Jan. 3, 1933. L. G. COPEMAN 1,893,228

METHOD AND APPARATUS OF REFRIGERATING

Filed April 16, 1931 2 Sheets-Sheet 1

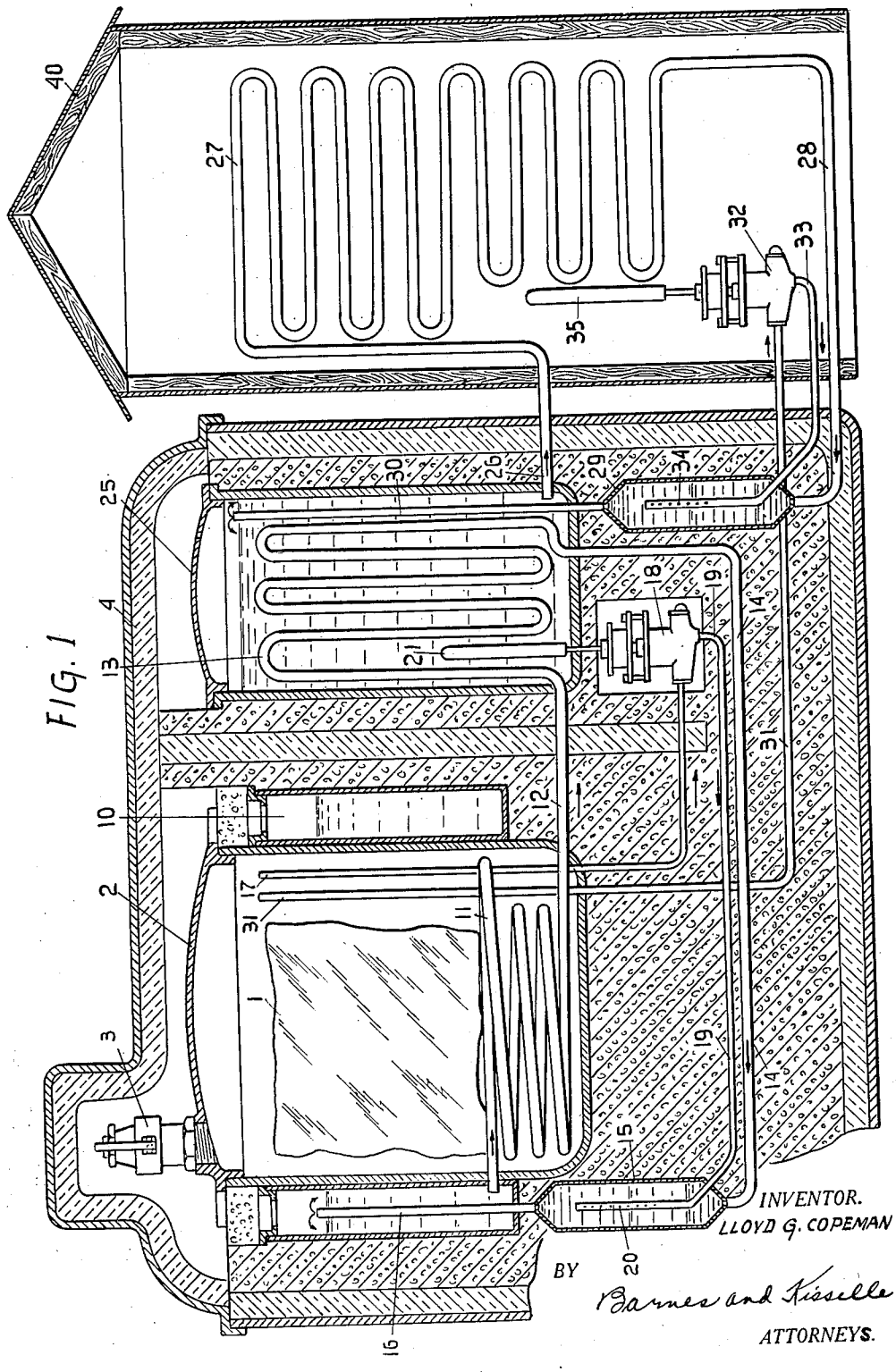


FIG. 1

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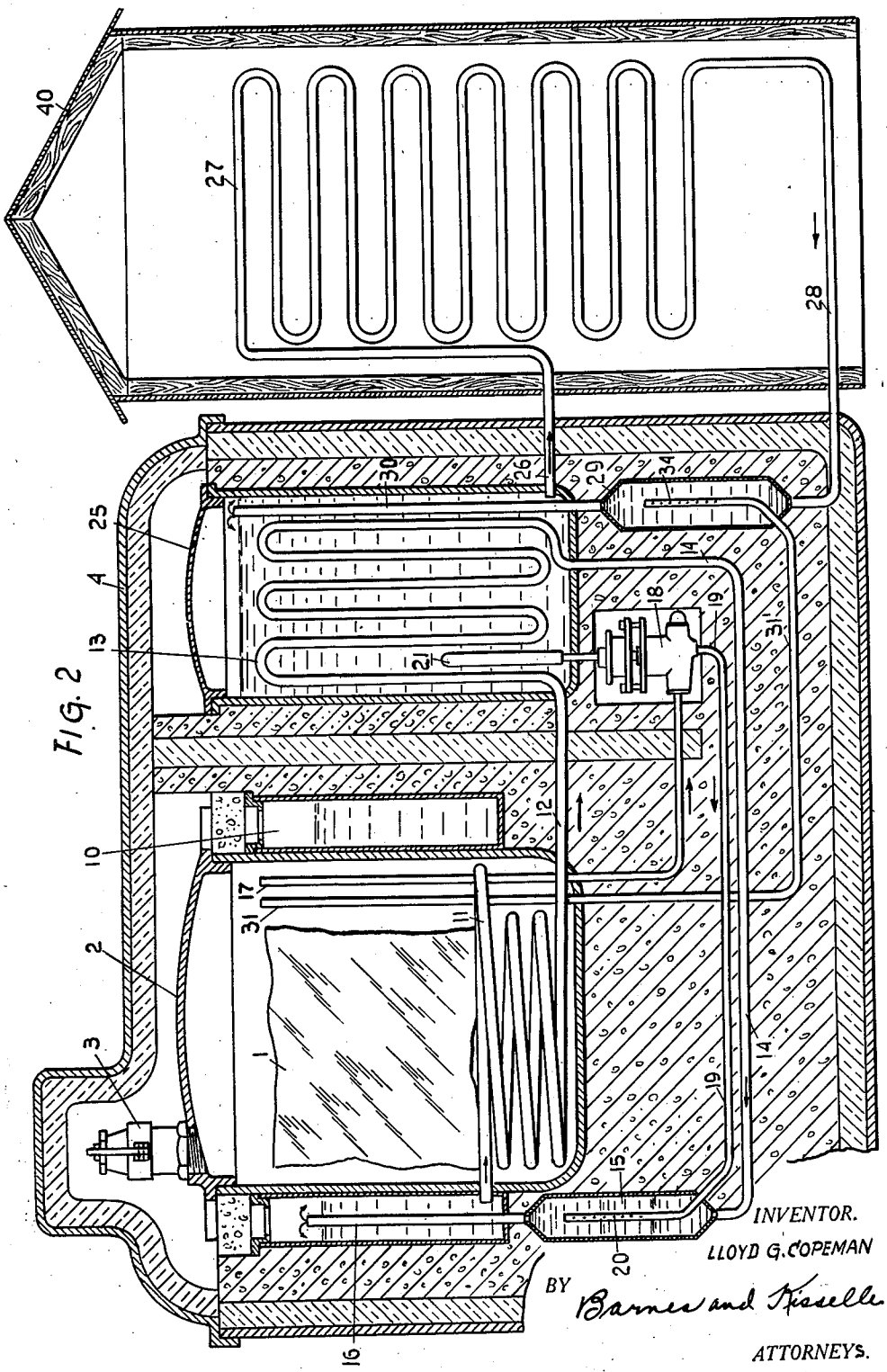


FIG. 2

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Patented Jan. 3, 1933

1,893,228

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR REFRIGERATING

Application filed April 16, 1931. Serial No. 530,545.

