June 6, 1939. P. W. DES ROCHES 2,161,667

REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 1

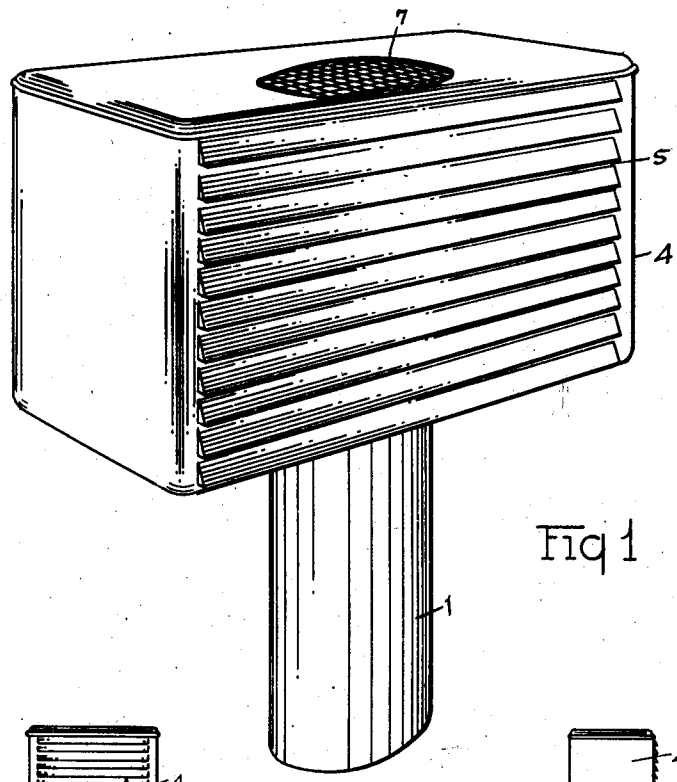


Fig 1

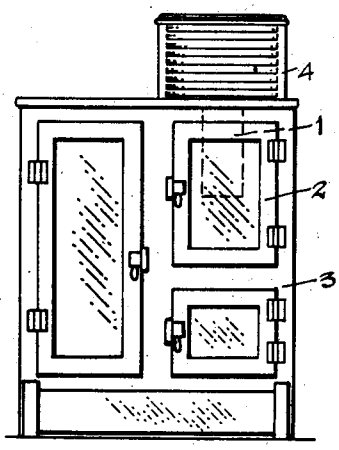


Fig 2

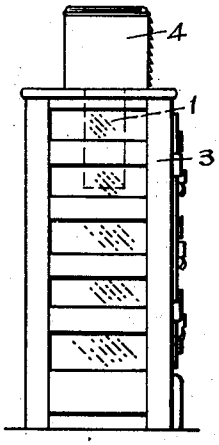


Fig 3

Inventor

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Attorney

June 6, 1939. P. W. DES ROCHES 2,161,667

REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 2

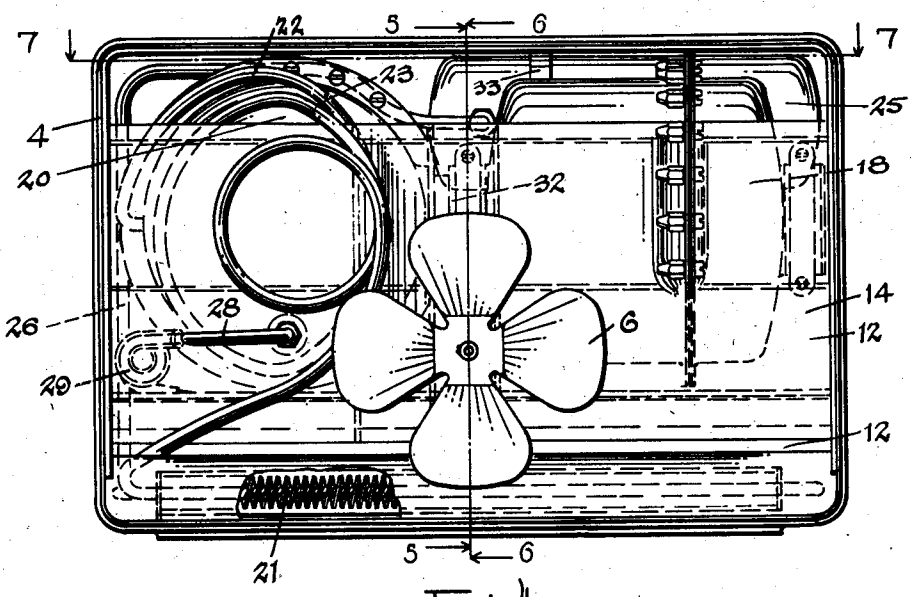


Fig 4

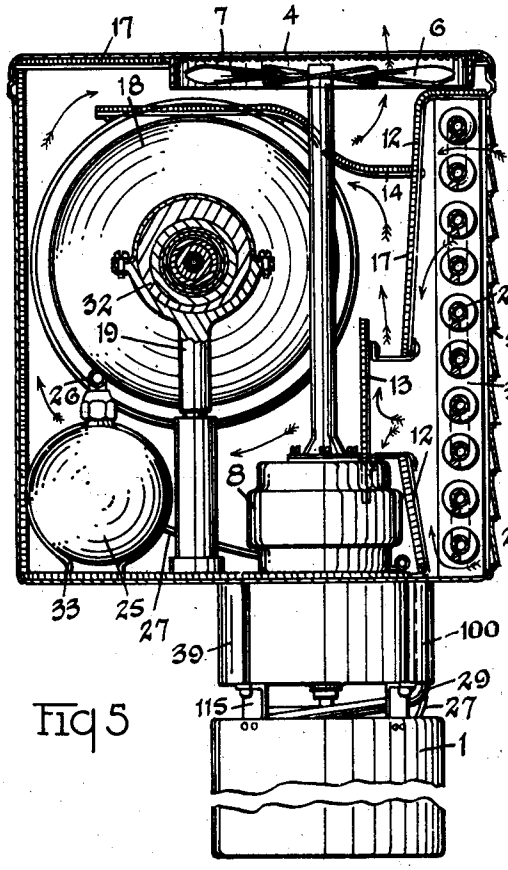


Fig 5

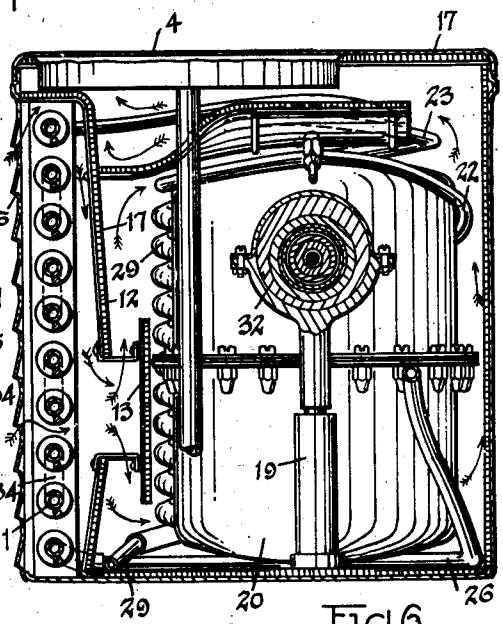


Fig 6

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June 6, 1939. P. W. DES ROCHES 2,161,667

REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 3

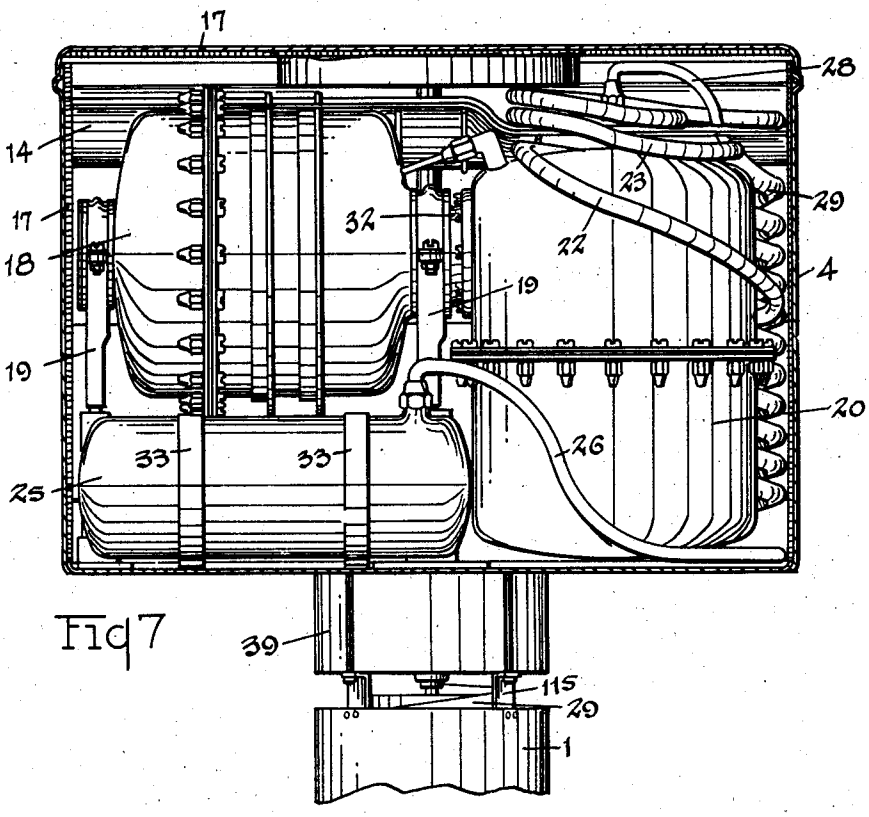


Fig 7

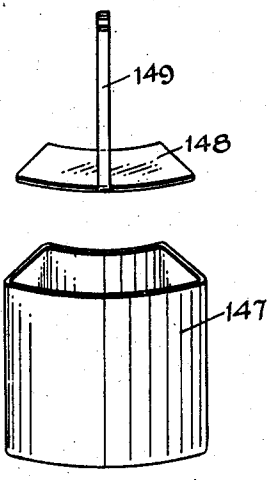


Fig 8

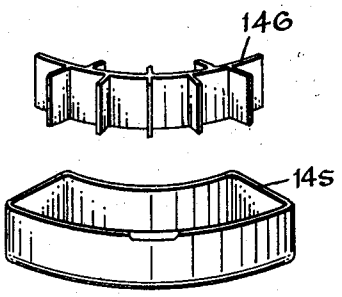


Fig 9

Inventor

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REFRIGERATING UNIT

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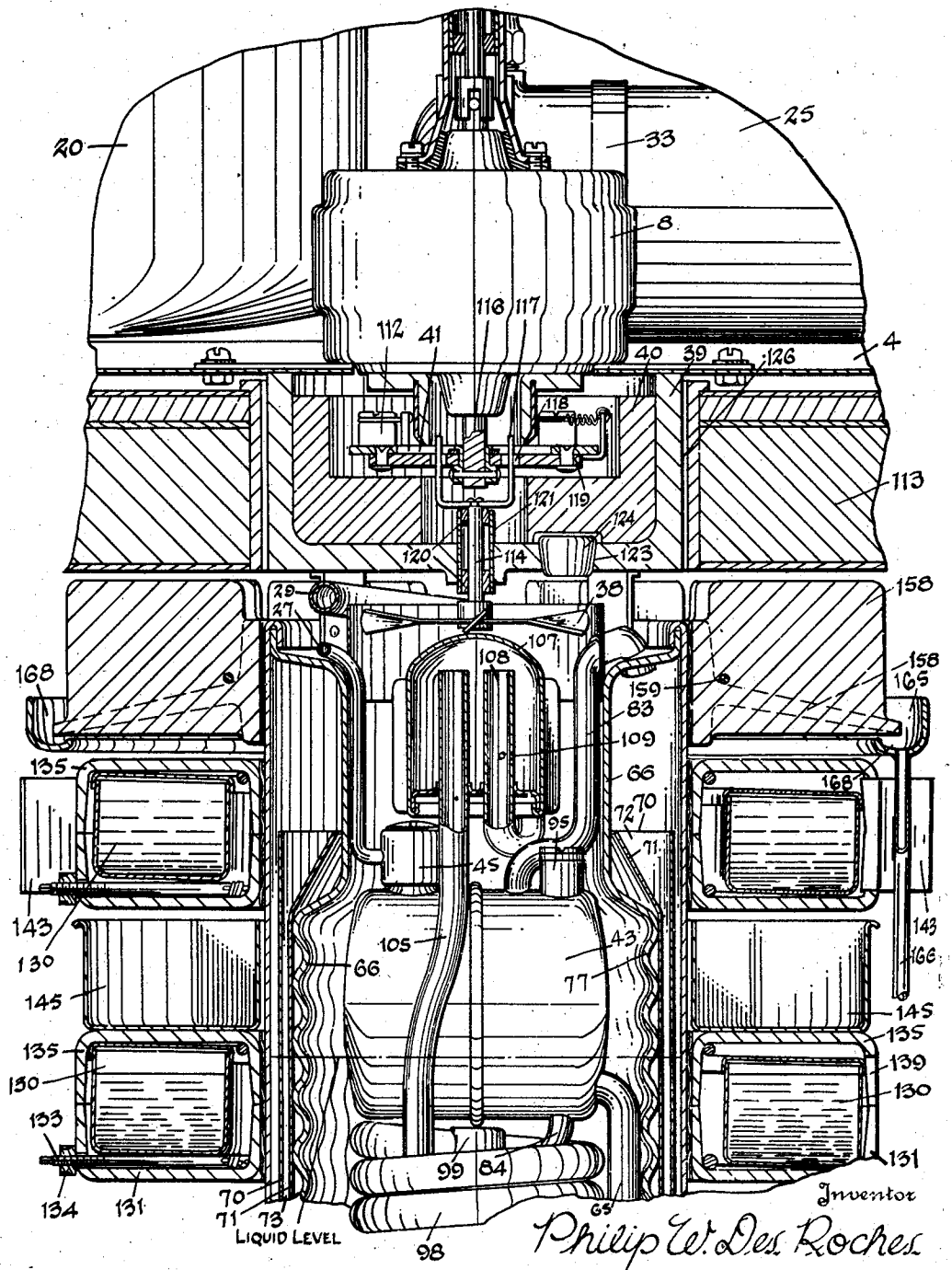


Fig 10

Inventor

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By Frank P. Crampton

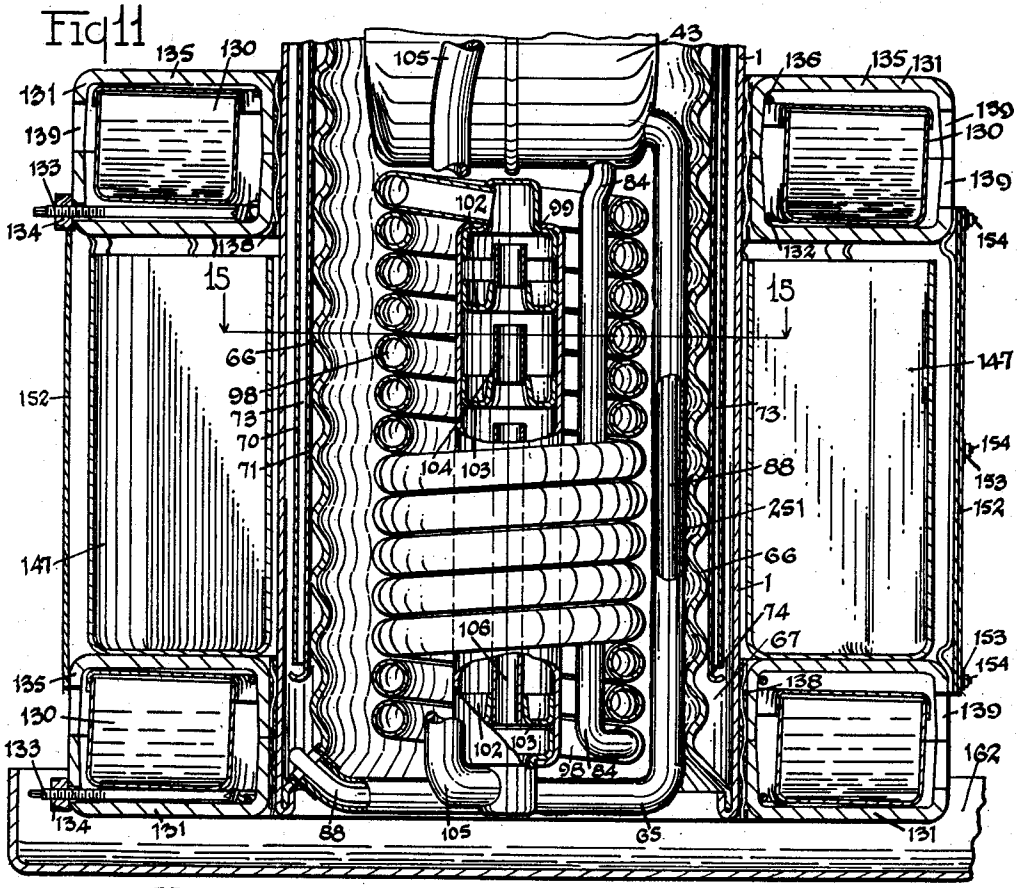
Attorney

June 6, 1939. P. W. DES ROCHES 2,161,667

REFRIGERATING UNIT

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Fig 11



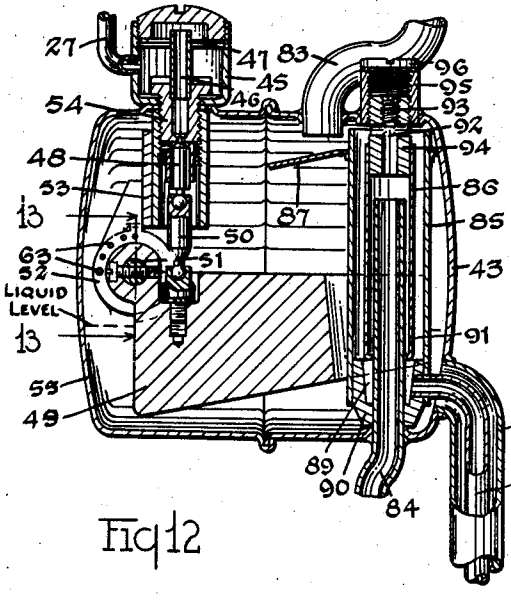


Fig 12

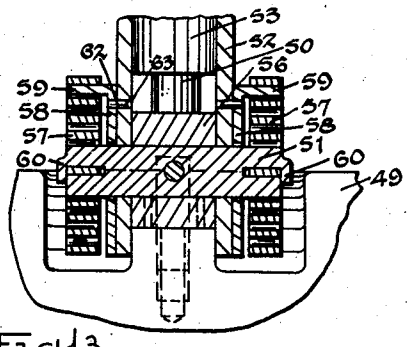


Fig 13

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REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 6

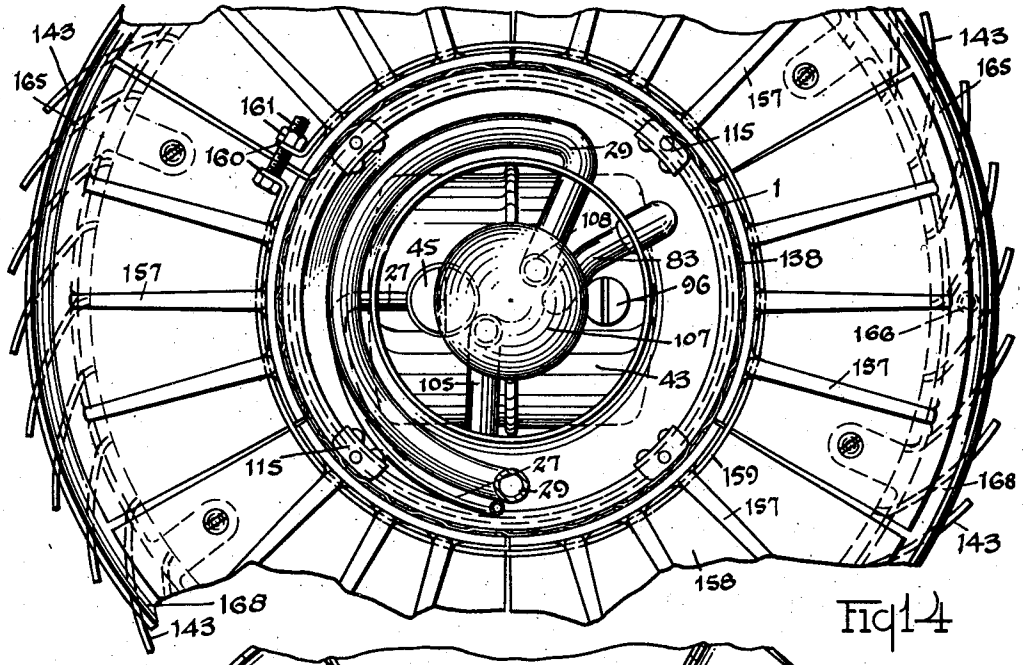


Fig 14

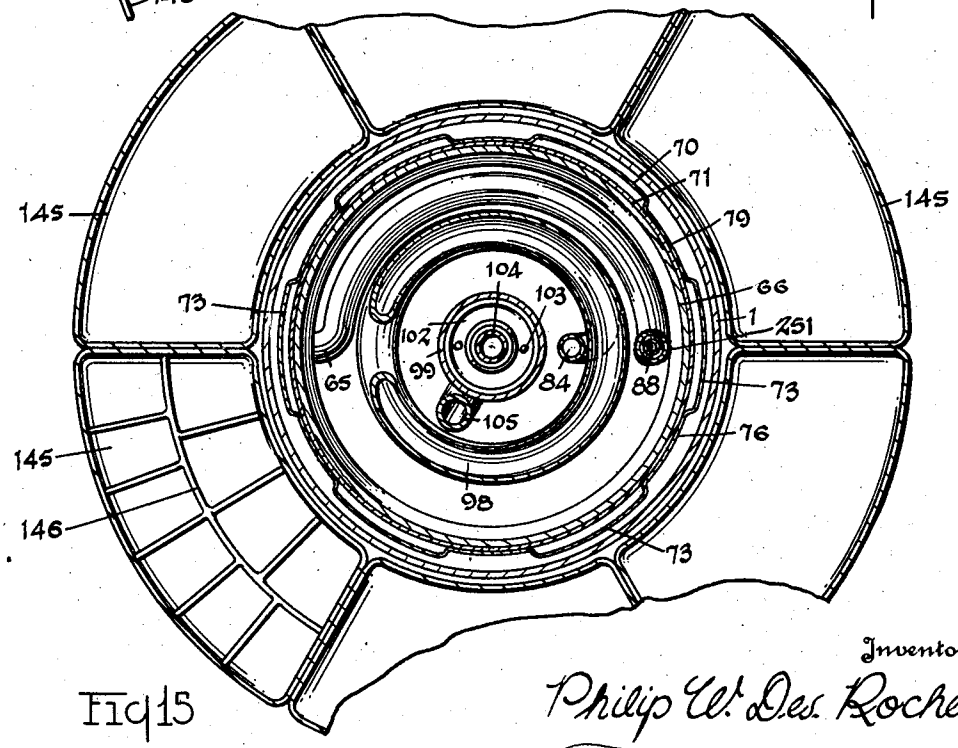


Fig 15

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June 6, 1939. P. W. DES ROCHES 2,161,667

REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 7

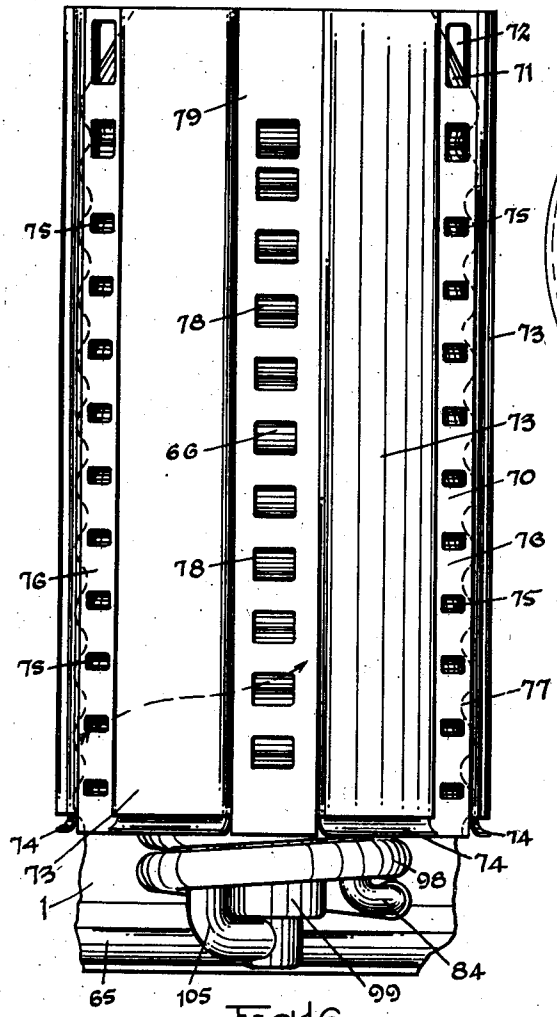


Fig 16

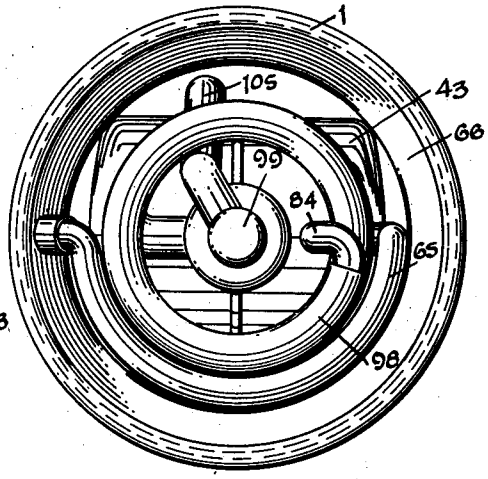


Fig 17

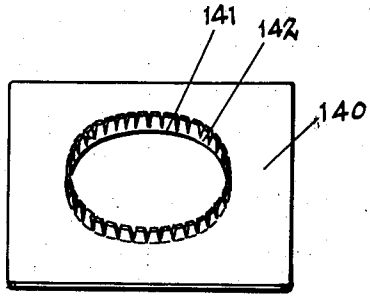


Fig 28

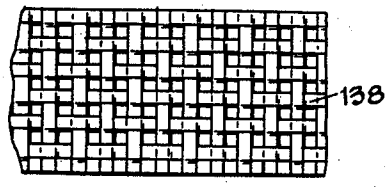


Fig 18

Inventor

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Attorney

June 6, 1939. P. W. DES ROCHES 2,161,667

REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 8

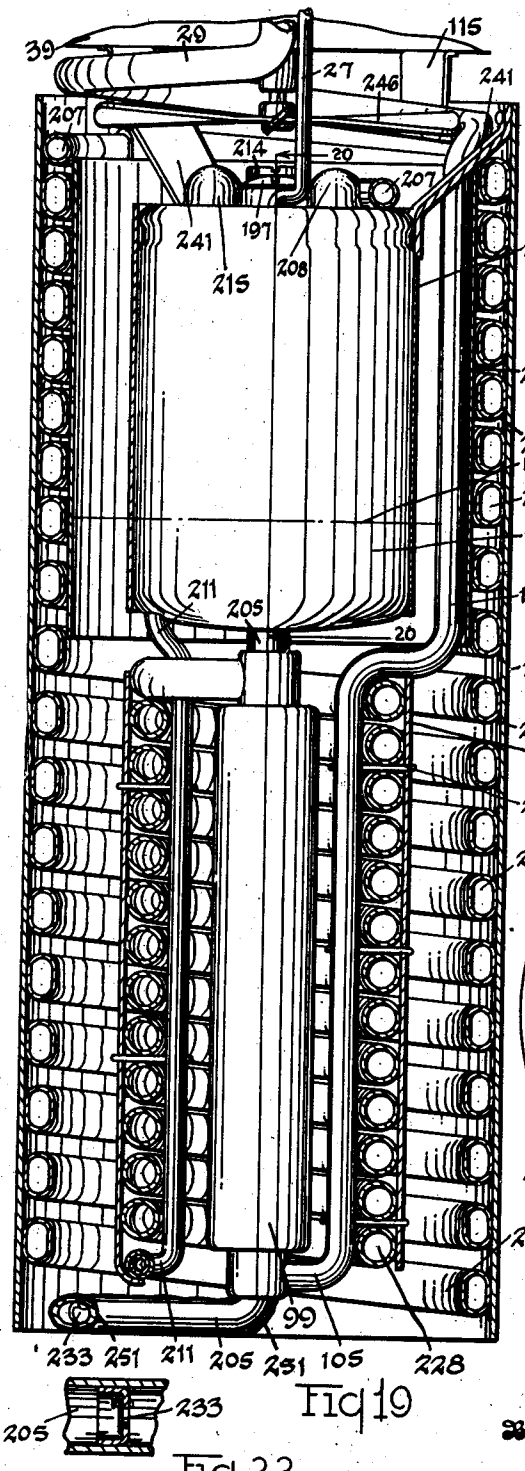


Fig 19

Fig 22

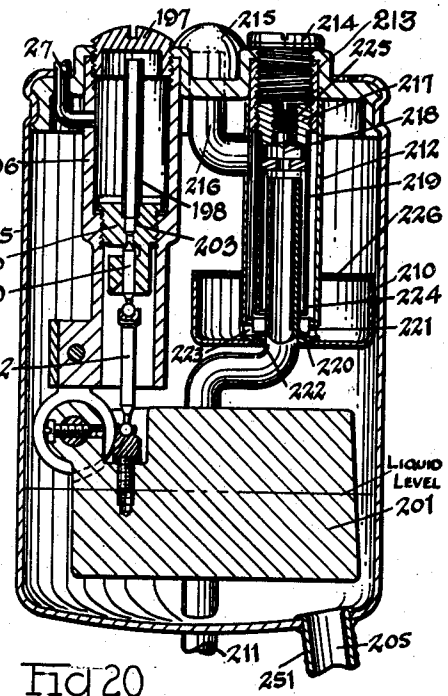


Fig 20

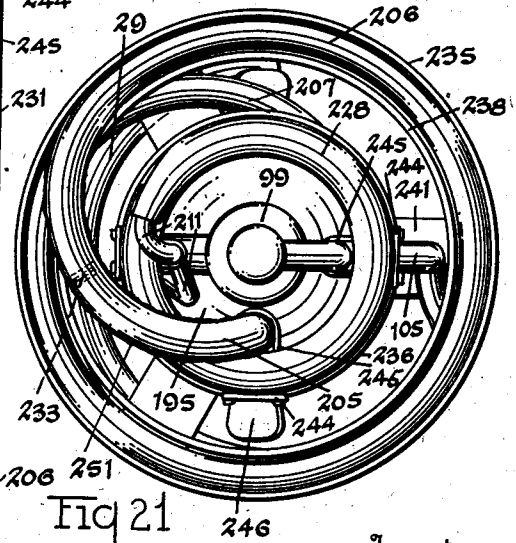


Fig 21

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REFRIGERATING UNIT

Original Filed June 13, 1930 9 Sheets-Sheet 9

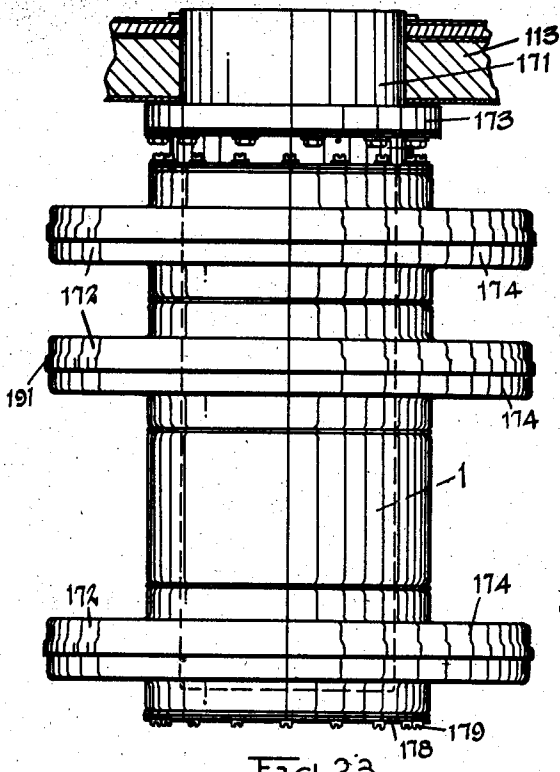


Fig 23

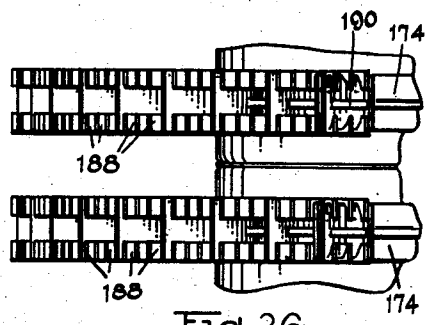


Fig 26

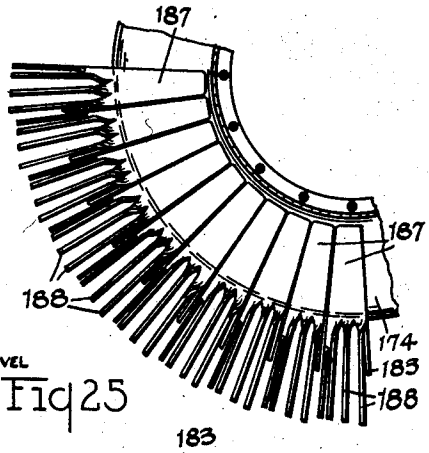


Fig 25

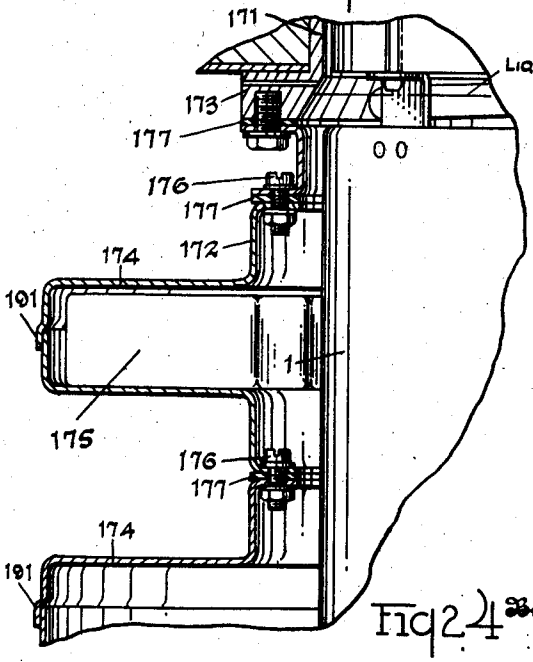


Fig 24

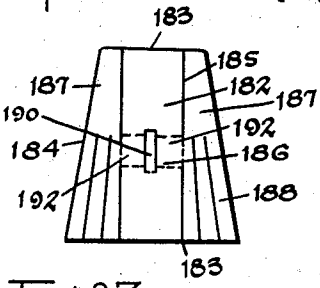


Fig 27

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By Hamet F. Crampton.

Attorney

Patented June 6, 1939 2,161,667

UNITED STATES PATENT OFFICE

2,161,667

REFRIGERATING UNIT

Philip W. Des Roches, Detroit, Mich.

