Aug. 1, 1939. M. H. McMECHAN 2,167,667

MEANS FOR REFRIGERATION

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Fig. 1

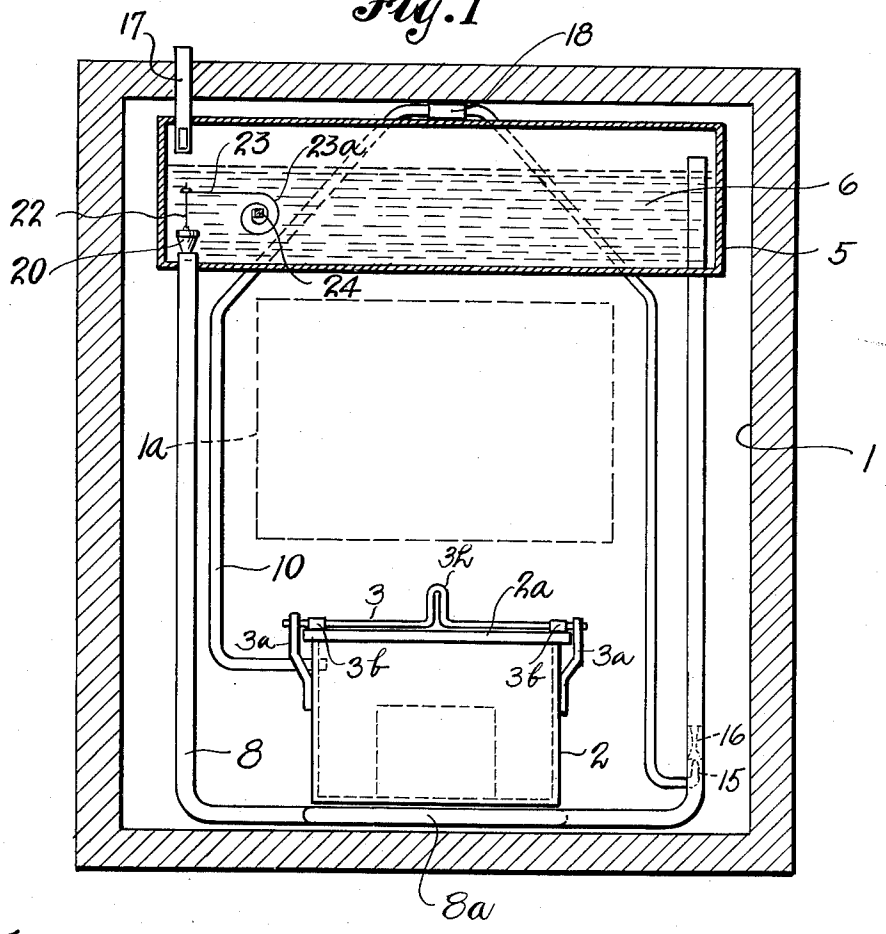
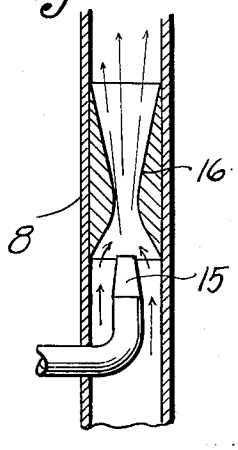


Fig. 2



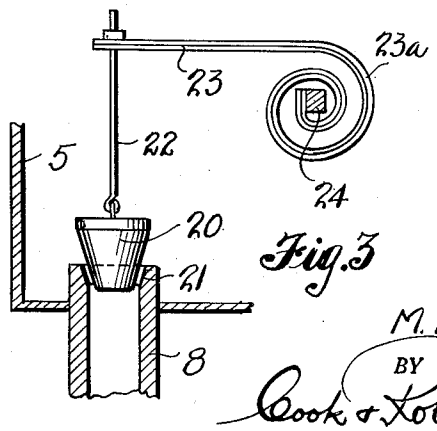
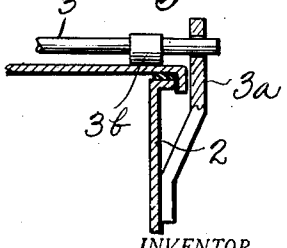


