June 19, 1934. W. H. HOODLESS 1,963,743

REFRIGERATING CONTAINER

Filed May 31, 1930

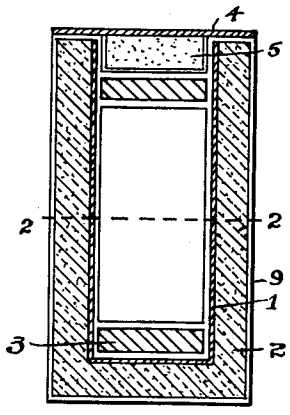


Fig. 1

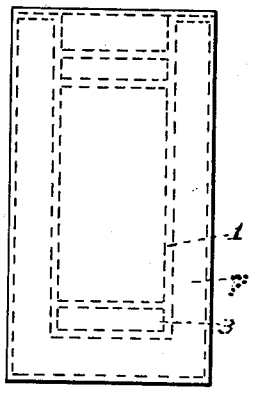


Fig. 4

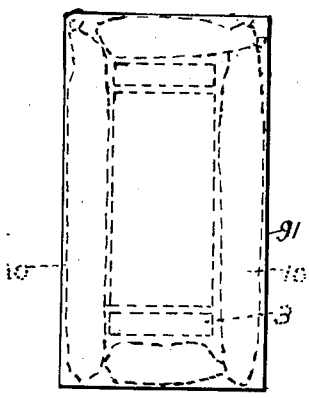


Fig. 6

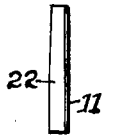


Fig. 9

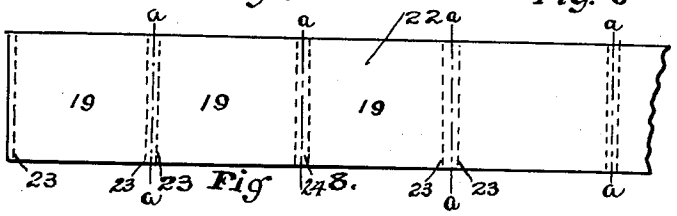


Fig. 8.

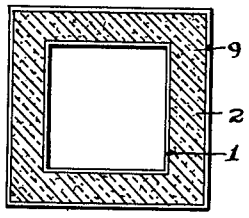


Fig. 2

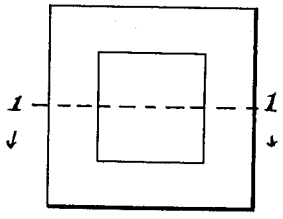


Fig. 3

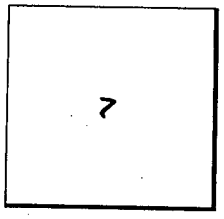


Fig. 5

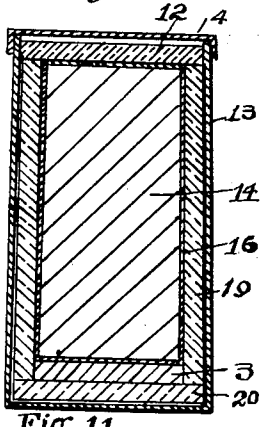


Fig. 11.

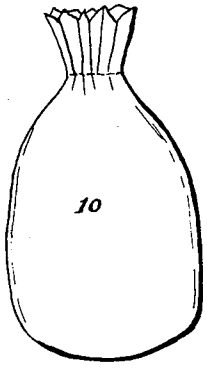


Fig. 7

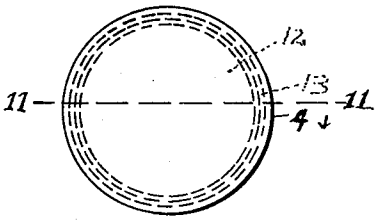


Fig. 10.