This invention has to do with the refrigerating art and it is concerned particularly with a refrigerating system which employs as the cold-producing medium a substance which gasifies from solid form, as for example, solid CO_2. A circulatory system of a suitable liquid or refrigerant is employed—any suitable liquid for the purpose may be used; we shall, however, term this liquid "brine" for the purpose of brevity and clarity, it being understood that the word "brine" is used in a broad sense and intended to include any liquid suitable for the purpose.

Brine is cooled or chilled by the absorption of heat therefrom in the evaporation of the solid CO_2 and the chilling of the brine may be such that its temperature may be far below the temperature which is desired in a compartment which is to be refrigerated. In other words, for example, let us assume that a compartment to be refrigerated is to be maintained preferably at or about zero degrees Fahrenheit. The chilled brine may reach a temperature many degrees below zero Fahrenheit. This represents such a large differential that if this chilled brine is conducted through cooling coils in the compartment to be refrigerated it is difficult to maintain zero temperature in the refrigerated compartment in a uniform manner. In other words, while the top of the compartment may be about zero degrees F. the bottom may be considerably below zero degrees F. thus representing a differential temperature from top to bottom in the refrigerated compartment; and/or the compartment may be at or about zero degrees F. at a point therein remote from the brine coils yet considerably below zero degrees F. next adjacent or in close proximity to the brine coils. In short, the temperature in the refrigerated compartment may not be uniform.

The present invention contemplates a method and apparatus for refrigerating in such wise that a greater degree of uniformity of temperature in the refrigerated compartment may be maintained. Suitable controlling thermostats may be provided in carrying out the invention.

In the accompanying drawings:

Fig. 1 is a diagrammatic lay-out with some parts shown in section illustrating the method and apparatus of this invention.

Fig. 2 is a similar diagrammatic lay-out showing another form.

The solid refrigerating substance, such as solid CO_2 is illustrated at 1 and it may be confined in a suitable container 2 provided with a relief valve 3 for some of the gases, and the container 2 together with other parts may be confined in an insulated compartment or chamber 4. The system of refrigerating by employing solid CO_2 or the like is broadly covered in my copending application #496,845, filed November 20, 1930.

Surrounding the CO_2 container 2 there may be a brine receptacle 10 for containing a body of brine which is chilled by the evaporation of the solid substance. This brine is passed through a cyclic path which may be as follows: a coil 11, which may pass through the container 2 to further cool the brine, is connected by pipe 12 to coils 13; coils 13 may, for the return of the brine, be connected by pipe 14 to pipe 16 which returns the brine to the container 10. A suitable device in the form of a chamber or cylinder 15 may be provided through which the brine passes.

The brine may circulate through the above described path following the direction of the indicating arrows and pass through the various elements of its cyclic path substantially in the order in which these elements have been described. The brine may be circulated in this path through the means of gas power derived from the gas, or evaporation of the solid CO_2. For this purpose, a tube 17 may extend into the compartment 2 and lead into a valve housing 18; tube 19 may lead from the valve housing into the cyl-

inder 15 and there be provided with gas discharge apertures 20. Some of the gas in compartment 2 flows through the tube 17, valve housing 18, tube 19, and discharges into the brine through the apertures 20. The discharged gas globules or gas pistons rise through tube 16 effecting movement of the brine upwardly through tube 16 to the end that the brine is moved through its cyclic path and discharged back into tank 10. It is not deemed necessary to illustrate the valve mechanism, as any kind of opening and closing valve may be employed. The valve within the housing 18 is preferably controlled thermostatically as by means of a thermostat having a feeler leg or sensitive element 21. This type of valve control is old in the art and need not be detailed—suffice to say that expanding and contracting gas may be sealed in the leg 21 and its expansion and contraction controls the valve in housing 18.

