March 25, 1930. J. W. MARTIN, JR 1,752,277

REFRIGERATIVE HEAT INSULATING APPARATUS AND METHOD

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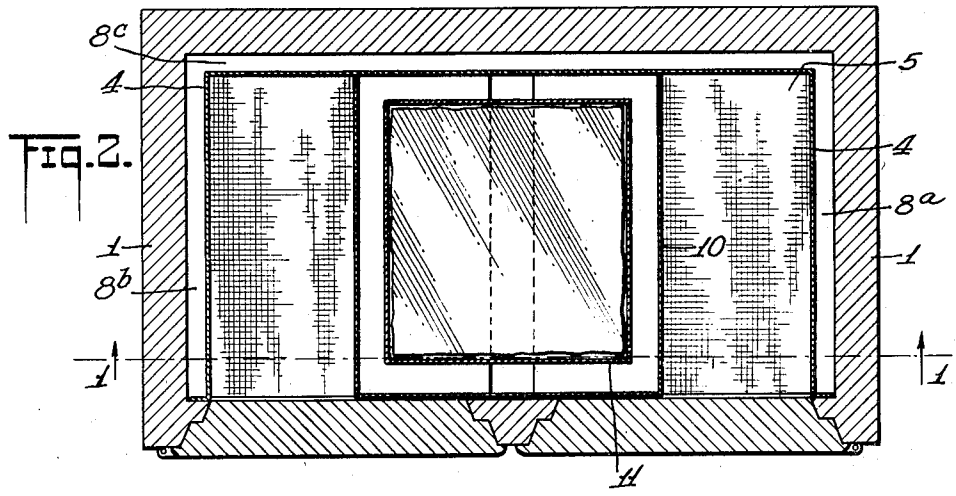


Fig. 2.

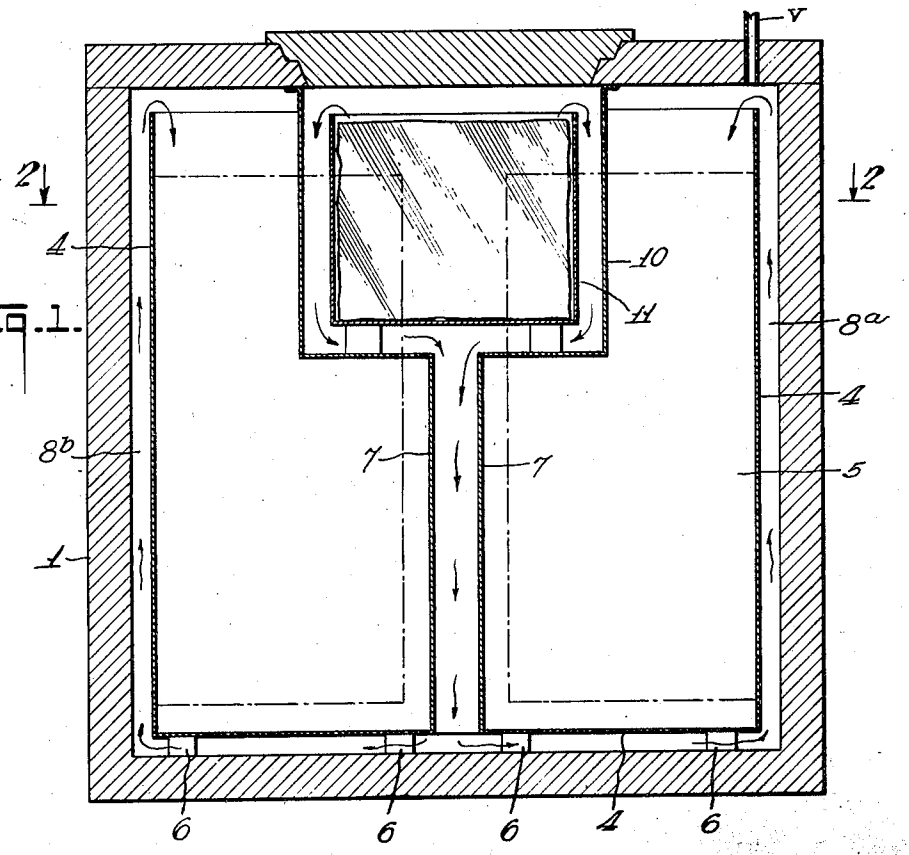


Fig. 1.

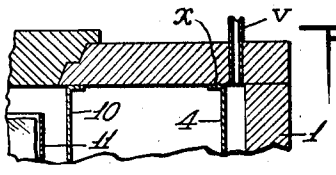


Fig. 6.