Fig. 3

Fig. 4



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Fig. 5

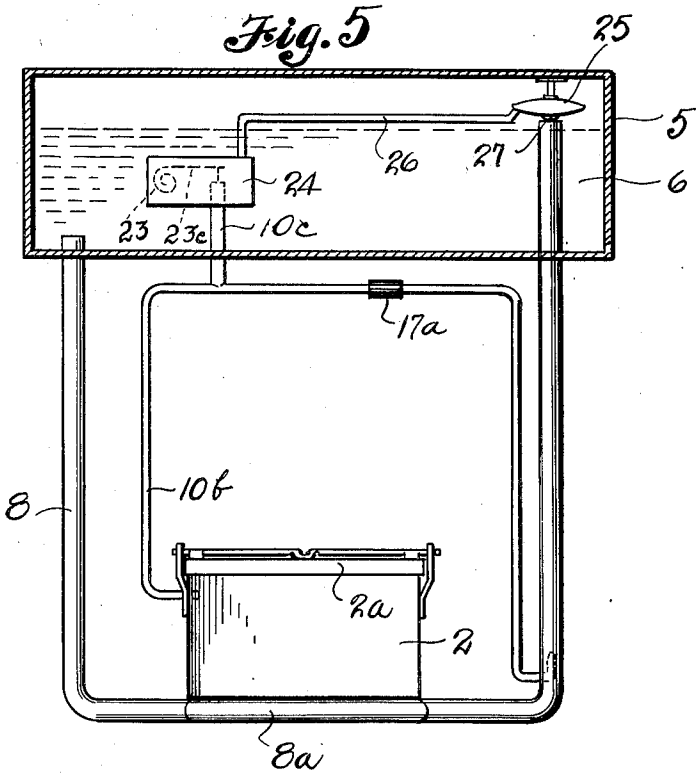


Fig. 6

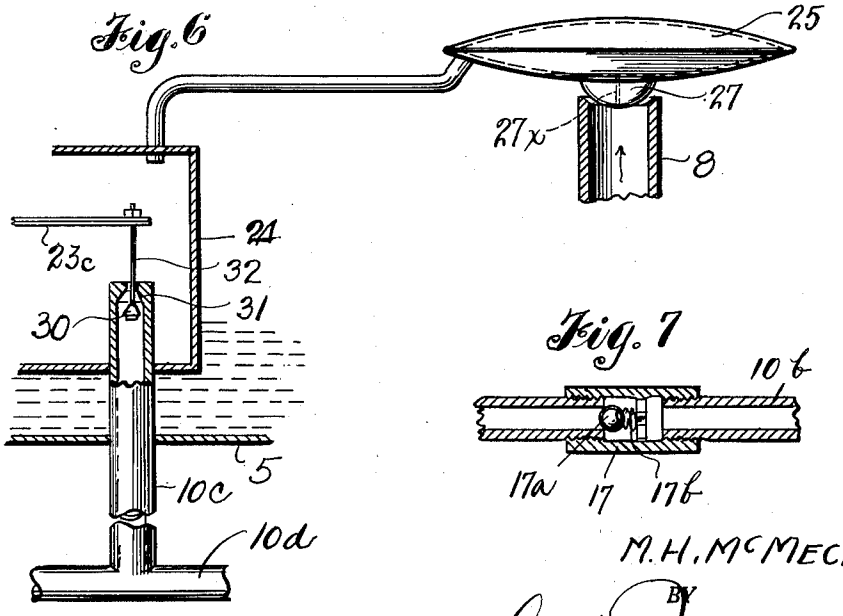


Fig. 7

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Fig. 8

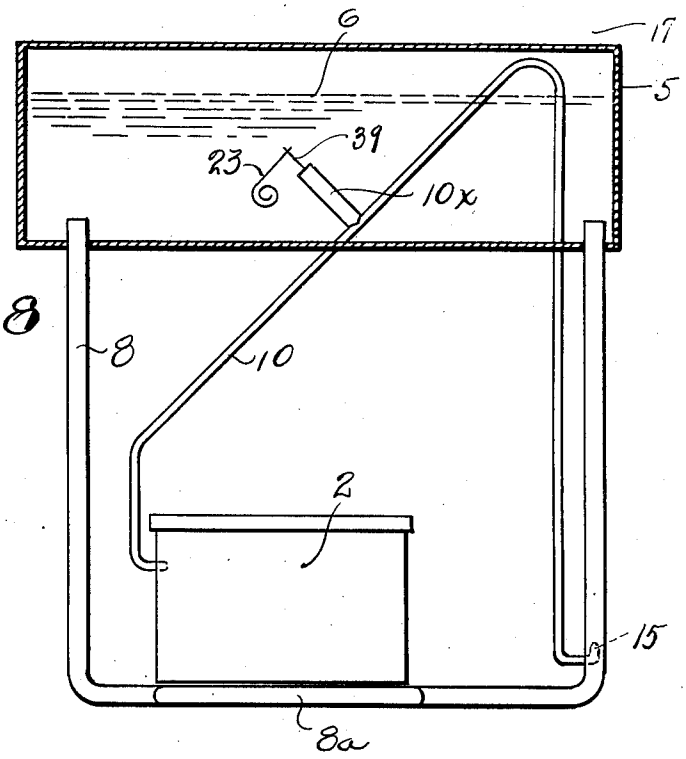


Fig. 9

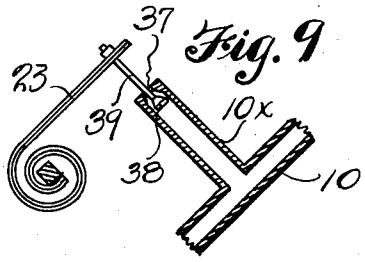


Fig. 10

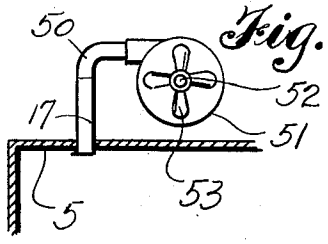
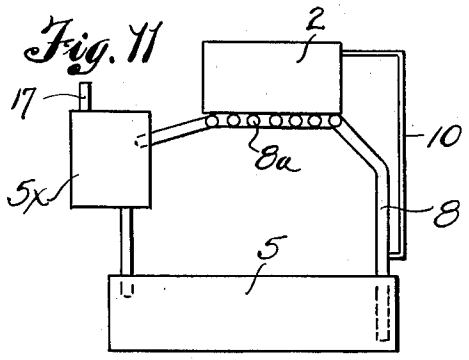


Fig. 11



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UNITED STATES PATENT OFFICE

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MEANS FOR REFRIGERATION

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Application December 27, 1937, Serial No. 181,920

11 Claims. (Cl. 62—91.5)

This invention relates to the art of refrigeration and cooling, and it has reference more particularly to a method of and an apparatus for refrigerating enclosed areas by the circulation therein of a liquid refrigerant which is cooled to a desired refrigerating temperature by means of what is generally known in trade as "Dry Ice", or by any similar product which is the equivalent in its evaporative action to solidified or liquefied carbon dioxide.

The present invention has for its principal object to provide a novel method and apparatus whereby the circulation of the liquid refrigerant, through its circuit about or within the area to be cooled, may be both effected and regulated by utilization of the energy or power that is available in the gas that results from the evaporation of the solidified or liquefied carbon dioxide incident to the absorption of heat from the circulated liquid refrigerant.