The above described brine system may be termed the primary brine circulation. The invention contemplates another body of brine which may be and preferably is separate from the primary body of brine, the secondary body of brine being cooled by the first and utilized for refrigerating the compartment. The secondary body of brine is contained in part in the compartment or vessel 25 which may also be within the compartment 4. The secondary body of brine may be moved through the following path; tube or pipe 26 connecting into vessel 25 leading to cooling coils 27; from the cooling coils 27 there may be a pipe 28 which leads the brine to a pipe 30, which discharges the same back into vessel 25. Between pipes 28 and 30 there may be a chamber or cylinder 29 similar to cylinder 15 above described. The secondary body of brine may be circulated also by gas power incident to the evaporation of the solid substance; for this purpose a tube 31, having its open end disposed within the container 2, leads into valve housing 32, and tube 33 leads into cylinder 39 wherein it is provided with gas discharge apertures 34. The pressure of gas within the container 2 causes movement of some of the gas through the tube 31, valve 32 when open, tube 33 discharging the same into cylinder 29; the gas rises through tube 30, carrying with it the brine therein in such manner as to effect movement of the secondary body of brine through the path above described.

A compartment to be cooled or refrigerated is represented at 40 and the coils 27 may be located therein. The compartment 40 may be any compartment which is to be refrigerated, as for example, a large storage chamber or storage warehouse, a railroad car, or a smaller refrigerated compartment or cabinet for commercial or household use. Here again it may be stated that it is not necessary to show the valve details in housing 32. This valve may be thermostatically controlled as by means of sensitive element or feeler leg 35 which may contain an expanding or contracting gas for actuating valve 32.

The operation is as follows:

Assume that it is desirable to maintain a temperature of 0° F. in the compartment 40. When the temperature in compartment 40 rises to a point above 0° the gas in sensitive element 35 expands and opens valve 32. This permits some of the CO_2 gas to pass therethrough to be discharged into cylinder 29 which causes a circulation of the secondary body of brine. The brine which has been warmed by heat absorption in coils 27 is moved back into vessel 25 and the brine in vessel 25, which has been cooled as will presently be described, moves through pipe 26 into coils 27. When the brine movement has been sufficient to lower the temperature in compartment 40 to the desired point, then the valve 32 closes. When the brine in vessel 25 is relatively warm it acts upon the sensitive element 20 to the end that valve 18 opens, and thus some of the CO_2 gases move through this valve to be discharged in cylinder 15 thus setting up movement of the primary body of brine. This causes the chilled brine in tank 10 and coil 11 to move into coil 13 thus cooling the body of secondary brine in vessel 25, and the circulation of the primary body of brine continues until valve 18 is closed.

Accordingly, the valve 32 may be adjusted to maintain a range of temperature in the compartment 40 in the vicinity of the desired temperature to be maintained therein. The brine which enters the coil 13 may have a temperature far below that desired in the compartment 40 but the valve 18 may be adjusted to operate in such manner that the body of secondary brine in compartment 25 is chilled sufficiently to obtain an advantageous refrigerating action in compartment 40. In other words, while the differential between the temperature in compartment 40 and the temperature of the primary body of brine may be great, yet the differential between the desired temperature and compartment 40 and the brine entering coils 27 may be held within relatively close limits so that a wide differential is not present in the compartment 40. In other words, the cooling of the secondary body of brine in the vessel 25 may be controlled to obtain the desirable refrigerating action in compartment 40.