Refiled for abandoned application Serial No. 461,012, June 13, 1930. This application December 18, 1936, Serial No. 116,727

23 Claims. (Cl. 62—115)

My invention has for its object to provide an efficient refrigerating unit which may be readily connected to a receptacle or container for chilling the interior of the receptacle or container or their contents. It particularly has for its object to provide a self-contained unitary structure that may be readily connected to receptacles, containers, and boxes of different forms and used for a great variety of purposes. Thus, the invention lies in so constructing such an element that it may be contained in a small volume, will be of light weight and which will, nevertheless, efficiently perform the function of chilling or refrigerating articles. Preferably, the refrigerating unit is so formed that it may be readily carried by an individual and may be used without variation of form or dimensions in the chilling of the interior of receptacles and containers of different forms and, moreover, may be inserted in containers and receptacles that are already commonly used for containing articles that are to be kept cool. The invention is, therefore, contained in structures that may be readily inserted in ice boxes, in display counters, in water cooling units, beverage cooling units, etc., that are now in use, and moreover may be readily removed therefrom without disconnecting the refrigerating circuit, and transferred to other containers for chilling purposes. Thus the transfer or replacement may be made by those unskilled in the refrigerating art.

The invention also provides means for controlling the humidity of the interior of the receptacle that is chilled by the refrigerating unit so as to prevent excess reduction of the humidity, making the invention valuable in its application to the chilling of certain articles wherein excess reduction of the humidity is injurious. The invention also has for its object to provide a structure wherein excess frosting is avoided, thus extending the period of continued operation of the apparatus and quite entirely eliminating the necessity of frequent cessation of refrigerating operations, by manual control in order to completely defrost the unit, while at the same time the refrigerating unit is operated at a low temperature and at a temperature at which ordinary refrigerating machines rapidly produce frost on the surfaces of their parts.

The invention also has for its object to provide a unit that is so formed that enclosures may be readily attached thereto for chilling the said enclosures and their contacts. Also, the invention provides a structure that may be enclosed in a fluid container having a high heat conductivity, and which will extend or enlarge the surface area of the refrigerating unit and provide for chilling containers and their contents. Thus the invention affords a structure wherein display articles may be chilled by the chilling unit, the chilling zone being greatly extended to encompass the articles. The extended areas also afford a means for chilling the air or atmosphere in which the articles are located. The invention also provides a refrigerant unit wherein a small amount of refrigerant may be used to produce a largre amount of heat absorption. The invention also provides a means for greatly extending the area of the heat conductive surfaces and thus greatly increasing the rate of heat transmission.

The invention also has for its object to provide a means for absorbing sound produced by the operation of the refrigerating unit.

The invention also provides a container for a liquid from which the heat may be reduced and which will efficiently withdraw heat from the wall of the container and will afford a cold storage means over an extended period of time.

The invention also provides a means for heat insulating exterior of containers that are located in heat conductive relation with the refrigerating unit, whereby the contents of such containers will be quickly chilled.

The invention has for its object other features and advantages which will appear from the following description and upon examination of the drawings.

The invention may be contained in refrigerating devices of different forms and structures containing the invention and may be varied in their details without departing from the spirit of the invention, and also parts of the structure claimed in the claims may be used in connection with other devices and parts for accomplishing results similar to those described herein, and thus embodying features of my invention. To illustrate a practical application of the invention, I have selected a refrigerating unit and a modification thereof as examples illustrative of embodiments of my invention, and shall describe the refrigerating unit, and its modification, hereinafter. The structures referred to are shown in the accompanying drawings.

Fig. 1 is a perspective view of the refrigerating unit. Fig. 2 illustrates its application to the ordinary ice box which is indicated conventionally. Fig. 3 illustrates a side view of the refrigerating unit and the ice box. Figs. 2 and 3 are used to get an idea of the relative sizes of the parts of the refrigerating unit. Fig. 4 is a view of the

condensing chamber having the condensing elements of the refrigerating unit, the cover illustrated in Fig. 1 being shown removed. Fig. 5 is a view of a part section taken on the plane of the line 5—5 indicated in Fig. 4. Fig. 6 is a view of a part section taken on the plane of the same line looking in the direction of the arrows 6—6 indicated in Fig. 4. Fig. 7 is a view of a section taken on the plane of the line 7—7 as indicated in Fig. 4, and illustrates the relative positions of the compressor elements of the refrigerating unit. Fig. 8 illustrates one form of a receptacle for chilling material. Fig. 9 illustrates another form of receptacle for chilling material. The receptacles shown in Figs. 8 and 9 are attached for adjustment to the expansion shell containing the expansion chambers of the refrigerating element and shown in Figs. 1 and 7. Fig. 10 is an enlarged sectional view illustrating the details of construction of the upper part of the refrigerating unit. Fig. 11 is a similar view illustrating the details of the lower part of the refrigerating unit. Fig. 12 is a view of a section of the control valve for regulating the operations of the refrigerating unit. Fig. 13 is a view of a section taken on the plane of the line 13—13 indicated in Fig. 12, considerably enlarged. Fig. 14 illustrates a top view of the expansion shell containing the expansion chambers of the refrigerating unit. Fig. 15 is a view of a section on the plane of the line 15—15 indicated in Fig. 11. Fig. 16 illustrates a side view of the expansion elements contained in the expansion shell illustrated in Figs. 10, 11, and 15. Fig. 17 is an inverted view of the lower end of the expansion elements of the refrigerating elements shown in Fig. 11. Fig. 18 illustrates a portion of a conducting element located intermediate the surfaces of the parts of the refrigerating unit to insure transmission of heat from the articles or material to be chilled and the surfaces of other parts of the refrigerating unit. Fig. 19 illustrates a modified form of the expansion elements of the refrigerating unit. Fig. 20 is a liquid level control valve for controlling the operations of the refrigerating unit. Fig. 21 is an inverted view of the bottom of the expansion elements shown in Fig. 19. Fig. 22 is a view of a section of a valve which may be located in one of the elements illustrated in Fig. 19 for insuring the positive circulation of the refrigerating fluids. Fig. 23 illustrates a side view of an extension of the expansion chamber of the expansion shell whereby the area of the heat conductive surface of the expansion shell may be magnified. The device shown in Fig. 23 is a container having a heat transmitting medium between the shell of the refrigerating unit and the surface of the container which constitutes an enlargement of a heat conductive area of the surface of the shell. Fig. 24 is a view of a section of the extension part illustrated in Fig. 23 and illustrates its relation to the expansion shell of the refrigerating unit. Fig. 25 illustrates a top view of the shell extension shown in Fig. 23 having means for further increasing the surface areas. Fig. 26 is a side view of the part of the shell extension and fins shown in Fig. 25. Fig. 27 illustrates one of the fin blanks from which one of the fins, shown in Figs. 25 and 26 may be formed. Fig. 28 illustrates a removable shelf part.

The constructions containing my invention are particularly so formed that they may be embodied in relatively small shells, whereby they may be connected to containers with very small openings. The expansion elements of the refrigerating unit are located in a shell that is placed in a container having a heat insulating wall while the other elements of the refrigerating unit are located in a shell that is positioned on the outside of the container. Thus the construction containing my invention is such that it may be readily connected as a unit to any form of container that is used for any purpose. When the unit has been thus connected, its refrigerating efficiency will exist and be utilized in the chilling of boxes and containers of different forms, such as those of large dimensions, as well as those of small dimensions, and for refrigerating materials and articles located in receptacles that are positioned contiguous to the expansion chamber of the refrigerating unit, or, in chilling the air and producing circulation of the air throughout the container, as well as chilling small receptacles containing materials that are usually iced or frozen. The same efficiency may be obtained where perishable articles are to be placed on display. The expansion shell of the refrigerating unit, that is, the shell containing expansion chambers, may thus be extended to produce the transference of heat from articles and material and from the atmosphere within a very large space or volume and through a very large surface area, although the expansion shell itself has a relatively small diameter and is inserted through a small opening. Preferably, the main expansion chamber is formed annular, whereby both its inner wall increases the convection and the circulation of the fluid chilled thereby.

As shown in Figs. 1, 2, and 3, the refrigerating unit may be applied to an ice box or refrigerator box heretofore used, and which are commonly chilled by the use of ice, in the manner well known in the art. The refrigerating unit forming my invention, may be located in refrigerating relation to the interior of the ice box by boring a small hole in the top of the box and inserting the expansion shell 1 in the ice chamber that is closed by the door of the ice box 3. The space occupied by the expansion shell 1 being relatively small, leaves a large volume for the storage of articles that are to kept chilled by the use of the refrigerating element. The compressor elements of the refrigerating unit is located in the shell 4 which is positioned on the top of the ice box. The parts within the shells 1 and 4 are interconnected by suitable pipes that interconnect the compressor elements and the expansion elements of a refrigerating apparatus.

In order that a suitable amount of air may be distributed over the parts that become heated in their operations, the shell 4 is provided with louver openings 5 for the admission of air to cool the compressor, condenser, receiver, and motor, located within the shell 4. The air is drawn into and circulated through the shell 4 by means of a fan 6 which is located in proximity to a screened opening 7 formed in the top of the shell. The fan 6 is operated by the motor 8 to draw the air through the louver openings and cause it to circulate in and about the parts of the apparatus located in the shell 4 and expel it through the openings 7.

The condenser is located between the louvers 5 and baffle plates 12, that extend from the top and bottom of the shell 4, causing the movement of the air over the parts of the pipes that form the condenser. The space between the

baffle plates 12 is covered by the baffle plate 13 located in spaced relation from the edge portions of the baffle plates 12 and so as to cause the air to move upwardly and downwardly and to distribute itself vertically so as to pass to all of the spaces intermediate the elements that are contained in the shell 4. Also, the outlets 7 and the fan 6 are covered with a baffle plate 14 which prevents short circuiting of the air from the space in between the edge parts of the baffle plates 12 and 13 of the outlet 7, and so as to force the air to pass over the motor and compressor.

Preferably not only the air is baffled in its movement through the shell 4 to cause it to move over the surfaces of each and all of the elements contained within the shell, but also to dampen the sound that is produced by reason of the operation of the refrigerating elements contained in the shell 4. The refrigerating elements contained in the shell are all sound-proofed by walls or parts that are covered with sound proofing material 17, and the openings are baffled by the baffles 12, 13, and 14 which are covered with sound proofing material 17. Consequently, the sound that is produced by the operation of the refrigerating elements within the shell is not afforded any direct passage outside the shell and, consequently, will be confined largely to the shell, and the sound that reaches the exterior of the shell 4 is greatly reduced.

The motor 18 is supported in the shell 4 by means of the standards 19. Its shaft is connected to the compressor 20 that may be of any suitable type for the compression of refrigerant vapor. The compressor 20 is connected to the condenser 21 by means of the pipe 22, which is provided with a plurality of coils, or loops, 23, to enable flexible mounting of the connecting pipe between the compressor 20 and the condenser 21. This prevents fracture of the pipe due to the vibration caused by the operation of the motor and the compressor. The condenser 21 is connected to the liquid receiver 25 by means of the pipe 26 and the receiver is connected to the expansion elements, in the expansion shell 1, by means of the pipe 27. The return from the expansion elements in the shell 1 is through the pipe 28 to the compressor 20. The pipe 28 is formed into a plurality of vertically rising loops 29. The loops 29 afford a means of connection between the compressor 20 with the expansion elements in the shell 1 and prevent fracture by vibration produced by the operation of the compressor. If desired, the pipe 28, and its loops 29, may be heat insulated to prevent undue heating and expansion of the fluids returning to the compressor.

The compressor 20 is supported by means of the connection 32 between its wall and the wall of the motor 18. The receiver 25 is secured by means of straps 33 to the bottom of the shell 4, and the condenser 21 is supported by straps 34 perforated to receive end portions of the loops of the coil that forms the condenser 21. The straps fit the space on the inside of the louvers 5 and in front of the baffles 12.

The motor 8 that operates the fan 6 is also used for operating a fan or impeller 38 located in the upper end of the shell 1, for producing desired forced circulation of the medium to be chilled, such as the air of the ice box, or other container in which the shell 1 is located, or liquid, where the liquid is to be chilled for circulation as a chilling medium.

