Jan. 15, 1935. J. R. REPLOGLE 1,987,707

FREEZING COIL

Filed Oct. 12, 1931 2 Sheets-Sheet 1

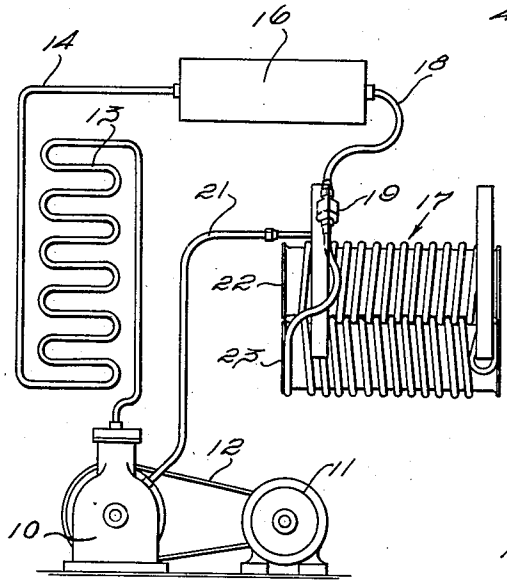


Fig. 1.

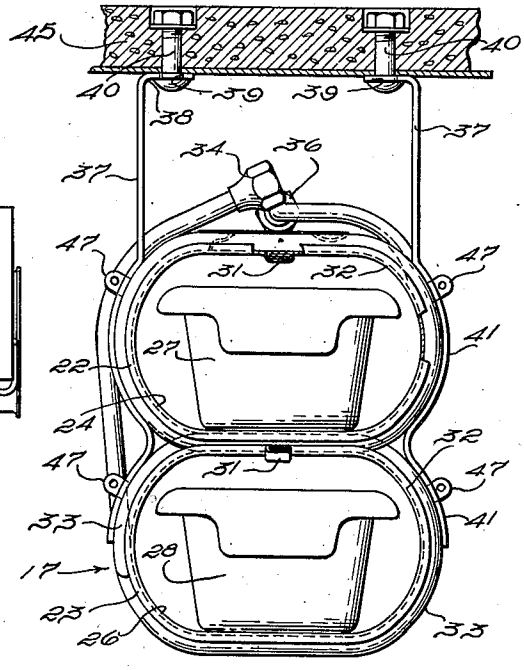


Fig. 2.

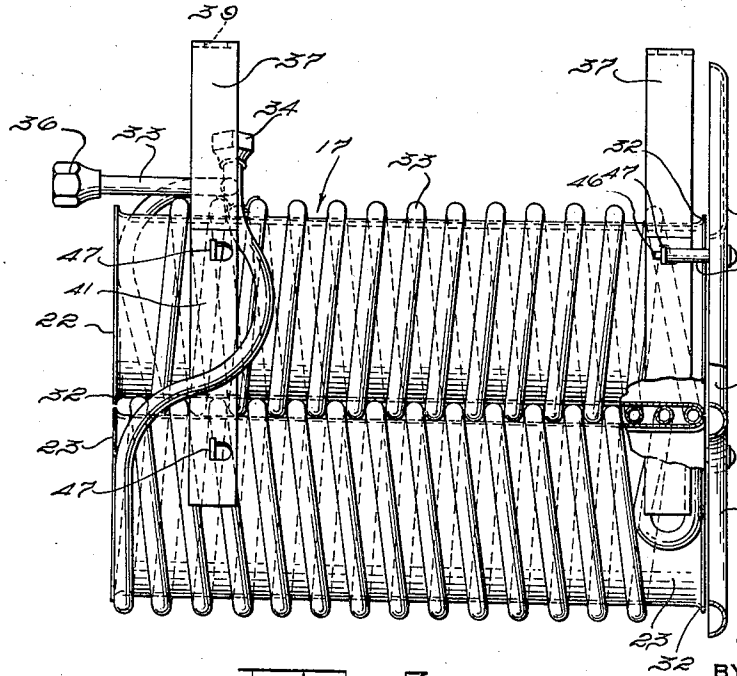


Fig. 3.