More specifically stated, the object of the present invention resides in the provision of novel apparatus whereby the gas which is created by evaporation of the CO_2, or whatever similar refrigerant may be used, incident to its absorption of heat from the circulated refrigerating medium, may be caused to be discharged under pressure into the stream of liquid refrigerant in such direction and manner that it will operate as a propelling means whereby to maintain circulation of the refrigerant in accordance with the rate of generation and pressure of the gas from the carbon dioxide.

It is also an object of this invention to provide means for effecting an automatic temperature regulation in the refrigerated area by the provision of thermostatic means either by controlling the rate or periods of flow of the circulated medium in its circuit, or by controlling the application of the power of the generated gas.

It is also an object to provide for utilizing the energy of discharged gas for creating or facilitating the circulation of air in a refrigerated area.

Another object is to provide an apparatus wherein it is practical to locate the food compartment either above or below the receptacle for the solidified refrigerant.

Still other objects of the invention reside in the details of construction of parts, in their combination and in the method and mode of operation of preferred and alternative forms of construction, as will hereinafter be fully described.

In accomplishing the various objects of the invention, I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein—

Fig. 1 is a view diagrammatically illustrating the present method of refrigeration and a preferred form of apparatus whereby the method may be carried out.

Fig. 2 is an enlarged, sectional detail of the gas delivery nozzle and Venturi passage as provided in the circuit of the liquid refrigerant, for creating circulation of the refrigerant in its circuit.