Intermediate the shell 4 and the evaporative units of the system there is located a heat insulating plug. The plug is formed of a suitable heat insulating material, such as hard rubber, or molded composition, and may be made of any desired thickness according to the thickness of the wall of the box or other container in which the shell 1 is to be located. Within the plug 39 is located an insulating cup or block 40 which is formed of balsa wood or cork to increase the heat insulation of the connection between the shells 1 and 4. If desired, a centrifugal switch 41 may be located on the shaft of the motor 8 to produce the required circuit opening operation of the split-phase coil of the compressor motor 18 which operates to enable the starting of the compressor motor, and then cuts out the split-phase winding when the motor has come up to a predetermined speed. The motor circuits are closed by a suitable pressure or thermostatic switch, when such interconnections between the motors are used, to produce substantially simultaneous operation.

The refrigerating liquid from the receiver 25, passes through the pipe 27, to the shell 43 according to the level of the liquid in the shell. The pipe 27 communicates with the trap 45 having the passageway 46. A filter screen 47 is located intermediate the outlet of the pipe 27 and the inlet of the passageway 46 to catch dirt particles and ice needles that may be entrained in the refrigerating fluid and prevent their further movement through the apparatus, and when the compressor ceases operation the objectionable particles will fall to the bottom of the trap 45 and be retained therein. The dirt and water remaining in the bottom of the trap 45 may be subsequently removed by discharging the same through an opening which may be made into the trap 45 near the bottom thereof. The pressure of the liquid then forces the dirt outwardly and the small opening may then be promptly closed by reinsertion of a gasketed screw or other means for closing the relatively small opening. The lower end of the passageway 46 is closed by means of the needle valve 48 that is operated by a liquid level responsive member 49 which is connected to the valve 48 through the link 30. The liquid level responsive member 49 is a weighted member that is, preferably formed solid and is pivotally supported by means of the pivot pin 51 located in the ears 52 secured to a tube 53 that forms a part of the connector 54 between the trap 45 and the control valve shell 55. The pivot pin 51 extends through an ear 56 formed integral with the weighted member 49, and located on one side of the vertical line through the center of gravity. Its weight and a part of the pressure on the valve 48 is counterbalanced by the convolute springs 57 which are connected at one end to the circular discs 58 having the ears 59. The discs 58 are secured to the brackets 52 and the inner ends of the convolute springs are connected to the ends of the pivot pin 51 and secured therein by the ears 60 which are folded over the edges of the inner ends of the convolute springs. The discs 58 are angularly movable on the pivot pin 51 to adjust the tension of the convolute springs 57 to vary the counterbalancing effect of the springs on the forces that are exerted on the member 49, and are secured in their adjusted positions by means of the pins 62 that may be inserted in openings 63 formed in the brackets 52. The weight of the member 49 thus responds to the changes in the level of the liquid in the shell 55 by reason of the change in buoyancy exerted on the weighted member 49.

This operates to open the valve when the level of the liquid falls below a certain point, and allows the fluid to pass through the pipe 27 into the shell 55, until the weighted member 49 again rises and closes the valve by the rise in the level of the liquid.

The shell 55 communicates with the expansion elements of the refrigerating unit and, as the liquid is released, it flows from the shell 55 into the pipe 65 which communicates with the chamber formed between the concentric shells 66 and the shell 1. The chamber 67 between the shells 66 and 1 is a slender annular chamber and forms an expansion chamber for the liquid that is discharged from the valve shell 55. This requires a small amount of liquid refrigerant to produce efficient refrigeration. Here the liquid evaporates and expands, which absorbs heat through the shell 1, and causes chilling of the materials or articles or parts that are in contact with the shell 1. The liquid rises in the chamber 67 to the same height that it is in the shell 55 and as determined by the valve mechanism contained within the shell 55. The shell 66 is so formed that its upper extremity is increased in its sectional area. Its upper end forms a chamber wherein the gas which is formed by the expansion or evaporation of the liquid in the lower confines of the shells 66 and 1 may be separated from the liquid.

The lower portions of the shells 66 and 1, being located in close proximity to each other, the transformation of liquid into gas takes place substantially in contact with the inner surface of the shell 1 and the heat transmission is thus through the highly conductive sheet metal of which the shell 1 is formed. In the upper region of the chamber 67, there is also the expansion of the gas which absorbs heat through the shell 1 and chills the exterior article or materials that are in contact with the shell.

The portion of the shell 66, having the larger diameter, is, preferably, corrugated to prevent collapsing due to the exterior pressure on the shell. Thus, the wall of the shell 66 may be made very thin and yet will withstand such exterior pressure as it will be subjected to in the refrigerating unit. Where the shell 66 is contracted to a small diameter, the corrugations may be omitted, but preferably the upper end of the shell is flared outwardly in order to form a strengthening flange or heat part which will sustain the upper end of the shell 66.

The ends of the shells 66 and 1 may be connected together in any suitable manner, such as by spinning over the edges of the shell 1 onto the edges of the ends of the shell 66 and soldering the joints together gas tight.

In order to break down the surface film of the refrigerant and afford rapid heat transference to the refrigerant, the liquid and gas is rapidly moved over the surface of the chamber. The construction is such that there will be formed definite upward streams of the liquid and the gas and downward streams of the liquid within the chamber 67. In the particular form of construction shown, a shell 70 is provided with means for directing the streams of the refrigerant. It may be provided with vertical corrugations 73 to form vertical flues. They are located with reference to the shell 1 to form wide and narrow passageways between the shell 70 and the shell 1 for the movement of the gas and liquid in the chamber 67. If desired, a shell 71 is located within the vertically corrugated shell 70 and contiguous to the shell 66. The space between the upper edge portions of the shells 71 and 70 are made funnel shaped or flared to form a relatively large opening at the upper ends of the passageways that are formed by the vertical corrugations in the shell 70. The upper edge portions are located in the upper end of the chamber 67 and the shell 71 is tapered inwardly to form a large annular mouth at the upper end of the shell. Thus the liquid, which is transformed rapidly to gas along the inner surface of the shell 1, passes rapidly upward through the passageways afforded by the vertical corrugations of the shell 70 and carries with it the liquid located in the passageways. This breaks down any film formation and maintains the liquid in intimate heat transfer relation from points exterior to the chamber 67. In the large portion of the chamber 67, the gases separate from the liquids and expand and the liquids descend by being caught by the annular mouth 72 between the shells 70 and 71 and descend through the passageways 73 afforded by the vertical corrugations of the shell 70 to the lower end of the chamber 67 producing rapid up and down currents.

In order to prevent the gases that may be transformed from the liquid in the lower end of the chamber 67 from passing into the spaces between the shells 70 and 71, at their lower ends, a suitable baffle may be provided which extends over the lower ends of the passageways to deflect the gases to the spaces between the shell 70 and the shell 1. Thus, the shells 71 may be flanged outwardly, as at 74 to cover the lower ends of the inner passageways 73 between the shell 70 and the shell 71. This will, however, permit the downwardly moving liquids to enter the lower end of the chamber 67 while it directs the circulatory movements of the liquid and gas upward and allows free movement of the liquid downward. The liquid is thus brought into continuous contact with the inner surface of the shell 1 by a rapid circulation which enables rapid absorption of the heat through the shell 1 and the consequent rapid transformation of the liquid into a gas, and at the same time, breaks down all surface films.

A plurality of annular intercommunicating chambers are formed between the corrugated portions of the shell 66 and the substantially cylindrical shell 71, in which the refrigerant element is located. There will be absorption of heat through the wall of the shell 66 which will mean the expansion of the liquid within the annular chambers between the corrugations of the shell 66 into a gas. In order to direct the gas, together with the liquid, into the upwardly moving gas and liquid located between the shell 70 and the shell 1, the shell 71 and the shell 70 are provided with openings extending along the corrugations of the shell 70 that make substantial contact with the shell 71, which allows the liquid and gas that arises from between the shells 66 and 71 to pass upwardly in the upwardly moving stream of the gas and liquid, into the upper end of the chamber 67. Thus, the openings 75 in the corrugations 76 will allow adjustment of the liquid within the spaces of the corrugations 77 of the shell 66 and movement of the gas and liquid through the openings 78 in the alternate corrugations 79. There will thus be produced circulatory movement of the liquid in the spaces of the corrugations 77 and movement of the gas and liquids into the rapidly upwardly moving streams formed by the vertical corrugations of

the shell 70, and located between the shells 70 and 71.

In order to produce equalized pressure and maintain the effective level of the liquid within the chamber 67, at the level maintained by the level controlling valve in the shell 55, the upper end of the chamber 67 is connected to the top of the shell 55 by means of the pipe 83. In the operation of the apparatus, the gas is drawn from the space above the level of the liquid as determined by the liquid level controlling valve in the shell 55. In the particular form of construction shown, the gases are withdrawn from the expansion elements contained within the expansion shell 1, through the pipe 84, which communicates with the interior of the shell 55 at a point above the level of the liquid. The upper end of the pipe 84 is protected as against any foaming that might occur within the liquid of the shell 55 due to the absorption of heat by the liquid and the consequent conversion into gas and the expansion of the gas, by means of the pipes 85 and 86, and also by means of the baffle 87.

The suction through the pipe 84 is that produced through the secondary associated expansion unit located in the shell by the operation of the compressor, as described hereinafter.

The lubricant, used in lubricating the compressor, is carried into the refrigerating elements by the action of the compressor, and, with the boiling off of the refrigerant that takes place in the expansion chamber, is collected therein and clogs the passageways and reduces the efficiency of the machine. The accumulation of the lubricant may eventually result in running the compressor dry, which would result in the destruction of the compressor. In order to insure the regular and positive return of any lubricant that may have been carried over with the liquid into the expansion elements of the shell 1, back to the compressor, the lubricant, which ordinarily would become highly concentrated in the chamber 67, is drawn upward together with a small amount of the refrigerant liquid that may be mixed therewith through the pipe 88 that is preferably located within the pipe 65. The pipe 65 is filled with the refrigerant liquid and, hence, there will be very little absorption of heat by the liquid within the pipe 88, and, consequently there will be very little transformation of the small amount of refrigerant liquid into a gas within the pipe 88, which would otherwise disturb the movement of the liquid within the pipe 86. Thus, the lubricant that may be have been concentrated or otherwise collected by means of the evaporation of the refrigerant liquid in the chamber 67 will be returned to the compressor through the pipes 88 and 84.

The pipe 88 communicates with a conical chamber 89 formed in the plug 90, which closes the lower end of the pipe 85. The tube 86 is adjustably located with reference to the chamber 89 to regulate the connection, between the interior of the chamber and the interior of the pipe 85, exterior to the adjustable pipe 86. The lower end of the pipe 86, below the level of the liquid, is provided with a plurality of small openings 91. The upper end of the pipe 84 extends to a point near the upper end of the pipe 86. The upper end of the pipe 86 communicates with the upper end of the pipe 85, or, more accurately, with the upper part of the shell 55 through the passageway 92. The effective cross-sectional area of which is varied as may be desired by means of the small screw 93 located in a plug 94 that, except for the passageway 92, closes the upper end of the pipe 86. The plug 94 is located in the neck 95 connected to the upper end of the shell 55. The neck 95 is closed by means of a cap or plug 96. The plug 94 is threaded and thus adjustable in the neck 95, and the pipe 86 is secured to the plug 95 and, consequently, the lower end of the pipe 86 may be adjusted with reference to the edge of the tapered chamber 89 in the plug 90. Thus, the reduction of pressure or draft through the pipe 88 may be adjusted manually by the adjustment of the pipe 86 with reference to the chamber 89, also by the adjustment of the passageway 92 by the pin 93 to vary the draft or reduction of pressure in the pipe 88 according to the draft or reduction of pressure in the upper end of the shell 55. Likewise, the draft or reduction of pressure to remove the gases that are located in the upper ends of the chamber 67 and of the shell 55 is adjusted with reference to that which draws the refrigerant liquid and lubricant from the chamber 67.