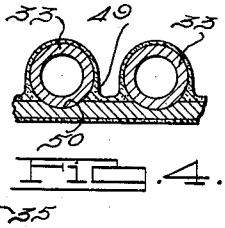


Fig. 4.

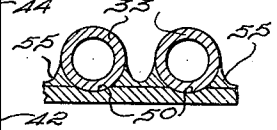


Fig. 5.

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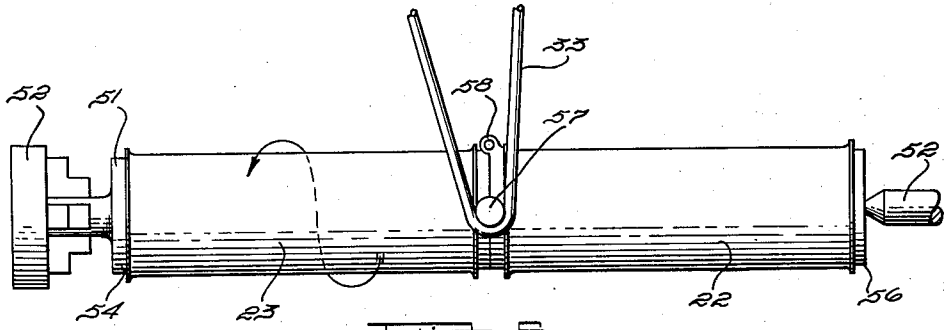


Fig. 6.

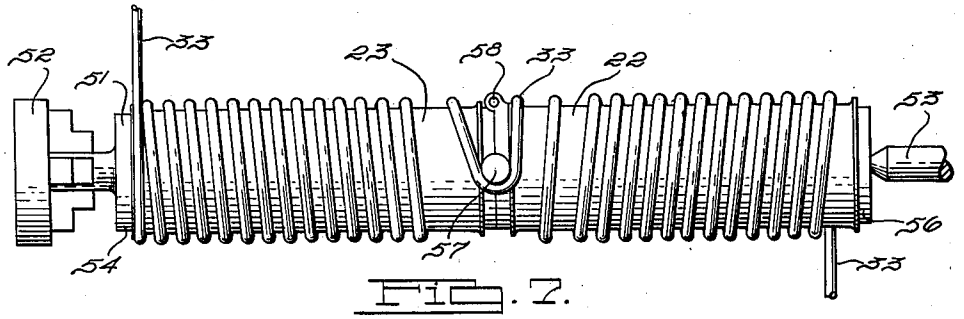


Fig. 7.

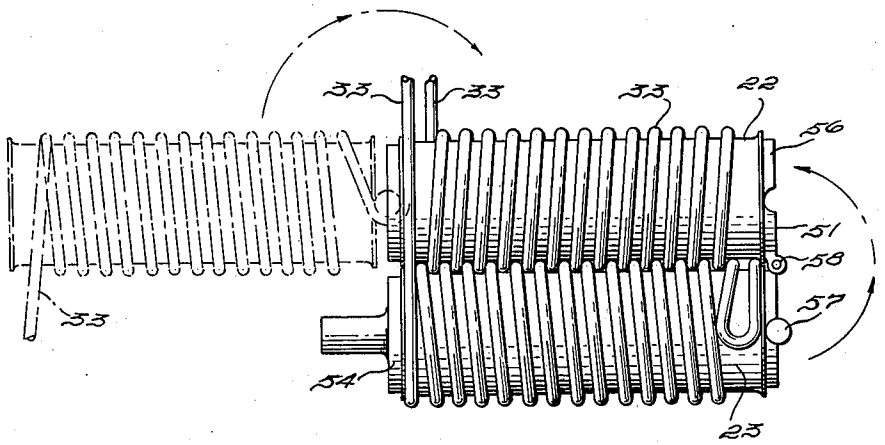


Fig. 8.

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UNITED STATES PATENT OFFICE

1,987,707

FREEZING COIL

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Application October 12, 1931, Serial No. 568,269

6 Claims. (Cl. 62—126)

This invention relates to refrigerating apparatus and has particular relation to a novel freezing coil or refrigerant evaporating unit employed in such apparatus and to a novel method of manufacturing such product.

