front of the horizontal return bends.

2. A cooling unit or evaporator comprising a looped coil provided with a plurality of U-shaped loops disposed one above the other, each of said loops including a closed end and straight pipe sections extending therefrom in spaced relation, the straight pipe sections of each loop being in or approximately in a horizontal plane, metal plates connecting the straight pipe sections of each U-shaped loop to provide a plurality of supporting surfaces upon which may be placed matter to be frozen, said plates being formed of good thermal conductive material, the undersides of said plates being formed with pairs of downwardly depending flanges or ribs, said pairs of flanges being spaced apart a distance corresponding to the spacing of the straight pipe sections of each U-shaped loop, the flanges or ribs of each pair being spaced apart a distance adjusted to the circumference of each of the straight pipe sections, said flanges or ribs being bent about said straight pipe sections, the portions of said plates above said flanges or ribs constituting parts of said supporting surfaces, and an inverted U-shaped shell having the closed end serving as the top and the spaced apart sides serving as the sidewalls of the unit, said plates serving as shelves extending between said sidewalls.

3. A cooling unit or evaporator comprising a looped coil provided with a U-shaped loop having a closed end at the front of the unit and parallel arms extending rearwardly from such closed end, said parallel arms being in or approximately in a horizontal plane, a metal plate connecting said parallel arms to provide a supporting surface upon which may be placed matter to be frozen, said plate being formed of good thermal conductive material, the underside of said plate being formed with pairs of downwardly depending flanges or ribs, said pairs of flanges being spaced apart a distance corresponding to the spacing of said parallel arms, the flanges or ribs of each pair being spaced apart a distance adjusted to the circumference of each of the parallel arms of said U-shaped loop, said flanges or ribs being bent about said parallel arms, the portions of said plate above said flanges or ribs constituting parts of said supporting surface, and a lip extending downwardly at the forward end of said plate in front of the closed end of said U-shaped loop.

4. A cooling unit or evaporator comprising a shell providing a freezing enclosure, said shell having spaced apart side walls and horizontally disposed parts extending between said side walls, the major portion of each of said parts providing a smooth supporting surface upon which may be placed matter to be frozen, a looped coil having a plurality of loops disposed one above the other, each loop having spaced apart arms or straight portions in or approximately in a horizontal plane, horizontal bends at one end of said shell connecting the spaced apart arms of said loops, vertical bends at the other end of said shell connecting the vertically spaced arms of adjacent loops disposed one above the other, and channels extending from the front to the rear of said shell at regions adjacent to and within said side walls, said channels having spaced apart sides to receive and embrace the straight portions of said looped coil, said channels being formed on one or more of said horizontally disposed parts by a plurality of ribs formed integrally therewith, two of said ribs extending downwardly from one side edge of said horizontally disposed part at a region adjacent to and along one of said side walls and two other ribs extending downwardly from the opposite edge of said part at a region adjacent to and along said other side wall, said horizontally disposed part having channels formed by said ribs being so constructed and arranged that said part can be mounted on the spaced apart straight portions of a loop of said coil with said ribs at each edge of said part spaced a distance sufficient for said straight portions to pass into the channels formed by said ribs, and, after said straight portions are in said channels, said ribs can be bent about said straight portions to embrace the latter.

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