The pipe 84 communicates with the lower end of the coil 98. The coil 98 may have any suitable length and may if desired extend to any point below or beyond the end of the shell 1. The length and shape into which the coil 98 may be formed may be greatly varied in order to extend the chilling area of the coil. Thus, the pipe 98 may be run out in a straight line laterally or vertically in order to reach regions that are to be chilled by the unit. Preferably, the coil 98 is located within the circle of the edge of the shell 1 for the purpose of insertion of the expansion elements of the refrigerating unit through an opening provided for the receipt of the shell 1. In the particular form of construction shown, the coil 98 is located within the shell 66, and concentric therewith, and so as to afford passageways interior and exterior to the coil to permit free movement of a medium for the transmission of heat or of the gas or material that is to be chilled by the unit. In the coil 98, further boiling of the liquid refrigerant takes place and, thus, concentrates the lubricant and moves the lubricant toward the compressor.

The coil 98 communicates at its upper end with a liquid trap 99 wherein the liquid refrigerant that has not been entirely converted into a vapor in the coil 98 and the lubricant will be caught and maintained until the liquid refrigerant is converted into a gas. The trap 99 is provided with a plurality of cups 102 having minute openings 103 which gradually permit movement of the liquid from one cup to the cup below, while the gas, as it is formed from the liquid, passes through the central flanged or piped openings 104 until the bottom cup receives substantially only lubricant liquid, the liquid refrigerant having been converted quite entirely into a gas. The lubricant liquid is then deposited on the bottom of the trap 99 whence it is drawn by the rush or rapid stream of gas, during the operation of the compressor, into the compressor in finely divided portions through the pipe 105. The trap 99 may be centrally located with respect to the shell 1, or at any point with reference to the system. In a preferred form, it is located coaxially within the coil 98 and within the shell 1.

It is desirable in many cases to locate a liquid trap at a point in the expansion elements of the refrigerating unit where the temperature of the medium or the material or gas to be chilled by the unit is at its highest point. The chilled

material will pass downward giving place to hotter material and consequently the hotter gases will bring about more rapid or more thorough distillation of the refrigerant liquid from the lubricant. In the form of construction shown, the pipe 105 terminates within a shell 107 and near the upper end of the shell. Preferably, the top of the shell 107 is dome shaped for distribution of the liquids after they are carried through the pipe 105 by the gas. The gas passes out of the shell 107 through the upturned end 108 of the pipe 29, while the liquids will be sprayed and caught by the dome shaped top and disposed on the bottom of the shell. The pipe 29, near the bottom of the shell, is provided with a plurality of small openings 109, which will permit the reintroduction of the oil in finely divided quantities into the circulatory system in the passageways that lead to the compressor. The oil that is thus directed into the passageway to the compressor is still further concentrated within the shell 107.

The pipe 29 is connected to the inlet side of the compressor. It is preferably provided with a loop at the point of its connection with the expansion elements of the shell 1, to provide for adjustment of the shell 1, with reference to the shell 4 to provide for iceboxes of different thicknesses, without breaking any connections or making any disconnection.

The flooded evaporative system or the dry evaporative system of refrigeration may be utilized for absorbing heat. The difference of the two systems being largely one of regulation of refrigerant liquid supply to the evaporative units of the system, the systems described above may be varied from the flooded evaporative system described above to the dry evaporative system.

The pipe 29 passes through the channel or groove 100 formed in the plug 39 (Fig. 5) which may be made to have a height equal to the thickness of the wall 113 of the icebox. In order to provide for iceboxes having different thicknesses of walls, suitable spacing blocks or members may be located intermediate the brackets 115 and the plug 39. The evaporative units are connected to and through the plug 39 to support the evaporative units of the system within the container. Thus, the compressor may be located at a point remote from the plug, such as underneath the container or at a place remote from the container, but may be connected to the evaporative units by means of pipes that pass through the plug. Also, the switch 41 is connected to an extension shaft 116 of the motor 8. This connection is made by means of the fingers 117 which engage the holes 118 formed in a plate 119 which forms a part of the switch 112 and is connected to the shaft 116. The fan 38 is connected to a shaft 114 having bearings 120 located in a tube 121 which is adjustable with reference to the bottom of the plug 39 and, consequently, the fan 38 may be lowered after the shell 1 is lowered by reason of its insertion in an icebox or container having a wall of greater thickness than is provided for by the relation of the plug 39.

In order to adjust the position of the pipe 86 and the passageway 92, the cup 40 may be removed from the plug 39 and a screw driver inserted through an opening 123 to engage the cap 96, the plug 94, and the pin 93, and make the desired adjustments. The opening 123 may be closed by a suitable plug 124.

In order to prevent the compressor from drawing a relatively large quantity of liquid refrigerant and lubricant when the compressor starts, the trap 99 is provided with a means for limiting the amount of the accumulated liquid that may pass into the passageways leading to the compressor. The lower cup 102 is provided with a pipe 106 that has length sufficient to extend above the level of the liquid that may collect in the trap 99 and, consequently, when the compressor starts only that liquid located in the lower end of the pipe 105 and the pipe 106 connected to the bottom cup 102 will move towards the compressor while the remainder of the liquid will be held by the cup. The liquid will then gradually discharge from the bottom cup 102 through the holes 103. Also, the liquid that moves toward the compressor when it starts will be sprayed or sub-divided by striking the dome in the upper trap or shell 107.

After the insertion of the shell 1 through the small opening 126 formed in the wall 113 of the container, suitable receptacles or other devices that are to be chilled by the chilling elements of the refrigerating unit contained within the shell 1 may be located in heat conductive relation to the shell 1. If desired, the shell 1 may be inserted into a liquid or into a gas which is to be chilled, such as water or air. Also, lateral shelves may be attached to the shell 1, after its insertion, on which the receptacles or articles may be located in order to locate such articles in heat conductive relation to the refrigerating shell 1. If desired, freezable liquid may be disposed in heat conductive relation to the shell 1 by locating it in a container that is attached to the shell 1. The container walls may be used, if desired, to support articles or materials that are to be chilled by the refrigerating elements in the shell 1. Thus, there is provided a means for maintaining the articles in a chilled condition and retaining the low temperature producible by the refrigerating unit for increasing the length of the periods in the cycle of operation in the refrigerating system and, more particularly, maintain the container in which the shell 1 is located at a low temperature for a long period of time in case the electric current, which operates the motor should be stopped for any reason. Thus, the containers 130 for containing water, or a mixture of elements that will reduce the freezing point of the mixture, may be located in the container 130 for cold storage.

The containers 130 may be, if desired, enclosed within a shell 131 that may be formed of segmental parts that are secured together in any way desired. Thus, the segments of the shell 131 may be bound together and against the shell 1 by means of a wire 132 which may be drawn tightly by any suitable means, such as by means of the bolt 133, which is connected at any point to the wire band 132. If desired, the wire band 132 may extend through the end of the bolt 133. Rotation of the bolt 133 will wind the wire band 132 at the point of connection of the wire band 132 with the bolt 133, which will secure the segmental parts of the shell 131 in thermal contact with the shell 1. In order to secure the bolt 133 in position to maintain the wire band 132 tight, a thumb nut 134, which is threaded onto the outer end of the bolt 133, may be rotated to draw the bolt 133 outwardly and, consequently, draw on the band 132. The pressure of the surface of the nut 134 against the surface of the shell 131 and the friction of the surface of the thread of the bolt with the nut 134 will prevent reverse rotation of the bolt 133 and thus the shell

131 will be tightly held in position. If desired, a cover 135 which may be also formed of segments may be secured above the shell 131 and to the shell 1 in the same manner that the shell 131 is secured, as by the wire band 136, which may also be drawn by a bolt similar to the bolt 133 and secured by a thumb nut similar to the thumb nut 134.

A plurality of such containers 130 and closure members 131 may be secured to the wall of the shell 1 in order to provide for the desired cold storage. The closure members 131 form means for supporting the articles to be chilled and, being formed of metal, they afford a heat conductive means as between the articles or containers placed thereon. In order to increase the heat conductivity and insure intimate conductive relation between the enclosures 131 and the shell 1, metal elastic strips 138 may be located intermediate the segments that form the closure member 131. The elastic heat conductor may be formed of flat metal strips woven in a form of a basket weave that may be located intermediate the surface of the segments that form the closure member 131 and the wall of the shell 1. Any suitable elastic metal contact members may be interposed between the shells 131 and the shell 1.

The wall of the enclosures 131 may be provided with a plurality of elastic fins which are inserted in slots 139. The fins 143 may be pressed into the slots to make good heat conductive contact between the fin 143 and the outer portions of the enclosures 131. The fins 143 are preferably curved to reduce the space required, and yet maintain the fins in spaced relation to enable air to move over their surfaces vertically. The fins will operate to increase the transmission of the heat of the air surrounding the shell 1 to the heat absorbing elements contained within the shell and may be bent to be located in close proximity to the wall 131 or may be spread towards the radial lines from the center of the container to which the fins are connected.

If desired, any suitable shape of shelf may be used for supporting containers for cold storage purposes, or for supporting articles that are to be chilled. The outlines of such shelves may be varied as desired. Thus the shelves may be formed of flat metal parts, such as shown in Fig. 28. The one shown in Fig. 28 is irregular in form, that is, it is shown as square and its opening 141 has a diameter substantially the same as the diameter of the shell 1. It is provided with a plurality of spring fingers 142 that will frictionally engage the surface of the shell 1. Also, if desired, the spring fingers 142 may be tightly pressed against the shell 1 by any suitable means to secure the shelf 140 in position on the shell 1.

If desired, ice cube trays 145 may be located on one or more of the shelves. The ice cube trays 145 are preferably segmental in form, and, when placed together in position, form an annulus of a plurality of containers. Material other than water may be inserted in the trays 145 to be frozen or chilled as may be desired. Separating partitions 146 may be located in the trays 145 to enable ready division of the food or water when frozen. If desired, a plurality of receptacles 147 having a considerable depth may also be located on one of the shelves that are secured to the shell 1. If desired, a plate 148 may be located on the bottom of the receptacle 147 for the removal of the frozen or chilled food. The plate 148 is provided with an arm or handle 149 for lifting the food from the receptacle 147.

If desired, increased absorption of heat from the material contained within any of the containers that are located on the shell 1 and its associated shelf parts may be accomplished by covering the outer surfaces of such containers by a covering that operates to prevent the transmission of heat from articles exterior to the said receptacles. The covering may be formed of sheet metal provided an air space is located between the sheet metal and the outer surfaces of the receptacles. Preferably, a covering of flexible heat insulating material is disposed around the segmental receptacles to prevent the transmission of heat from other articles through the outer walls of the receptacles, such as the flexible heat insulating cover 152. The covering 152 is secured to the shelf on which the receptacles 147 are located and also may be secured to the shelf located above, as by suitable buttons 153 and the cooperative securing studs 154.

For air refrigeration, particularly to refrigerate the air of the container in which the shell 1 is located, and at the same time to reduce the humidity of the air before it passes within the closely positioned parts within the corrugated shell 66, I have provided a plurality of fins 157 that may be secured by any means to the upper end of the shell 1. The fins 157 may be made radial and extend to points in close proximity to the inner surface of the wall 113. The outer edges of the fins 157 may be comparatively wide and so as to extend well below the upper edge of the shell 1. If desired, they may be supported on a plate 158 that may be formed integrally with the fins 157. Thus, the entrance space for the air current induced by the operation of the fan 38 as well as by the convection of the air downwardly produced by the chilling of the air within the corrugated shell 66 will be large and consequently the air will move slowly over the fins 157 which are in heat conductive relation with the shell 1, and enable the disposition of the moisture on the surfaces of the fins, which will also collect on the plate 158. When the compressor is in operation, the fan 38 will drive the air, having the major portion of its moisture removed, rapidly through the spaces within the shell 66 and prevent frosting of the parts located within the shell 66 and also prevent, or greatly reduce, the frosting of the inner surface of the shell 66. During the periods in which the motor is at rest, the convection of the air within the shell 66 will cause inward movement of the relatively warm air, which will also cause remelting of the frost from the fins. Also, the temperature of the upper end of the shell 1 rises by reason of the fact that the refrigerant liquid descends to the level as determined by the float.