An object of the invention is to provide an inexpensive and efficient refrigerant evaporating coil which can be manufactured in sections capable of being employed in multiple to construct evaporating units of varying size or capacity and which does not require the employment of expensive machinery in its manufacture.

Another object of the invention is to provide a refrigerant evaporating unit which can be manufactured almost entirely out of metallic shells and tubes now commonly used in the manufacture of refrigerating apparatus, thereby eliminating the necessity for expensive tanks and other complicated structural elements which have been heretofore required in the construction of such apparatus.

Another object of the invention is to provide a refrigerant evaporating unit composed of a plurality of separately constructed sections or elements which when assembled into an operative unit are capable of transferring heat from one to another in order to rapidly reduce the temperature in any particular part of the structure in which a refrigerating load may be concentrated.

Another object of the invention is to provide a novel method of constructing evaporating units of shells and tubes and of forming a good thermal contact between such shells and tubes by the operation by which the evaporating unit is finished or coated with material to impart thereto a pleasing and sanitary appearance.

The invention comprises generally a refrigerant evaporating unit consisting of one or more sleeves around which a ductible metallic conduit is wound. In a unit embracing a plurality of sleeves the conduit is wound first around one and then another in such manner that when the sleeves are disposed in parallel relation and brought together, the convolutions of conduits on one sleeve will be interposed between the convolutions of conduit on the other thus permitting the convolutions of conduit on one sleeve to be in thermal contact not only with the sleeve on which it is wound but with the adjacent sleeve. The sleeves are so wound on rotatable mandrels that a plurality of these refrigerating elements can be constructed with a single continuous conduit. When completely assembled the unit is covered with a coating of material having relatively high heat conductive properties to provide good thermal contact between the conduits and sleeves and to render the units pleasing in appearance.

For a better understanding of the invention reference may be had to the accompanying drawings forming a part of the specification, in which:

Figure 1 is a diagrammatical illustration of a conventional refrigerating system in which is employed an evaporating unit embracing the principles of this invention.

Fig. 2 is an end elevational view of the refrigerant evaporating unit employed in the refrigerating system disclosed by Fig. 1.

Fig. 3 is an enlarged side elevational view of the refrigerant evaporating unit illustrated by Figs. 1 and 2 in which portions of the structure are broken away in order to more clearly indicate its construction.

Figs. 4 and 5 are fragmentary sectional views of the evaporating unit illustrating different finishing coatings applied to the surfaces thereof.

Figs. 6, 7 and 8 are views illustrating a preferred method of constructing the refrigerant evaporating unit disclosed in the preceding figures and certain apparatus employed in the practice of such methods.

Referring particularly to Fig. 1 of the drawings, the refrigerating system disclosed therein comprises a compressor 10, driven by a motor 11 through an arrangement of pulleys and belts 12, which discharges compressed refrigerant having a corresponding temperature greater than the temperature of the surrounding atmosphere into a refrigerant condenser 13. In the condenser the heat of vaporization is dissipated from the fluid and it proceeds therefrom in a liquid state through a conduit 14 into a refrigerant receiver 16 from which it is supplied to a refrigerant evaporating unit 17 through a conduit 18 and an expansion valve 19 according to the refrigeration load which is placed upon the system. Expansion valve 19 provides for a reduction in the pressure of the fluid discharged into the evaporating unit and it is exhausted therefrom in the form of a vapor to the low side of the compressor 10 through a conduit 21.

The evaporating unit or freezing coil 17, as illustrated more particularly by Figs. 2 and 3, comprises a pair of metallic sleeves or shells 22 and 23 forming freezing compartments 24 and 26 in which freezing trays 27 and 28 are respectively inserted. Each of the sleeves 22 and 23 consist of a sheet of metal which is formed on an oval-shape mandrel or in any other suitable manner and provided with telescoping flanges at the edges forming a seam as indicated at 31. At the oppo-

site extremities of the sleeves the edges thereof are flared outwardly slightly as indicated at 32 to give the structure a better appearance and to facilitate the insertion of ice trays therein and the winding of conduit thereon. Each of the sleeves has spirally or helically wound thereon a section of a refrigerant evaporating conduit or tube 33, each convolution of said conduit on one sleeve being interposed between convolutions of said conduit on the other sleeve and hence the adjacent portions of each sleeve contact with sections of conduit wound on both sleeves. The opposite extremities of the conduit terminate in a region above the unit and are there provided with couplings indicated at 34 and 36 for attachment to the expansion valve 19 and the suction line 21 respectively.