Fig. 3 is a sectional detail, showing the valve mechanism and one kind of thermostatic control therefor, whereby the circulation of the liquid refrigerant is regulated as a means for maintaining a desired degree of temperature in the refrigerated area.

Fig. 4 is a detail of the refrigerant container cover clamp.

Fig. 5 is a diagrammatic illustration of an apparatus of an alternative form of device utilized for control of temperature.

Fig. 6 is a view showing details of the thermostatic diverting valve and wafer, as used in the device of Fig. 5.

Fig. 7 is a detail of the back check valve used in the gas line.

Fig. 8 is a view diagrammatically illustrating still another alternative apparatus for control of gas delivery and circulation of the liquid refrigerant as a means of temperature regulation.

Fig. 9 is an enlarged sectional detail of the control mechanism as used in the apparatus of Fig. 8.

Fig. 10 is a view diagrammatically illustrating means for utilizing escaping gas as a means for facilitating circulation of air within an enclosed, refrigerated area.

Fig. 11 diagrammatically illustrates an alternative construction wherein the ice box is located above the brine storage tank.

In the following description the word "ice" will be used to designate the solidified refrigerant which, as was previously explained, might be solidified carbon dioxide, CO_2, or any equivalent product suitable for refrigeration, either of a solid or liquid nature which creates a gas incident to its absorption of heat.

Referring more in detail to the drawings—

The present method and apparatus, while especially useful for all kinds of domestic and commercial refrigeration, is also quite applicable to the cooling or refrigerating of trucks, railway cars or other vehicles which may be used in the

transportation of perishable products, and in the following description, it is intended that the apparatus shall be considered to be of a construction applicable to any of these uses.

As a matter explanatory to the present invention, it will here be mentioned that solidified carbon dioxide, or what is commercially known as "dry ice" has not been used heretofore to any material extent either in domestic refrigeration or in trucks and railway cars, principally because few practical means have been developed for controlling the rate of use of the refrigerant. The usual procedure has been merely to place a certain quantity of solidified CO_2 in an enclosure or area to be cooled, and to permit it to evaporate under no control whatsoever. As a result, products adjacent or close to the refrigerant became frozen too hard and those further away from it were very apt to be inadequately cooled. In some instances, a circulated liquid refrigerant has been employed in connection with use of CO_2, but in such cases, circulation of the liquid refrigerant has been either by natural flow, which is inadequate, or by use of power propelled electrical or mechanical devices, which were undesirable by reason of adding greatly to the expense of equipment and operation, and in most cases, were impractical because of the cost of operation.

In view of the undesirable and inadequate features of systems as heretofore generally used, the present method and apparatus has been designed to make practical the use of solidified CO_2 for both large and small plants and to eliminate the necessity for mechanical or electrical means for effecting circulation of the refrigerant by a utilization of the energy in the gas generated by the evaporation of the CO_2 as a means for effecting circulation of the liquid refrigerant in the cooling circuit.

Referring now to the disclosures of Figs. 1, 2, 3 and 4, which show a preferred form of apparatus for domestic use: 1 designates an enclosed area to be refrigerated; it being understood that this area might represent the refrigerating compartment of a refrigerator either for domestic or for commercial uses, or it might be the area within a refrigerator car, boat or vehicle designed for the transportation of perishable products.

Within the enclosed area 1 which would be suitably insulated, and preferably below the food compartment designated at *1a*, is a metallic container 2 for enclosing therein a quantity of a solidified refrigerant, such as carbon dioxide; this container, in the present instance, being of a box-like form, and equipped with a removable lid or cover *2a*. This cover is adapted to be held tightly closed by any suitable means to retain gas under pressure in the container. The means now employed for clamping the cover in closed position comprises a cross rod 3 adapted to seat at its ends revolubly in notches in straps *3a* fixed to the side walls of the container 2. On the rod are cams *3b* adapted, by rotation of the rod, to press the cover down in sealed position. A handle 3L is provided on the rod for rotating it to release or clamp the cover. A gasket 4 is interposed between the cover and top edge of the container to seal the joint. When the handle is in released position, the rod may be unseated for removal of the cover.

Located at a suitable distance above the ice container 2 and usually above the compartment *1a*, is a closed storage vessel, or tank 5 containing a liquid refrigerant or brine suitable for circulation in a pipe system; the liquid being designated at 6.