The fins 157 may be removably secured to the shell 1 in any suitable manner after the insertion of the shell 1 into the container. In the form of construction shown, the plate 158 may be formed of a plurality of segments that have each a plurality of fins 157 and they may be tightly secured in position on the upper end of the shell 1 by means of a wire band 159. The wire band may be provided with eyes 160 at its ends, and the ends may be drawn together by means of the bolt and nut 161. A suitable elastic metallic plate, such as the woven heat conductor member 138, may be located intermediate the segments of the plate 158, and the fins 157,

in order to increase the thermal conductivity between the shell 1 and the fins 157.

The water that is deposited on the fins 157 and the plate 158 may be conveyed to a pan 162, which may be suitably located to collect the drippings from the plate 158 and the fins 157, as well as the fins 143. In the form of construction shown, the water pan 162 is located in proximity to the lower end of the shell 1. Thus, the air will be recharged with moisture after it has passed through the spaces within the shell 66 and has again become warm as it passes to other parts of the refrigerator by the forced circulation. This may be desirable in connection with the preservation of certain articles, and at the same time, greatly reduce the frosting on the surface of the shell 66 and the parts contained within the shell. It will greatly reduce dehydration of articles that may be contained in the container, or icebox, in which the shell 1 is located.

If desired, the pan 162 may be extended to cover a considerable area in order to afford a large evaporative surface and to convey the water to remote parts of the container in which the shell 1 is located and which will, by absorption, give up the water that is contained within the pan to the air in comparatively remote parts of the container.

To prevent the dripping of the water from the plate 158, if desired, the plate 158 may be provided with a flange 165, and a pipe 166 may be connected through the flange 165 to convey the water from the plate 158 to the pan 162 or to convey the water to any other suitable container. If desired, a trough 168 may be located below the edge of the plate 158 for collection of the moisture from the plate 158, and the pipe 166 may be connected to the trough for conducting the water to the pan or to any other receptacle.

If desired, the surface area through which heat may be absorbed from articles or fluid may be greatly extended and, at the same time, greatly increase the capacity of the conductive portion of the refrigerating unit within the shell 1. As is well known, a liquid in contact with a surface will transmit heat from that surface more readily than gas in contact with that surface. Increasing the area of the contact surface increases quite proportionately, its conductivity and to greatly increase the capacity of the refrigerating unit, I have provided a means for circulating a liquid through the shell 1 in place of circulating air. As is well known, liquids will absorb and transmit heat more readily than gases, and, furthermore, it affords an opportunity to greatly increase the area of the surface through which heat may be absorbed by articles to be chilled. Furthermore, it affords a means whereby the articles located remote from the refrigerating unit may also be chilled by conducting such liquid to such remote points. The container of the liquid medium may thus be extended or may be located at points more or less remote from the refrigerating unit and, furthermore, the heat absorbing areas may be localized as may be desired within a container in connection with which the refrigerating unit is used. As illustrative of the utility of a liquid circulating medum, I have provided a construction for supporting articles about the unit on shelves or parts that are much larger than in the form of construction where they are supported on shelves directly connected to the shell 1. Thus, such an arrangement may be used for display purposes, such as in counters where food is to be displayed or from which food is to be dispensed and which has to be maintained in a chilled atmosphere for their preservation. Such an arrangement is shown in Figs. 23 and 24.

Thus, the refrigerating unit may be extended without varying the construction and consequently the refrigerating unit may be applied to chilling articles and materials under a great variety of conditions without altering the construction of the refrigerating unit.

The shell 1 may be surrounded with a liquid container 172. The liquid container 172 is, preferably, secured to a ring 173 located above the upper shell 1 and the container is filled to a point slightly above the upper edge of the shell 1.

The ring 173 may be connected to a cylindrical part 171 which surrounds the cup 139. The inner diameter of the cylindrical part 171 is, preferably, formed larger than the diameter of the shell 1 whereby the refrigerating unit may be removed from the container in connection with which the refrigerating unit is used, and without removing or disconnecting the liquid container 172.

The fan 38, or impeller, being located well below the edge of the shell 1, will, during the operation of the compressor, cause the liquid to pass downward within the corrugated shell 66 and over the surface of the shell 66 and the surfaces of the parts contained in the shell. The liquid will pass below the lower edge of the shell 1 laterally to the outside of the shell 1 and upwardly through the liquid container 172. The impeller will thus produce a rapid circulation of the liquid contained within the liquid container 172 and the shell 1 and, by reason of its intimate contact with the surfaces of the shell 1, the shell 66 and the other refrigerating elements, contained within the shell 66, chill the liquid which will, in its circuitous movement, pass over the surfaces of the liquid container 172. If desired, a pipe having fins, or a receptacle communicating through a pipe without fins, may be located at any point within the container for extending the circulation and a wider distribution of the chilled zone. Thus, the capacity of the refrigerating unit is greatly extended without alteration of the structure of the refrigerating unit.

If desired, sealed receptacles 175 may be located in the shelf parts 174 of the container 172. Freezable liquid, such as water, or mixture of water and alcohol, may be located in the sealed receptacles to form a cold storage means and aid in extending the periods in the cycle of operations of the refrigerating apparatus. The sealed receptacles 175 are preferably formed annular in form, or they may be made segmental and placed in position in the shelf parts 174 in advance of the assembly of the liquid container 172.

The liquid that is used is, preferably, a non-corrosive anti-freeze mixture, such as alcohol and water, or glycerine and water, or other ingredients that will not freeze at the temperature to which the refrigerating may cool the liquid. Also, the impeller used is smaller than the fan that would ordinarily be used in connection with air circulation.

The liquid container 172 may be made to conform to any desired shape and consequently it may be provided with shelf parts 174 for the support of ice trays, cold storage containers and receptacles in which foods may be frozen or chilled substantially by direct conduction as described above. In the particular construction shown in Figs. 23 and 24, the liquid container 172 is formed of a plurality of sections that are suit-

ably joined together by means of bolts 176 and which are suitably sealed at their points of connection by means of gaskets 177. The lower end may be closed by a suitable plate 178 that is secured by means of screws 179.

In order to produce more effective refrigeration of the air, a plurality of fins may be connected to the shelf parts 174. The fins may be made up of separated elements having suitable width and construction to permit free movement of the air between the fins and yet be located in heat conductive relation to the parts of the container 172. As shown in Figs. 25 and 26, the fins are attached to the shelf parts 174 by elastic clamping portions which frictionally hold the fins in position by the yielding pressure that is exerted between the parts.

The fins are formed from blanks that may be cut from metal strips and so that there will be no waste of the sheet material from which they may be formed. The blanks 182 have two parallel edges 183 and two converging edges 184. It is cut along the slotted lines 185 and is bent along the dotted lines 186 to form a substantially box shape having two tongues 187 that are located substantially the same distance apart that the outer surfaces of the shelf parts 174 are located. The blanks are formed from elastic sheet metal and, consequently, the tongues 187 will elastically clamp the upper and lower sides of the shelf parts. The portions 188 may be bent or twisted angularly so that they will lie in a plane at right angles to the plane of the tongues 187. Thus, they will be located vertically and effectively chill the air and cause convection of the air downwardly through the fins. The slot formed by the cutting of the portion 190 and bending along the dotted lines 186 near the ends of the cut portion 190, forms the portion 190 into a tongue which is displaced outwardly from the contiguous portions of the fin from which it is cut along its side edges. This forms a slot, or recess, in which the overlapping portions 191, of the container 172, may be located, while the contiguous areas 192 will be placed in contact with the portions of the shelf parts 174 located above and below the overlapping portions 191.

In the form of construction shown in Figs. 19 to 22, the evaporative units partake of a form slightly different from that shown in the refrigerating unit illustrated in Figs. 4 to 20. The liquid receiver of the condensing unit of the shell 4 is connected by the pipe 27 to the control valve shell 195. It enters a sleeve 196 that is closed by a plug 197 that may be threaded through an opening formed in the shell 195 and into the end of the sleeve 196. The upper end of the sleeve 196 communicates with a passageway 203 through the pipe 198. The passageway 203 is controlled by the valve 199 which is slidably movable in the plug 200 that closes the lower end part of the sleeve 196 except for the passageway 203. The valve 199 is controlled by the liquid level responsive member 201. The movable valve member 199 is connected to the liquid level responsive member 201 by means of the link 202 and operates to close and open the valve 199 substantially as in the form of construction shown in Figs. 4 to 18. The liquid from the shell 195 passes through the pipe 205 and communicates with the lower end of the coil 206. The coil 206 communicates with the interior of the shell 195 through the pipe 207 which enters the dome 208, whence the liquid drops to the cup 210, unless the cup 210 is filled with a liquid, whereupon it flows to the bottom of the shell 195. The movement of the liquid above the level of that determined by the liquid level responsive member 201 is due to the absorption of heat through the pipe that forms the coil 206 which transforms the liquid into a gas and also causes the expansion of the gas, and, consequently, an upward rise of the gas and of the liquid within the pipe 206, is produced. The liquid, however, passes into the shell 195 and permits separation of the gas from the liquid and the liquid flows down through the pipe 205 to the lower end of the coil 206. When the liquid is transformed into a gas, the member 201 opens the valve 199 and permits an additional supply of liquid in the part of the system consisting of the pipe 205, and the coil pipe 206. There is thus produced a circulatory movement of the liquid and the separation of the gas as the heat is absorbed through the pipe 206.

The gas is withdrawn from this circuitous path through the pipe 211. The pipe 211 terminates near the upper end of the sleeve 212 which is secured to the collar 213 that is closed by means of a plug 214 that extends through an opening formed in the head of the shell 195. The sleeve 212 is connected to the interior of the dome 215 by means of a pipe 216. The dome 215 is located in the head of the shell 195 to locate the upper end of the pipe 216 well above the level of the liquid. This affords a large expansion chamber and prevents drawing uncontrolled amounts of refrigerant liquid through the pipe 211 to the compressor or through the auxiliary expansion elements of the refrigerating unit. The pipe 216 communicates with the sleeve 212 at a point near the upper end of the sleeve 212 and a plug 217 and, having a narrow passageway 218, operates to restrict the movement of the gas into the pipe 211. The plug 217 is located in the upper end of a second sleeve 219 in which the upper end of the pipe 211 is located. The pipe 219 has an inturned lower edge portion 220 which is located in the chamber 221 formed in the cap 222 that has a passageway 223 that communicates with the bottom of the cup 210. The upper end of the sleeve 219 is connected to the plug 217 which may be adjusted in its position, particularly, the position of the lower end of the pipe 219 may be adjusted within the chamber 220 to regulate the movement of the liquid through the chamber 220 into the space between the end of the pipe 211 and the sleeve 219 to the openings 224 that are formed in the sleeve 219. Thus, liquid may be drawn into the pipe 211 in amounts that are controlled by the adjustment of the plug 217 and, consequently, by the adjustment of the inlet from the cup 210. Thus, the rate of flow as between that of the liquid and of the gas may be also controlled by the pin 225 which is adjustably located in the plug 217 to vary the restriction of the passageway 218. The cup 210 is preferably covered with a screen 226 to prevent dirt from fouling the passageways that lead from the cup into the pipe 211.

The pipe 211 is connected to the lower end of the coil 228 where expansion of the gas takes place and also where any of the liquid that is drawn from the cup 210 is transformed into a gas. The upper end of the coil 228 is connected to the trap 99 where the lubricant is concentrated and returned with the gas in uniformly sub-divided quantities through the pipe 105. If desired, the coil pipe 206 is so formed that the upper coils 230 are located closer together than

the lower turned coils 231. This is to increase the volume above the normal liquid level as determined by the member 201 for the expansion of the gas. This enables a better separation of the gas from the liquid while well within the coiled pipe 206, the gas will discharge into the shell 195 while the liquid will be caught in the cup 210. The liquid within the cup will thus be quite completely separated from the gas, particularly that portion of the liquid located at the bottom of the cup, and hence liquid that is drawn into the pipe 211 will not be of a frothy character, but will pass down with the cold gas in divided and controlled quantities.