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Fig. 5.

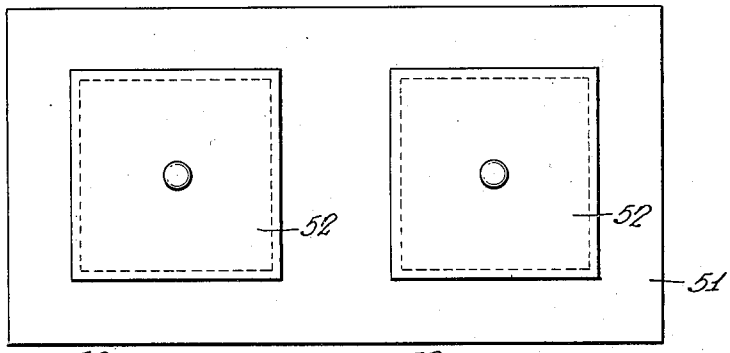


Fig. 3.

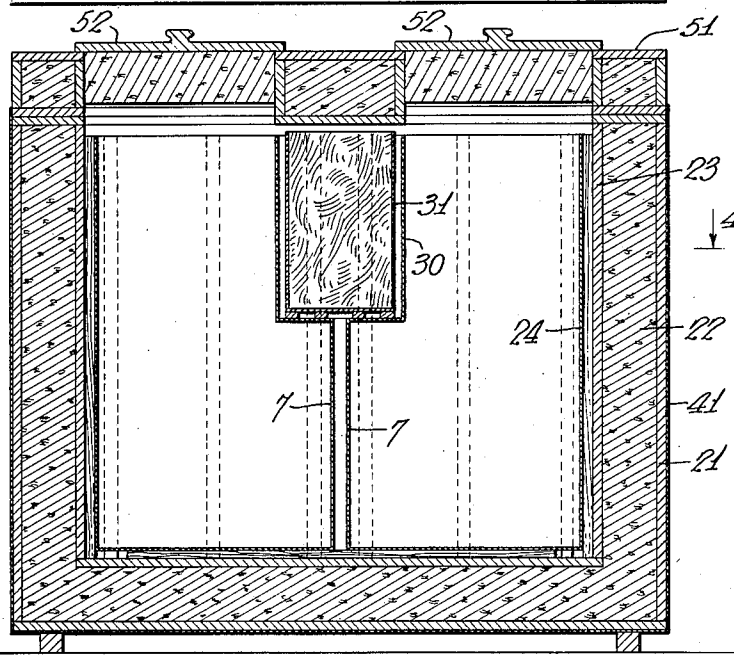
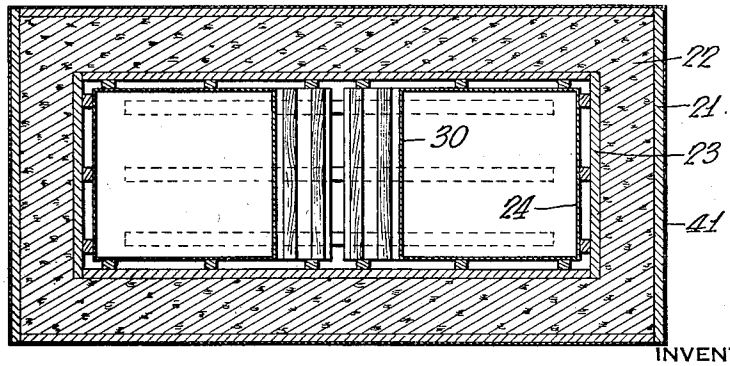


Fig. 4.



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REFRIGERATIVE HEAT-INSULATING APPARATUS AND METHOD

Application filed March 2, 1929. Serial No. 343,988.

My present invention relates to refrigeration by methods and apparatus, some of the primary essentials of which are disclosed in my prior application, Ser. No. 116,103, filed June 15, 1926, and the apparatus actually shown herein includes said features, together with certain variations which will be explained hereinafter.

My present invention is related to that of my said prior application in that it concerns methods of and apparatus for solving certain special problems presented by attempts to employ solid carbon dioxide for ordinary commercial refrigerating purposes. Commercially, solid carbon dioxide in relatively dense form is made either by freezing the liquid directly to the solid blocks or by expanding the liquid to form solid, which is then compressed into blocks of desired density. Among the unique factors involved in the use of such refrigerant are the following:

The solid carbon dioxide melts or rather sublimates directly to a gas, without any intermediate state. The volume of the gas evolved is approximately 500 times the volume of the block, for blocks having a density of about sixty-five pounds per cubic foot. The temperature of the sublimated gas while nominally, approximately 114° F. below zero, may vary within wide limits above and below this temperature, which may be roughly indicated as somewhere between −85° F. and −140° F.