Hangers or brackets 37 are secured in pairs to the side of the evaporating unit, the upper extremity of each bracket 37 being bent as indicated at 38 and provided with an opening indicated at 39 for attachment by bolts or other suitable fastening devices 40 to the interior surface of an upper wall of a refrigerator 45. The lower portions of the hangers 37 contacting with the evaporating unit 17 are provided with curved portions indicated at 41 which follow the contour of the conduit surrounding the sleeve in order to render the hangers easily attachable to the unit and to generally improve their appearance. Such lower curved portions of the hangers extend from one of the sleeves to another and thus serve to rigidly secure the elements of the structure together.

In order to improve the appearance of the unit a baffle 35, having openings 42 and 43 therein to render the sleeves 22 and 23 accessible, is employed on the front of the unit and extends from adjacent the top of the refrigerator to a short distance beneath the lower extremity of the evaporating unit. This baffle is secured to the evaporator by suitable studs indicated at 44, the extremities of which are threaded at 46 to engage threaded openings formed in cut-out lugs 47 projecting outwardly from the hangers 37.

In an evaporating unit of this design numerous materials and finishes may be employed, depending upon the service to be rendered by the refrigerator or as a matter of preference. For example the sleeves 22 and 23 may if desired be constructed of sheet copper material and the conduits 33 of copper tubing in which event the conduit may be soldered to the sleeves or the entire unit may be dipped in tin or solder. Or, the sleeves may be made of sheet iron or steel and the tubes or conduit of copper or vice versa and the finishing operation performed as above. The conduits may be wound directly on a surface of the sleeves or a spiral groove may be either turned, spun or otherwise formed in the outer surface, as indicated at 50 in Figs. 4 and 5, to receive the conduit. In the event a groove is formed in the outer surface of the sleeve in either of the ways mentioned above it will be somewhat easier to wind the conduit on the sleeve or sleeves and it may be possible to obtain a better thermal contact between the different elements.

In such construction wherein either copper or steel is employed for the conduits or sleeves and the unit is finished by dipping in solder or tin the solder or tin will form a thin coating over the entire surface of the structure except in the region just outside the thermally contacting surfaces between the conduit and sleeve where a relatively large quantity of solder or tin will collect, as indicated at 55, which will materially increase the amount of metal through which heat absorbed by the evaporating unit may flow through the sleeve and conduit into the refrigerant contained in the latter.

The evaporating unit may also be constructed of steel sleeves and steel conduit in which event the conduit may be either brazed to the sleeves in a well known manner or the entire structure may be coated with vitreous enamel as indicated at 49 in Fig. 4. In order to provide a nice finish for the unit several coats of enamel may be employed to provide a relatively thick coating for the unit which will hold the tubes and sleeves securely together.

In case it is desired to enamel the assembly as above described, it is preferable that the coil be so rigidly associated with the sleeve as to prevent any possible relative movement of working of the two parts in order that rupture of the enamel will be guarded against. One effective means for so rigidly associating the parts is to spot weld each turn of the coil at several places to the sleeve, and where the sleeve is rectangular in section rather than oval as shown, the spot welds should be made on each face of the sleeve for each turn of the coil.

In the construction of the evaporating unit heretofore described any suitable means for rotating the sleeves 22 and 23 may be employed. For example, a mandrel 51 may be mounted between the head stock 52 and the tail stock 53 of a lathe (not shown) and by the operation of the lathe the mandrel 51 is rotated in the direction indicated by the arrow in Fig. 6.