A modified form of the invention is shown in Fig. 2. Many of the parts of the form shown in Fig. 2 are the same as those shown in Fig. 1. Accordingly, they have the same reference characters applied thereto and need not be redescribed. The principal variation resides in that the valve controlling the circulation of the secondary body of brine is dispensed with. It will be noted that tube 31'

enters directly into the cylinder 29; thus so long as there is a body of solid substance in the chamber 2 the secondary body of brine is constantly moving. The thermostatically controlled valve 18 is employed and it is controlled in a manner like that in the Fig. 1 form. In the operation and with the secondary body of brine in constant movement let us assume that the compartment 40 is calling for refrigeration, its temperature having risen above the desired point. This means that the secondary body of brine has been warmed and the valve 18 and its thermostat control may be arranged so that at this time the valve 18 opens with the result that the primary body of brine is circulated and the secondary body of brine in the vessel 25 is cooled to then in turn refrigerate the compartment 40. After this has progressed for a period of time, the brine in tank 25 has been cooled, the temperature in compartment 40 is lowered, and the valve 18 may then close. Accordingly, while the secondary body of brine moves constantly, its temperature is effective for controlling the circulation of the primary body of brine.

In each form of the invention the refrigerated compartment is cooled by a body of brine which is not in itself chilled by direct association with the evaporating CO_2. Thus the differential, as between the desired temperature in the compartment and the temperature of the refrigerating brine as it enters the coils therein, may be held within limits in order to effect a more or less uniform temperature throughout the interior of the refrigerated compartment. The primary body of brine which is chilled directly by the evaporating CO_2 does not directly refrigerate the compartment but is employed as a transfer medium, so to speak.

Substances other than CO_2 may be employed; that is, substances which may change from a solid into a gaseous form directly upon evaporation, and in some of the claims appended hereto the phrase "solid CO_2 or the like" is employed and this is intended to cover other substances which may be employed as the cooling medium. Likewise, the word "brine" is used in the broad sense to include any and all liquids suitable for the purpose. It is entirely feasible that different types of brine may be employed for the primary and secondary circulatory systems. While it is advantageous to impart movement to the brine by the gas power produced by the evaporating CO_2 or the like, it is to be appreciated that the brine may be moved in other ways, as for example, employing a mechanically operated pump system.

Where, in the claims appended hereto, the term "CO_2" is used, such use, it is to be understood, is descriptive and not limiting, as it is the full intention that equivalent substitutes for CO_2 be covered.

I claim:

1. The method of refrigerating which comprises chilling a primary body of brine by bringing it into heat exchange relation with solid CO_2, circulating the primary body of brine in a cyclic path, effecting heat exchange between the primary body of brine and a secondary body of brine relatively remote from the solid CO_2, and circulating the secondary body of brine in a cyclic path through a relatively remote region to be refrigerated.

2. The method of refrigerating which comprises circulating a primary body of brine in a cyclic path, chilling the brine by bringing it into heat exchange relation with a body of solid CO_2 circulating a secondary body of brine in a cyclic path which has heat exchange relation with a region to be refrigerated, bringing the primary and secondary bodies of brine into heat exchange relation, and controlling the flow of the primary body of brine in its cyclic path in accordance with the temperature in the refrigerated region.

3. The method of refrigerating which comprises circulating a primary body of brine in a cyclic path, chilling the brine by bringing it into heat exchange relation with a body of solid CO_2 circulating a secondary body of brine in a cyclic path which has heat exchange relation with a region to be refrigerated, bringing the primary and secondary bodies of brine into heat exchange relation, and controlling the flow of the primary body of brine in its cyclic path by the temperature of the secondary body of brine.

4. The method of refrigerating which comprises circulating a primary body of brine in a cyclic path, chilling the brine by bringing it into heat exchange relation with a body of solid CO_2, circulating a secondary body of brine in a cyclic path which has heat exchange relation with a region to be refrigerated, bringing the primary and secondary bodies of brine into heat exchange relation, controlling the flow of the primary body of brine in its cyclic path by the temperature of the secondary body of brine and controlling the flow of the secondary body of brine in its cyclic path by the temperature in the region being refrigerated.

5. The method of refrigerating which comprises circulating a body of brine through passages having parts in heat exchange relation with a body of solid CO_2, circulating another body of brine through passages having parts in heat exchange relation with some of the passages for the first mentioned body of brine, and having parts in heat exchange relation with a region to be refrigerated, and controlling the circulation of the first mentioned body of brine by the temperature of the second mentioned body of brine.