My prior application has been amended and is now directed more particularly to controlling this wide variation of temperature by thermo circulation of the gas through counterbalancing columns of gas and by accelerated or retarded sublimating rate, specifically by varying the percentage of air in the circulating refrigerant medium or by varying the rate of flow thereof, or both, and while my present apparatus may operate in accordance with said principles, the subject matter herein set forth is not limited to such methods of control. Moreover, the solid carbon dioxide is shown as located in a container open for escape of gas, at the top only, so that the gas surrounds and submerges the solid.

Furthermore, in said prior application, it is set forth that heat insulation, meaning insulating material such as balsa wood, cork, kapok and the like, as material for the exterior walls of the refrigerator, may be disregarded because it is well understood that the sublimating rate will be greater or less according as this kind of insulation is greater or less, and, as stated in said application, the problems there concern the active or dynamic factors of the sublimating rate.

On the other hand, my present invention is directed more particularly to the heat insulating material of the walls and to the effective use of the dry carbon dioxide gas which is given off by the sublimating solid carbon dioxide and to this end, said gas is brought in direct contact with the insulating material, preferably before the gas has had an opportunity to pick up much moisture. The thermo circulation to which my said application, Ser. No. 116,103, is more particularly directed or, even better, the forced circulation to which my application, Ser. No. 324,639, is more particularly directed, insures proper flow of dry gas to the insulating material of the walls, but any system wherein reasonably dry gas copiously bathes the insulation material of the walls is within the scope of my present invention.

The fact is that carbon dioxide gas is an effective chemical dryer as regards moisture in cells as well as on the surface of cellular insulating materials such as kapok, cork, balsa wood, soft wood and even hard wood, and if the gas is reasonably dry, it has a remarkable chemical effect as well as absorbent effect, in drying as well as displacing air from such cellular materials.

In ordinary refrigerators there is an appreciable deposition of moisture in the insulation. This deposition occurs when, due to normal termally induced air currents, air at room temperature is drawn in through leaks in the upper portion of the outer walls of the refrigerator and is voided through the lower portions of the shell. During its passage through the cooler insulation mass its water carrying capacity is lowered and water is deposited in the insulation.

Even where a relatively tight outer shell or coating is used, the actual "breathing" of the insulation space takes place, due to the fluctuations in volume of air content brought about by temperature changes. There have been occasions where water has in this manner so saturated the insulation mass that it actually dripped from the insulation. It has been proved that such deposits of moisture may decrease the insulating value of said material as much as 75%.

On the other hand, dry carbon dioxide gas is not merely an absorbent like dry air would be. It is also an active chemical dryer, the chemical reaction set up being thought to be CO_2 plus H_2O equals H_2CO_3. This reaction first operates on the suspended vapor and on the exterior surface films of moisture on the fibers of the insulation. This solution of CO_2 in water, probably H_2CO_3 (carbonic acid) has less vapor tension than water and evaporates more easily, but in addition there is an osmotic pressure operating to transfer CO_2 through the cell walls and change the interior water to this more easily vaporized acid.

From the above, the advantage of my invention will be obvious since it provides not only for keeping the material dry, but also for making it drier than it was when originally installed, plus the superior insulating value of the carbon dioxide gas as contrasted with air.

In the accompanying drawings,

Fig. 1 is a characteristic vertical section, in the nature of a diagram illustrating my present invention;

Fig. 2 is a section on the line 2, 2, Fig. 1;

Fig. 3 is a similar view illustrating a more concrete embodiment of a slightly different form of the invention;

Fig. 4 is a section on the line 4, 4, Fig 3, the solid carbon dioxide and container therefor being removed; and

Fig. 5 is a top plan view; and

Fig. 6 is a fragmentary detail of a modification.

The outer wall 1, with which my prior application was not particularly concerned, may be of almost any cellular insulating material and construction, provided the inner surface be not protected with metal but be left exposed to the gas. This does not prohibit ordinary shellac varnish and many other similar materials which experience has shown do not protect wood, cork or the like, from permeation by dry carbon dioxide gas. A convenient way for insuring effective application of the dry gas to the cellular insulating material of the walls is to have it circulate in the interspace between said walls and an interior can-like structure 4 within the interior 5 of which the products to be refrigerated are enclosed. In the drawing the metal structure 4 is shown as divided into two such storage spaces by double wall partition 7, 7, but it is obvious that the functioning would be the same for either half, if the other half were omitted.