The mandrel 51 in this instance comprises a pair of sections 54 and 56 having a hinge 58 at the adjacent edges thereof by means of which the sections of the mandrel may be brought into parallel rather than aligned relation. The mandrel 51 also embraces an outwardly extending pin or lug 57 for holding the conduit 33 during the winding operation and against which the inner end of the sleeves 22 and 23 abut when the sleeves are placed on the mandrel.

In the winding operation the sleeves 22 and 23 are first disposed on the mandrel 51 in a position abutting the pin 57 and the tube 33 is bent midway between its opposite ends in order to provide two sections disposed at a slight angle to each other and the bent portion between the two sections is fastened over the pin 57. The mandrel 51 is then rotated in such manner as to wind the sections and tubes 33 upon the sleeves 22 and 23 either in grooves formed in the surfaces of the sleeves or by employing suitable guiding apparatus (not shown) to wind the sections of the tube along the mandrel in the desired relation.

After the conduit is thus wound upon the mandrel the latter is removed from the rotating mechanism and the loop end of the conduit is removed from the pin 57, after which by operating the hinge 58, one section of the mandrel is brought into parallel relation with the other. Inasmuch as the conduit sections are wound upon the sleeves 22 and 23 in opposite directions from a central starting point, when the mandrels are brought together as previously indicated the adjacent portions of the convolutions of the conduits on each of the sleeves will have the same angular position and consequently can be made to lie in parallel relation in contact with both of the sleeves. The mandrel 51 is then removed from the sleeves 22

and 23 and the hangers 37 are fastened to the unit by soldering or other suitable means.

Coating material is then applied to the unit or any suitable means is employed for providing a good thermal contact between the conduit and the sleeve and for securing all of the elements of the structure together to form a rigid unit.

In the event it is desired to construct an evaporating unit embracing three or more freezing compartments rather than two as illustrated, this may be done simply by first constructing a unit embracing a pair of sleeves as hereinbefore described but employing a single length of conduit long enough for three sleeves. Instead of the conduit being bent in the middle to form two sections of equal length as is done when constructing a unit comprising two freezing compartments, the conduit is provided with a bend in a region where one third of the conduit will be on one side of the bend and two thirds on the other. This conduit is then employed as heretofore described in constructing a unit embracing a pair of sleeves but when such unit is completed a section of conduit sufficient to wrap another sleeve is left over.

One end of the mandrel 51 is then inserted in the sleeve from which this section of conduit extends and another sleeve is placed on the other end of the mandrel as is indicated in dotted lines in Fig. 8. The conduit is then wrapped around the pin 57 and wound around the third sleeve by rotating the mandrel and the triple sleeve unit now supported thereon. When this operation is completed the loop end of the tube then may be removed from the pin 57 and a section of the mandrel supporting the third sleeve may be bent upon its hinge in such manner that the third sleeve will assume a position parallel to and in thermal contact with the sleeve in which the opposite end of the mandrel is inserted. In this manner any number of sleeves may be added to the structure in order to provide a refrigerant evaporating unit having the desired number of freezing compartments.

The evaporating unit herein disclosed may be employed in a refrigerator either for the purpose of cooling the circulating air therein or for freezing trays of water inserted in the freezing compartment thereof or for both purposes.

When the evaporating unit is employed for cooling the air in the interior of the refrigerator the warm air comes in contact principally with the outside surfaces of the unit and particularly with the tubes surrounding the sleeves embraced therein. This contact with air tends to increase the temperature of the parts of the unit thus evaporating the refrigerant liquid admitted by the expansion valve.

The construction of the unit is such that not all of the refrigerant admitted by the expansion valve will be evaporated in any particular region of the evaporating unit whose temperature happens to be somewhat greater than the vaporization temperature of the liquid. Some of such liquid will be evaporated in this region and the remainder will continue to travel in the conduit toward the suction line end thereof.

Inasmuch as the present evaporating unit embraces a conduit having coil sections or convolutions it is apparent that the moving cloud of liquid particles introduced by the expansion valve will return in many instances several times to a region of the evaporating unit where heat is being absorbed. In this way heat will continue to be extracted from the air, or from any other source of heat, as the liquid particles continue their movement throughout the conduit.