6. The method of refrigerating which com-

prises chilling a primary body of brine by bringing it into heat exchange relation with a body of solid CO_2, circulating said brine in a cyclic path by gas power produced by evaporation of the solid CO_2, chilling a secondary body of brine by bringing it into heat exchange relation with the primary body of brine, and circulating a secondary body of brine in a cyclic path running through a region to be refrigerated.

7. The method of refrigerating which comprises chilling a primary body of brine by bringing it into heat exchange relation with a body of solid CO_2, circulating said brine in a cyclic path by gas power produced by evaporation of the solid CO_2, chilling a secondary body of brine by bringing it into heat exchange relation with the primary body of brine, and circulating a secondary body of brine in a cyclic path running through a region to be refrigerated by gas power derived from evaporation of the solid CO_2.

8. A refrigerating apparatus comprising a container for solid CO_2, means containing a body of brine in heat exchange relation with the CO_2 and including circulating coils, means containing another body of brine in heat exchange relation with said circulating coils and including other circulating coils in heat exchange relation with a region to be refrigerated.

9. A refrigerating apparatus comprising a container for solid CO_2, means providing cyclic passageways for a body of brine with parts in heat exchange relation with the solid CO_2 and parts remote from those parts in heat exchange relation with the CO_2, means providing cyclic passageways for another body of brine including parts in heat exchange relation with the said remote parts of the passageways of the first mentioned body of brine, means for flowing the second body of brine through its cyclic passageways, and a compartment to be refrigerated with which some of the means containing the second body of brine is in heat exchange relation.

10. A refrigerating apparatus comprising a container for a body of solid CO_2, a brine tank positioned in heat exchange relation with the solid CO_2, circulating coils connecting into the brine tank, means for circulating the brine, another tank containing another body of brine, some of the said circulating coils being positioned within the second mentioned brine tank, circulating coils connecting into the second brine tank and located in heat exchange relation with a region to be refrigerated, and means for circulating both bodies of brine through their tanks and coils.

11. A refrigerating apparatus comprising a container for a body of solid CO_2, a brine tank positioned in heat exchange relation with the solid CO_2, circulating coils connecting into the brine tank, another tank containing another body of brine, some of the said circulating coils being positioned within the second mentioned brine tank, circulating coils connected into the second brine tank and located in heat exchange relation with a region to be refrigerated, and means employing gas power derived from the evaporation of solid CO_2, for circulating at least one body of brine through its tank and circulating coil.

12. A refrigerating apparatus comprising a container for a body of solid CO_2, a brine tank positioned in heat exchange relation with the solid CO_2, circulating coils connecting into the brine tank, another tank containing another body of brine, some of the said circulating coils being positioned within the second mentioned brine tank, circulating coils connecting into the second brine tank and located in heat exchange relation with a region to be refrigerated, and means employing gas power derived from the evaporation of the solid CO_2 for circulating both bodies of brine through their tanks and circulating coils.

13. A refrigerating apparatus comprising a container for a body of solid CO_2, a brine tank positioned in heat exchange relation with the solid CO_2, circulating coils connecting into the brine tank means for circulating the brine, another tank containing another body of brine, some of the said circulating coils being positioned within the second mentioned brine tank, circulating coils connecting into the second brine tank and located in heat exchange relation with a region to be refrigerated, and means governed by the temperature in said region for controlling the flow of the brine through the first mentioned tank and circulating coils.

14. A refrigerating apparatus comprising a container for a body of solid CO_2, a brine tank positioned in heat exchange relation with the solid CO_2, circulating coils connecting into the brine tank, another tank containing another body of brine, some of the said circulating coils being positioned within the second mentioned brine tank, circulating coils connecting into the second brine tank and located in heat exchange relation with a region to be refrigerated, means employing gas power derived from evaporation of the solid CO_2 for effecting circulation of both bodies of brine through their respective tanks and circulating coils, and means governed by the temperature of the brine in the second mentioned tank for controlling the circulation of the brine through the first mentioned tank and its associated circulating coils.

In testimony whereof I affix my signature.

LLOYD G. COPEMAN.