At the top of the double wall partition is shown an enlargement 10, to serve as a bunker for the supply of frozen carbon dioxide. This inner container structure is of sheet metal, because this is one of the few known materials impermeable by the gas, and the metal is carefully soldered, brazed or otherwise made gas-tight except for the top, which may be left open as shown, or may be closed in, according to the principles set forth in either one of my prior applications above referred to. Where side opening doors are provided, the door openings in container 4 will be sealed air-tight about the door openings in the insulating casing, certain asphalt compositions being preferable for this purpose.

Within the bunker 10, preferably spaced apart from the walls thereof, there is an inner water-tight, gas-tight box 11 containing the solid carbon dioxide, as shown. This box being tight, the solid carbon dioxide is kept bathed in an atmosphere of the dry gas which it generates. The excess gas as generated escapes through the top of the container as indicated by the arrows. If this container has a cover, more or less pressure may be maintained within the can 11, but the gas will force its way out the joint or through a high level vent which may be provided for the purpose. The escaping gas flows down in the interspace between the box 11 and bunker 10 and down through the interspace of partition 7, 7. Thence its path of escape is laterally along the floor of the insulating casing and upwardly in the interspaced 8^a, 8^b, 8^c. Spacing blocks or cleats 6, 6, may be provided to support both the metal container structure 4 and also the inner metal box 11.

The above arrangement constitutes one means in causing the dry carbon dioxide gas evolved in the bunker, to reach the insulating material of the casing in a substantially dry condition. It will be noted, however, that the gas starting at a very low temperature, say, $-110°$ F. more or less, is continuously being warmed up so that its vapor carrying capacity is being steadily increased by flow from colder to warmer regions. Consequently, it may contain or pick up some moisture before there is any tendency to deposit it, but to be a very active drying medium, it is desirable to prevent its contact with the refrigerated products until after it has acted on the insulation.

As explained above, the drying effect here contemplated is not merely a surface drying. The gas actually penetrates the material of the above mentioned cellular types, wood, cork, kapok, etc. If the exterior is as exposed

as the interior surface of the insulation, large amounts of the gas will ooze directly through, carrying heat and moisture outward through the wood. If outwardly restrained as by metal walls, there will be substantial up-circulation of gas in the material of the cork, etc.

If the ooze out of the gas in this way is too rapid it may be prevented, as in Figs. 3 and 4 by encasing the insulating container 1 in a seamless outer metal container 41, from which the gas can only escape over the top; or it may be partially prevented and controlled to any desired degree by coating said container with less impervious material.

In Figures 3, 4 and 5, I have shown a more concrete embodiment of a metal protected insulated casing which is extraordinarily effective. In this case there is an outer box 21 of hard wood adapted to afford physical strength and protection for a heavy insulating lining 22, which may be balsa wood, corkboard or compressed kapok. This insulating material may or may not be protected by an inner wooden lining 23, since the joints and the material of such a casing afford astonishingly small barrier to the passage of gas into the insulation 22 and into the material of the outer casing 21. The inner metal can structure 24 is quite similar to that in Fig. 1 as concerns being gas-tight, and supported away from the walls of the insulating casing so as to leave an interspace for the circulation of the dry carbon dioxide gas; also as affording two separate containers for material to be refrigerated, a bunker 30 containing metal box 31 in which the solid carbon dioxide is placed and out of the top of which the gas therefrom flows through the interspace between 30 and 31 and between the walls of hollow partition 7, 7.

This structure differs from that of Fig. 1 in that the two compartments afforded by the container 24 are accessible only from the top, thus making unnecessary the care which is required to seal this container to the outer container where doors are laterally open.

The outer container 21 may be cased in a water-tight, gas-tight metal container 41, which extends to a level near and preferably above the top of the insulating casing 1, and the latter in turn preferably extends above the top of the inner metal container 24, but these features, though important, are not essential to my present invention.

Thus arranged, the dry gas flowing in the interspace between the lining 23 and the container 24 readily oozes through the inner lining 23, the insulating material 22 and the protective wood casing 21, but further escape is absolutely blocked by the gas-tight outer container. Consequently, in this structure there will be a circulation of gas in the insulating material 22 similar to and in parallel with the free flow through the interspaces between 23 and 24, but none of the gas can really escape to the outside except by flowing over the top lip of the outer sheathing 41.

As shown, the top of the refrigerator is closed in by a removable cover 51, which is shown as provided with surface manholes with removable insulating covers 52. In this case the entire cover may be removed for replenishing the solid carbon dioxide in the box 31, but obviously the cover may be proportioned so that there could be a third manhole and plug cover for this purpose.