When the rate of heat transfer in the evaporating unit becomes so low that the liquid particles introduced by the expansion valve are not all vaporized prior to their arrival at the end of the conduit employed in the evaporating unit, a control apparatus (not shown) will discontinue the operation of the condensing unit until the temperature of the refrigerator increases to some predetermined maximum value when the condensing unit again will be placed in operation by the control.

If a warm tray of water for example, or other warm substance which it is desired to cool or freeze, is inserted in the freezing compartment 24 for example, it is apparent that a considerable amount of heat will be immediately transferred to the section of evaporating conduit surrounding such compartment and particularly to the parallel portions of each convolution of said conduit which lie directly beneath the tray and which are in direct thermal contact therewith through a portion of the sleeve of the freezing compartment on which the tray is supported.

Inasmuch as the conduit section surrounding the compartment 26 comprises a plurality of parallel portions which also are in direct thermal contact with the compartment 24 the warm substance in the tray will be employed in warming the entire conduit rather than just that portion surrounding the tray.

Under such circumstances the refrigerant liquid introduced by the expansion valve will be evaporated at a relatively high rate throughout the entire conduit and it will be a considerable period of time before the rate of heat transfer is reduced to such extent that any refrigerant liquid will flow therebeyond to affect the control apparatus. Hence the particles of liquid introduced by the expansion valve will continue to be vaporized at the relatively high rate in all sections of the conduit in which event a considerably greater period will elapse prior to the operation of the control apparatus. In this way it is possible to practically double the period of operation of the condensing unit when a warm tray of water or other substance is desired to be frozen or cooled and to greatly reduce the time required for freezing or cooling such substances.

It is to be understood that the structure herein disclosed is set forth merely for the purpose of illustrating the invention and hence is not to be considered in a limiting sense, but many modifications and changes may be made in both the structure and its construction within the spirit of the invention and the scope of the appended claims.

I claim:

1. A refrigerating system comprising a heat insulated cabinet, a metallic shell secured within said cabinet in contact both interiorly and exteriorly with the air contained within said cabinet, a continuous metallic conduit disposed upon one surface of the shell throughout substantially the entire extent thereof and a unitary vitreous enamel coating on both said conduit and sleeve for covering the exposed surfaces thereof and for providing a thermally conductive bond between the adjacent surfaces of the conduit and sleeve.

2. A refrigerating system comprising an insulated cabinet, a refrigerant evaporating unit disposed within said cabinet, said evaporating unit having a plurality of cut out lugs projecting from the surface thereof, a baffle for said evaporating

unit and means for rigidly securing said baffle to said cut out lugs.

3. A refrigerating unit comprising a heat insulated cabinet having a plurality of metallic shells disposed in spaced relation therein in contact both interiorly and exteriorly with the circulating air within said cabinet, a refrigerant evaporating conduit having a plurality of sections, each of said sections being spirally wound upon the exterior surface of a different one of said shells, and each of said sections having parallel portions in thermal contact with a plurality of said shells, and means for circulating a refrigerating fluid within said conduit.

4. A refrigerant evaporator including a pair of superimposed parallel shells, a refrigerant conduit in the form of a thread wound about each of said shells, the lower portion of the upper of said conduits and the upper portion of the lower of said conduits contacting both the bottom of the upper of said shells and the top of the lower of said shells.

5. A refrigerant evaporator including a pair of superimposed parallel shells, a refrigerant conduit section on each of said shells, each of said conduit sections including a double thread of tubing, the hand of the thread of one section being opposite to the hand of the thread of the other section, and the upper part of one of said sections and the lower part of the other of said sections contacting both said sleeves.

6. A refrigerant evaporator including a pair of superimposed parallel shells, a refrigerant conduit section on each of said shells, each of said conduit sections including a double thread of tubing, the hand of the thread of one section being opposite to the hand of the thread of the other section, adjacent ends of said tubing in one of said sections being interconnected for direct flow of refrigerant between them and the opposite ends being connected to adjacent ends of the tubing of the other of said sections, and means for introducing refrigerant into the opposite end of one of the tubes of said other of said sections and exhausting refrigerant from the corresponding end of the other of said tubes of said other of said sections.

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