Leading from the base of the tank 5 is a pipe line 8 for circulation of the liquid refrigerant. This pipe extends downwardly from tank 5 and may be formed into a series of loops or coils *8a* in close proximity to, or located within the walls of the container 2, and then extends upwardly into tank 5 through a sealed wall joint and opens into the tank. As here shown, the upper end of this end of the pipe opens above the level of liquid 6, but this is not necessarily so. Furthermore, a closed, flat tank or pan of brine may be employed in the container 1 in lieu of the coils *8a*.

It is to be understood that the pipe 8 is continuous and normally is filled with the liquid refrigerant. The refrigerant in the pipe will be cooled in coils *8a* by reason of the close proximity of the coils to the solidified refrigerant in container 2, and the extraction of heat from the contained liquid by the refrigerant. This pipe also extends through, about, or adjacent the food compartment *1a* for the cooling of the products which may be contained therein.

Leading from the container 2 is a gas discharge pipe 10. In a preferred arrangement, the pipe 10 extends upwardly to a height above the level of liquid refrigerant in tank 5 and then turns downwardly and enters the discharge end portion of pipe 8 preferably close to the container 2. The pipe 10 provides for the discharge into the pipe line 8, of gas that is created in tank 2 by reason of evaporation of the solidified carbon dioxide that is incident to its absorption of heat. This discharge of gas creates a pressure in pipe 8 whereby to induce circulation of the liquid.

In Fig. 2 is shown the details of construction of a gas delivery jet or nozzle at the discharge end of pipe 10 and a Venturi tube for augmenting the circulation of the liquid refrigerant in pipe 8 and tank 5. It will be noted in this illustration that the discharge end of pipe 10 terminates in a nozzle 15 directed toward the outlet end of pipe 8 into tank 5. This nozzle discharges the jet of gas directly through a Venturi tube 16 set in pipe 10, whereby to create a certain degree of suction that supplements the drive of the gas jet to increase the rate of circulation of the liquid refrigerant in its circuit.

Gas discharged into tank 5 from pipe 10 escapes from the system through one or more relief vents or pipes 17 in the top of tank 5; this gas, in some instances being utilized as will presently be explained.

It is desirable, in order to prevent any possibility of back flow of liquid refrigerant into the container 2, to locate a back check valve, as at 18, in the pipe line 10, preferably at a point above the level of liquid in the tank 5; it being understood that without such a back check valve, there is a possibility, especially in moving vehicles, that liquid might flow back through the discharge end portion of pipe 8, nozzle 15 and pipe 10 into the container 2, and this is undesirable.

For the purpose of regulating the temperature in the enclosure 1, there is provided a means for controlling the circulation of the liquid refrigerant. As seen in Figs. 1 and 3, a valve plug 20 is adapted to be lifted from and lowered against a ground valve seat 21 in the open end of pipe 8 through which liquid enters the pipe system from tank 5. This valve plug is suspended by a flexible cord 22 from the outer or movable end of a by-metal, thermostatic arm 23. The arm 23 is formed at one end into a spiral coil *23a* which

is fixed solidly at the inner end of the coil to a post 24 in tank 5. The arm and valve plug are so adjusted that, at a certain predetermined temperature of the liquid refrigerant in the tank 5, the valve will be lifted from the seat 21 and circulation of the liquid medium through pipe 8 will be permitted. When the temperature of the liquid in tank 5 becomes cooled to a predetermined, lower degree of temperature, the valve will again be seated to stop circulation as a means of preventing further cooling or lowering of temperature.

It is to be understood that any suitable, or standard type of adjustable thermostat may be employed for this purpose in lieu of that shown.

With the apparatus so constructed, it is apparent that the solidified carbon dioxide (CO_2) placed on the sealed vessel 2 will draw heat from the adjacent or surrounding pipe coils 8, and in accordance with the absorption of heat, the solidified refrigerant will evaporate and a gas thereby created. This gas, being confined in the closed vessel 2, will be discharged under pressure through pipe 10, past the valve 18 and through nozzle 15, into pipe 8. The force of the gas jet, augmented by the delivery of the jet through the Venturi tube 16, will create a forced circulation of the liquid medium in pipe 8, and tank 5, thus to effectively cool the enclosed area. When the temperature of liquid in tank 5 is lowered to the desired predetermined degree, the valve plug 20 is automatically seated, thus to stop circulation and prevent any further lowering of temperature.