In order to insure movement of the gas upwardly through the coil pipe 206 and prevent return movement by the shorter pipe 205, a one-way check valve 233 may be located near the juncture of the pipe 205 and the pipe 206, which will prevent return flow of the liquid from the pipe 206. The normal movement of the liquid and the gas within the pipe 206 will be upward owing to the fact that the column or weight per unit of volume, due to the head of the liquids in the pipes 205 and 206 is the same, although the gas, by reason of its buoyancy, will carry liquid ahead of it in its upward movement. If desired, the coiled pipe 206 may be covered by means of a shell 235. Also, the shell 195 may be covered on its outer surface with an insulating coating or covering 236 for reducing the rate of heat transmission from the air to the elements in which the absorption of heat takes place within the refrigerating unit. Also, if desired, a central insulating sleeve 238 may be located within the coiled pipe 206. The insulating sleeve 238 is located within the upper end part of the coil 206 but may be extended to cover the interior surfaces of the coil 206 throughout its entire length or any part thereof. The insulating coverings 236 and 238 operate to prevent excess heat absorption in the shell 195 and insure absorption of the major portion of the heat by the transformation of liquid into gas within the coiled pipe 206. The coverings 236 and 238 may be formed by painting the shell 195 and the inside of the coil of the pipe 206 with a suitable paint or mixture of paints to heat insulate these surfaces. The pipe 206 is, preferably, brought into intimate contact with the metallic shell 235 which corresponds to the shell 1 of the form of construction shown in Figs. 5 to 19. If desired, the pipe 206 may be soldered to the metallic shell 235 as indicated at 240.

Preferably, an insulating cover is placed on the pipes 65 and 205, in order to prevent the absorption of heat by the refrigerant material contained within these pipes, such as a coating of a plastic material or a painted covering of insulating material 251, which will reduce the tendency of the upward movement of the refrigerant liquid.

The shell 195 may be connected by means of brackets 241 to the upper edge of the shell 235 and the turns of the coil pipe 228 may be secured in their relation to each other by means of strips 244 and hooks 245 that connect the coils with the depending pipes 105 and 211 which operate to support the coiled pipe 228.

The air, or if desired, a liquid may be circulated by means of a suitable propeller, such as the fan 246. The propeller, when used in connection with liquid, will be relatively smaller and, when used for propelling air through the interior of the refrigerating shell 235, will be larger. The refrigerating shell 235 may be located within a liquid container that may be connected to other containers to distribute the heat absorptive areas throughout different parts of the container in connection with the refrigerating unit having the shell 235, is used in the same manner described in connection with the refrigeraitng unit having the shell 1.

The rapid circulation of the air reduces frosting and, taken in conjunction with the insulating coatings and shells, it practically eliminates frosting.

Any suitable thermic control device may be used for initiating the periodic operations of the compressor to maintain the temperature of any part of the system at the desired average temperature, preferably an adjustable thermic control element is placed in thermic relation with the shell enclosing the evaporative chambers.

I claim:

1. In a refrigerating system, a member located contiguous to the wall of the evaporative chamber of the system for directing the refrigerant gas upward and the refrigerant liquid downward, the said member having means for collecting the downward moving liquid and directing it laterally to the streams of upwardly moving gas and liquid.

2. In a refrigerating system, the system having an annular evaporative chamber, a vertically corrugated member located within the chamber and forming vertically disposed passageways for directing the refrigerant liquid and gas upward and refrigerant liquid downward.

3. In a refrigerating system, a shell forming the exterior wall of an evaporative chamber of the refrigerating system, a vertically corrugated shell located concentric to the surface of the first named shell to afford rapid absorption through the wall of the first named shell and rapid upward movement of the gas and liquid.

4. In a refrigerating system, evaporative chamber of the refrigerating system having substantially coaxial walls and forming an annular chamber and free passageway of heat transferring medium through the inner wall, walls formed to produce a large cross-sectional area in the upper end of the chamber and a small cross-sectional area in the lower end of the chamber, and means located in the portion of the chamber having the smaller cross-sectional area for directing streams of liquid and gas upward and for collecting liquid and directing it downward.

5. In a refrigerating system, evaporative chamber of the refrigerating system having substantially coaxial walls and forming an annular chamber and free passageway of heat transferring medium over the inner and outer walls, walls formed to produce a large cross-sectional area in the upper end of the chamber, means located in the portion of the chamber having the smaller cross-sectional area for directing streams of liquid and gas upward and for collecting liquid and directing it downward, and directing the liquid laterally to the upwardly moving streams of liquid and gas.

6. In a refrigerating apparatus, a part of the refrigerating apparatus having a surface adapted to absorb heat from the side of another part of the apparatus, the said surface located in close proximity to the said side, elastic sheet metal covering all parts of the opposing surfaces to secure intimate thermal contact between the surfaces at points distributed over all opposing parts of the surfaces.

7. In a refrigerating system, a shell having a pair of heat conductive walls and forming an evaporative chamber, and means forming a passageway located intermediate the said walls for directing refrigerant liquid downward and centrally with respect to the said walls and refrigerant liquid and gas upward along the surfaces of the said walls.

8. In a refrigerating system, a container having a heat transferring medium, a pair of coaxially arranged walls forming between the walls, an evaporative chamber and a passageway through the inner wall, means for directing the medium through the said passageway, one of the said walls having a stepped part displaced relative to another part of the shell at its upper end to form an enlarged part of the annular chamber between the said walls, the relatively small cross sectional area of the lower part of the chamber operating to produce rapid heat absorption from the medium, and the upper part of the chamber operative to produce rapid separation of the gas from the liquid.

9. In a refrigerating unit, an evaporative chamber formed to have a vertical passageway for the movement of the medium cooled by the evaporative chamber therethrough, a heat insulating material covering the surface of the said passageway, the outer exterior surface of the evaporative chamber in non-insulative relation to the medium exterior to the evaporative chamber.

10. In a refrigerating system, an expansion chamber, a means having a plurality of narrow passageways opening below the level of the liquid refrigerant extending downward from the expansion chamber and intercommunicating at their lower ends, certain of the passageways for directing refrigerant gas and liquid upward from the lower ends of the passageways to the expansion chamber and other of the passageways for directing refrigerant liquid downward to the lower ends of the passageways, the said expansion chamber having means for diverting refrigerant liquid to the passageways that direct the liquid downward and the last named passageways having means for directing the refrigerant fluid to the first named passageways to prevent interference between the upward and downward moving streams of liquid and gas.

11. In a refrigerating system, an evaporator and a refrigerating storage chamber, a liquid container surrounding the evaporator and containing a liquid non-freezable at operative temperatures of the system and in close heat conductive relation thereto, the said liquid container supported on and depending from the top wall of the refrigerating chamber, the liquid container formed to have a plurality of parallel, spaced, hollow shelves extending outwardly from the body of the container and into the refrigerating storage chamber, the interior of the hollow shelves communicating with the interior of the container and filled with the said non-freezable liquid, the shelf parts adapted to support material within the refrigerating chamber and in intimate heat conductive relation to the said liquid in the container and within the shelf parts.

12. In a refrigerating system, a container, a shell located in the container having an annular expansion chamber, and forming a vertically, centrally located passageway for chilling air, a plurality of fins connected to the upper end of the shell and extending outwardly from the upper end of the expansion chamber and located in heat conductive relation to the air that moves radially between the fins and inwardly with respect to the passageway and downwardly through the passageway, means for directing air between and along the surfaces of the fins to produce deposition of moisture from the air as it moves along the surfaces of the fins prior to its downward movement through the passageway to reduce the deposition of the moisture from the air within the passageway and to reduce frost formation within the passageway.

13. In a refrigerating system, an evaporator, a refrigerating storage chamber, a liquid container located in the refrigerating storage chamber and surrounding the evaporator, the space between the evaporator and the inner surface of the container containing liquid non-freezable at operative temperatures of the system, the liquid container formed of a plurality of elements and means for interconnecting the said elements, certain of the said elements having hollow shelves extending outwardly from the body of the container and into the refrigerating storage chamber and filled with the said liquid for supporting material within the refrigerating chamber and in intimate heat conductive relation to the said liquid.

14. In a refrigerating unit having an expansion chamber, an impeller for circulating air over the expansion chamber, a chilling means for collecting the moisture from the air, means for conducting the moisture to a point remote from the chilling means and in the path of the circulating air for recharging the air with its depleted moisture as the temperature of the air rises.

15. In a refrigerating system, a liquid trap interposed between the compressor and the evaporative chamber of the system, means for collecting liquid, a member for retaining a large portion of the collected liquid, and having a small outlet that gradually releases the said portion by gravity during the operation of the compressor.

16. In combination with a container having a relatively small opening in one end thereof, a removable refrigerating self-contained unit having a cylindrical shell insertible through the said opening and into the container and fitting the opening and containing the evaporator of the refrigerating system, a second shell connected to a first-named shell and containing the compressor, the compressor connected to the evaporator, and a plurality of shelf parts removably connected to the first-named shell and extending laterally from the cylindrical surface of the shell for supporting material and adapted to conduct heat from the material.

17. In combination with a container having an opening, a removable refrigerating self-contained unit, the evaporator of the refrigerating system insertible through the opening, a shell containing the compressor, the compressor connected to the evaporator, and a plurality of shelf parts removably connected to the evaporator of the refrigerating system and extending laterally from the outside lateral surfaces of the said evaporator and producing a cross dimension when connected to the evaporator greater than the dimension of the opening.

18. In combination with a container, a refrigerating apparatus having an evaporator, the container having a small opening having exterior dimensions substantially the same as the cross exterior dimensions of the evaporator, and a

plurality of shelf parts removably connected to the said evaporator and extending laterally from the sides of the evaporator, and spaced apart to receive material and adapted to conduct heat from the material to the evaporator.

19. In combination with a container, a refrigerating apparatus having an evaporator, the container having a small opening having exterior dimensions substantially the same as the cross exterior dimensions of the evaporator, a heat insulating member fitting the said opening and secured to the upper end of the said evaporator, and shelf parts removably connected to the said evaporator and having cross dimensions when connected to the evaporator in excess to the dimension of the opening.

20. In a refrigerating unit having an expansion chamber, a chilling means for collecting the moisture from the air, means for conducting the moisture to a point remote from the chilling means for recharging the air with its depleted moisture at a point where the temperature of the air is greater than at the chilling means.

21. In combination with a container to be cooled, a cooling unit consisting of two contiguous parts, one of the parts having a chamber for containing materials to be cooled and shielded from the convection air currents normally existing in the container and adapted to support and maintain the materials in intimate thermal contact with the shielded surface of the chamber, the other of said parts having means for maintaining the first-named part normally at a temperature below 32° Fahrenheit and adapted to chill the air within the container, and the said other part subject to the convection currents normally existing within the container, a heat insulating material located on the surface of the said other part to prevent frost the formation thereon notwithstanding the low temperature normally maintained in the first-named part of the cooling unit.

22. In a refrigerating apparatus, a food storage chamber having a relatively small opening in one end thereof, a compressor, a condenser, and an evaporator interconnected to form a unitary structure, the evaporator insertible through the said opening and into the food storage chamber, a plurality of shelf parts removably connected to the evaporator and extending laterally from the surface of the evaporator for supporting material and adapted to conduct heat from the material to the evaporator and having dimension transverse to the evaporator that is greater than the corresponding dimensions of the opening.

23. In a refrigerating system, a refrigerating storage chamber having an opening in one end and a liquid container formed of a plurality of elements, means for interconnecting the said elements, certain of the said elements having hollow shelf parts and means for securing the said container to the wall of the storage chamber and in substantial alignment with the said opening, an evaporator insertible through the said opening and into the container, the container having a liquid non-freezable at operative temperatures of the system and filling the space between the surface of the evaporator and the interior surfaces of the container and the hollow shelves whereby material may be supported on the shelves in intimate heat conductive relation to the liquid in the container and the shelf parts.

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