This structure differs from that shown in Fig. 1 in the detail that while the refrigerant container 31 is closed in gas-tight on four sides, the bunker 30 in which it is contained, is open at the ends. Consequently, while the gas spills over the top of the box 31 as before, it is then free to flow not only down through partition 7, 7, but also endwise directly into the front and rear circulatory spaces. This provision is desirable because of the proportions of the device which render the front and back wall insulation twice as great in area as the end wall insulation.

While I have shown structures in which the carbon dioxide gas is discharged into the refrigerating space after it has operated on the insulating walls, it will be evident, that the gas may be closed off from access to said space and vented directly outside as indicated at x, Fig 6.

It is also evident that the principles of construction and operation herein disclosed may be embodied in other structures adapted for special uses, as for instance transportation containers, motor trucks, tricycles, freight cars, refrigerator cars and the like.

Also, where the exterior metal container like 41 in Figs. 3, 4 and 5, is strong enough, the hard wood casing 21 may be omitted, as well as the inner lining 23; and kapok preferably in the form of canvas covered quilts or "blankets" may be used for part or all of the insulating material 23.

I claim:

1. The method of preserving or improving the insulating quality of the walls of a container, which includes by absorbing heat and sublimating solid carbon dioxide within said container, and confining and guiding circulation of the cold freshly evolved carbon dioxide gas in intimate contact with an inner surface of said walls.

2. The method of preserving or improving the insulating quality of the walls of a container, which includes sublimating solid carbon dioxide and circulating the cold freshly evolved carbon dioxide gas in intimate contact with the inner surface of said walls, and ensuring progressively increasing temperature for the gas and an upward circulation thereof by enclosing the insulating walls

of said container in the interspace between external and internal metal containers formed to permit escape of the gas only by high level overflow.

3. The method of refrigeration which includes completely enclosing a space to be refrigerated with bottom and side walls of cellular insulating material and, within said enclosed space, sublimating solid carbon dioxide to generate gas at a high level while affording confined paths for flow of said gas downward in refrigerant relation with said space to be refrigerated, and then upward in contact with and in permeating relation to said cellular insulating material constituting said walls.

4. The method of refrigeration which includes completely enclosing a space to be refrigerated with bottom and side walls of cellular insulating material and, within said enclosed space, sublimating solid carbon dioxide to generate gas at a high level, preventing indraft of air or gas from the refrigerated space, affording confined paths for flow of said gas in refrigerant relation with said space to be refrigerated, and also in contact with and in permeating relation to said cellular insulating material constituting said walls.

5. A refrigerator comprising a metal container having bottom and side walls enclosing a space to be refrigerated, a high level bunker for solid carbon dioxide exterior to but arranged to absorb heat derived from the interior of said container arranged for downflow of gas in heat exchange relation therewith, an exterior enclosing container of cellular insulating material arranged with respect to said bottom and side walls of said inner container to afford a circulatory gas path in which said gas flows downward and then upward in contact and permeating relation to the side walls of said enclosing container.

6. A refrigerator comprising a metal container having bottom and side walls enclosing a space to be refrigerated, a high level container enclosing solid carbon dioxide exterior to said metal container, closed against inlet of air or gas from said refrigerated space and arranged for downflow of gas in heat exchange relation with said space, an exterior enclosing container of cellular insulating material spaced apart from said bottom and side walls of said inner container to afford a circulatory interspace into which said gas flows downward and then upward in contact and permeating relation to the side walls of said container, the bottom and sides of said outer casing being protected.

7. A refrigerator comprising an outer hard wood container, a thick inner lining of cellular insulating material and within the latter, spaced apart from the walls thereof, an inner metal container for the products to be refrigerated, a high level container enclosing solid carbon dioxide arranged for high level down flow therefrom into the interspace whereby circulation of the gas in contact with the insulating walls is effected, upward along the inner surface of said insulating material.

8. A refrigerative container having enclosed therein a container enclosing solid carbon dioxide, said container being of metal formed and arranged so as to be gas tight up to a level higher than the ordinary level of the solid carbon dioxide contained therein so that in normal operation said solid is submerged in cold carbon dioxide gas which is substantially free from air, in combination with a refrigerator affording paths for conduction of said gas for cooling and insulating purposes, and into which paths the gas from said refrigerative container overflows.

9. A refrigerative container having enclosed therein a gas tight metal container enclosing solid carbon dioxide, said container being formed for escape of gas only by outflow from a higher level than the ordinary level of the solid carbon dioxide contained therein and arranged so that said overflow level is near the top of the enclosing container.

Signed at New York, in the county of New York, and State of New York, this 26th day of February, A. D. 1929.

JAMES W. MARTIN, JR.