The closing of the valve and incident stopping of circulation of the liquid refrigerant permits the temperature of the liquid in the tank to rise. Thus, when it reaches a certain degree, the valve plug is again lifted, circulation is resumed and the temperature again lowered to the desired degree.

The gas that is discharged through the pipe 10 into the tank 5 escapes through relief pipe 17.

Referring now to Figs. 6, 5 and 7, which illustrate a modified, or alternative construction, it will be observed that the gas discharge pipe 10*b*, corresponding to pipe 10 in the device of Fig. 1, extends from container 2 into pipe 8 at a point below tank 5, and is equipped with a back check valve as at 17*a*. Leading upwardly from the pipe 10*b*, and through the bottom wall of tank 5 into a liquid tight box 24, is a gas by-passing pipe 10*c*, and leading from the box 24 into an expandible wafer 25, that is supported closely above the upper end of the discharge portion of pipe 8, is a pipe 26. This wafer has a valve gasket 27 on its under side and the arrangement of the wafer and gasket relative to the pipe end is such that when the wafer is expanded by delivery of gas under pressure thereinto, the gasket will be seated against the open, upper end of pipe 8 to close it and thus stop the circulation of the liquid medium in pipe 8 as a means of preventing any further lowering of its temperature in tank 5. Also, the gas then discharged into pipe 8 will cause a backing up of the liquid in the pipe line, finally leaving no liquid in the coils to freeze.

The application of gas to the wafer 25 is under control of a valve 30 located in the open upper end of pipe 10*c*. A valve seat 31 is provided in the pipe, and the valve 30 is fixed on a rod 32 whereby to be lifted against the seat. The upper end of rod 32 is attached to the arm 23*c* of a thermostatic element 23, enclosed in the box 24 and which may be like that used in the device of Fig. 1, or any other device suitable for that purpose. It will thus be understood that in this construction, the temperature in the enclosed area is controlled by the flow of liquid refrigerant, and this, in turn, is controlled by the action of the flexible wafer. The ball check valve 17*a*, as seen in Fig. 7, is held yieldingly seated by a light, coiled spring 17*b*, thus to insure that pressure of gas will be diverted to the diaphragm when valve 30 is opened.

When valve 30 is closed, the gas in the wafer escapes through a small relief port 27*x* opening downwardly through washer 26, allowing the wafer to collapse and the liquid to resume circulation.

In Figs. 8 and 9 is illustrated still another means for temperature regulation, wherein the pipe 10 extends upwardly from vessel 2 into tank 5, the same as in the device of Fig. 1, and is provided, in the tank, with a lateral discharge pipe 10*x* equipped at its end with a discharge opening 37, see Fig. 9, controlled by a valve 38 on a stem 39 connected to the thermostatic element 23. When the temperature of liquid in tank 5 is above a certain desired degree, the valve will be held closed and all gas will be diverted into pipe 8 to cause a normal circulation of the liquid refrigerant, as previously explained, and a gradual lowering of temperature of the liquid, but when the temperature reaches a desired, lower degree, or is below that desired degree, the valve is opened and the gas is by-passed through the outlet 37; thus the circulation of the liquid stops with the result that the temperature of liquid rises until the valve is again closed to cause a resumption of circulation of liquid.

When refrigerating systems of this character are employed for the cooling of relatively large areas, it is sometimes desirable, in order to maintain a uniform condition of refrigeration in the entire area, that the air be circulated in the enclosed compartment. In the present instance, I contemplate utilizing the energy of gas escaping from the tank 5 for the purpose of maintaining a circulation of air and for this purpose, I have provided a pipe 50, as illustrated in Fig. 10, for conducting the escaping gas from the pipe 17 into a turbine motor 51 which may be of any suitable construction and which has its drive shaft 52 extended to a suitable location and there equipped with air propulsion fan 53. It is to be understood that the means illustrated in this figure, 9, is merely diagrammatic and is only for the purpose of illustrating the utilization of energy in the escaping gas for the purpose of creating or aiding in the circulation of refrigerated air in a closed compartment. Other forms of motors, fans or the like, might be employed for this purpose and propelled by the action of the gas created in the compartment 2 either before or after it is directed into the pipe line 8 as a means of facilitating the circulation of the liquid refrigerant.

It is to be understood that the design of the ice containing compartment 2, the tanks 5 and the coils 8, in any case, would be dependent, to a certain extent, upon the type or character of the refrigerator with which they are to be employed and the use to which the refrigerator is to be put. Therefore, it is not the intention that the present claims should be confined or limited by the disclosures with reference to design, size, proportion, etc., but that they shall be given the broadest interpretation possible commensurate with the spirit of the invention as herein disclosed.

The particular advantage in apparatus of this character is that no auxiliary power devices are required for the circulation of the liquid refrigerant, and that the temperature may be automatically regulated. These advantages make the method and equipment especially useful for home use, and also for large plants, either in stationary or traveling vehicles, as well as for ice cream caminets, frozen food cabinets, etc.

In Fig. 11, the brine tank **5** is located below the ice box **2**. Gas from the ice box is delivered through a vent pipe **10** into the pipe **8** as illustrated. In addition to the tank **5** there is a liquid level reserve tank **5x** with vent **17**.

Having thus described my invention what I claim as new therein and desire to secure by Letters Patent is—

1. A refrigerating device comprising a cooling enclosure, a gas-tight container for an evaporable refrigerant, a gas vented circuit containing a liquid refrigerant; said circuit passing within the said enclosure and in close proximity to the solidified refrigerant for cooling thereby, a gas discharge pipe leading from the container and into said liquid circuit for a discharge of gas from said container under pressure into the liquid whereby to cause circulation thereof about its circuit and means operated by gas vented from the circuit to create a flow of air.

2. A refrigerating device comprising a cooling enclosure, a gas-tight container for an evaporable refrigerant, a gas vented circuit containing a liquid refrigerant; said circuit passing in cooling proximity to said enclosure and in such proximity to the gas-tight container as to be cooled by the refrigerant therein, a gas discharge pipe leading from the chamber and into said liquid circuit for the discharge of gas from the container under pressure into the liquid in a direction whereby to cause circulation thereof, a valved passage in the liquid circuit and thermostatic means for opening and closing the valve.

3. A device as in claim 2 wherein the said thermostatic means is contained within the circulated liquid.

4. A refrigerating device comprising an enclosure, a gas-tight container in said enclosure for an evaporable refrigerant, a gas vented tank containing a liquid refrigerant, a circulating pipe for the liquid refrigerant leading downwardly from the tank, passing into close proximity to said container for cooling thereby and then discharging into said tank, a gas discharge pipe leading from the said container and opening into the discharge end portion of said circulating pipe in the direction of flow for discharge of gas under pressure to effect circulation of the liquid, a valve disposed in position to close the receiving end of the circulating pipe and a thermostatic means under control of temperature of the liquid for controlling the opening and closing of the valve.

5. A device as recited in claim 4 wherein the gas discharge pipe forms a loop that extends above the level of liquid in the said tank.

6. A device as recited in claim 4 wherein the gas discharge pipe has a back check valve therein.

7. A device as in claim 4 including an air circulating motor operable by the energy of gas vented from the said tank.

8. A refrigerating system including an enclosed area, a gas-tight container for an evaporable refrigerant, a vented brine tank, a brine circulating pipe leading from the tank into such proximity to the container as to be cooled by the refrigerant and having its discharge end opening into the tank, a gas delivery pipe leading from the container and opening into the discharge end portion of the brine circulating pipe for discharge of gas under pressure to create circulation of the brine, and a by-pass for the gas leading from said gas delivery pipe directly into the vented tank and a thermostatically controlled venting valve for said by-pass and adapted to be held open when the temperature of brine in the tank is below a predetermined degree.

9. A refrigerating system including an enclosed area, a gas-tight container having a solidified evaporable refrigerant, a vented tank above the container for a liquid refrigerant, a circulating pipe leading from the tank into such proximity to the container as to be cooled by the refrigerant and having its discharge end opening into the tank, a gas delivery pipe leading from the container and opening into the circulating pipe for discharge of gas under pressure in a manner to create circulation of the brine, a by-pass pipe for the gas leading to an expandible wafer in the brine tank, a normally closed valve in the by-pass, thermostatic means for opening the valve for by-passing of a gas to the wafer to expand the latter, and means on the wafer for sealing the discharge end of the circulating pipe when the wafer is expanded.

10. A device as in claim 9 wherein the wafer has an escape vent for venting gas into the circulating pipe to deflate the wafer when the by-pass valve is closed.

11. A device as in claim 9 wherein a back check valve under light spring pressure is located in the gas discharge pipe between the by-pass connection and the end of the gas pipe which opens into the circulating pipe.

MAURICE H. McMECHAN.