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REFRIGERATING CONTAINER

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Application May 31, 1930, Serial No. 458,201

9 Claims. (Cl. 62—91.5)

For the distribution of perishable food various forms of refrigerating containers have been designed hitherto. In some forms a cold interior package, containing the perishable food has been surrounded by a solid material that will not conduct or radiate heat readily and that will prevent, to some extent, the interchange of heat between the package of perishable food and the outside air, without the use of any agency, except the pre-cooled or frozen food itself, to lower the temperature of this insulating material. Such devices are sufficient to transport the food from the store to the place of consumption.

Other devices, utilized brine or ice from frozen water placed between water proof walls. Water proofing and other expensive features made the construction of these packages too expensive to be used in a throwaway package.

When the carbon dioxide in a solid form became procurable in commercial quantities, the use of this material as a refrigerant and its vapor as an insulating material became the subject of several attempts to design a satisfactory shipping throw-away container. Containers produced by these attempts were an advance on the prior art, and enabled cartons containing such materials as ice cream to be carried a greater distance than previously, but were subject to many objections. The attempt to use, as an insulator, the carbon dioxide gas, circulated outside of the walls of the inner carton, in a space between the inner carton and an outer carton surrounding it, was expensive. It required a great quantity of solid carbon dioxide and was uncertain in action due to leakage of heat through the edges and corners of the containers.

This leakage would be likely to suck down into the package around the carton immediately containing the perishable food, the warmer and lighter air from the outside. If there were any bellows action, and such action was almost certain to occur in handling, this sucking action was certain to be greatly increased, and so, unless the carbon dioxide gas was given off in considerable quantities from the block of solid carbon dioxide during the whole transportation period, devices of the character just above referred to, were most uncertain in action especially when the quantity of solid carbon dioxide placed in them had diminished considerably from an extended transportation of the package.

The attempt to combine the insulating properties of chilled air and carbon dioxide has hitherto failed. The containers using solid carbon dioxide that were used as a refrigerant hitherto depended either upon the flow of carbon dioxide through passages surrounding the material to be preserved, or upon a chilled material that did not contain air to any substantial extent, said material containing air in a course cellular structure or a structure having large interstices through which a gas could pass with considerable ease and through which the air will be forced out by the necessary excess of carbon dioxide gas evaporated from the solid carbon dioxide, so that the insulation depends very largely on the carbon dioxide gas alone. Because the specific gravity of carbon dioxide is 1.5, if in sufficient quantity, it will push out the air upward (but if in insufficient quantity it will leak out from the container at the bottom and suck in warm air.) Hence the large amount of solid carbon dioxide required also in this form of container. This especially is the case when the insulation space is provided with a lining of corrugated paper. The air interstices are large, the carbon dioxide vaporizes rapidly, and the apparatus' useful life is short and the consumption of solid carbon dioxide is large for the refrigeration secured.

Among the purposes of my invention are to use an insulating material that will avoid this rapid consumption of the solid carbon dioxide, that will contain a quantity of still chilled air as an insulation, that can be obtained in large quantities and cheaply, that will resist to a considerable extent the penetration to it of the carbon dioxide gas and the displacement of air through this penetration (air is a better insulator than carbon dioxide gas), that will be light in weight, freight being an important item, and other purposes that will appear from reading the detailed portion of this specification. For these purposes, my construction forms in the mass of the insulating material an approximation to a still air space, by sub-dividing the whole air content in the insulating material into many small volumes by partitions of a material and a form that have low thermal conductivity and will reduce the convection currents and radiation to a minimum and which is chilled by the gaseous carbon dioxide given off from the solid carbon dioxide.

I use, as an insulating material, a non-conducting substance that contains air in minutely comminuted interstices, that is rendered very cold by the solid and gaseous carbon dioxide refrigerant, but through which the gaseous carbon dioxide will not flow freely as it does in the devices just mentioned, but if it penetrates into it will be held in its pores without circulating through the mass of the insulating material, thus produc-

ing a body of still air and still carbon dioxide gas in these interstices.

A consideration of the transmission of heat through a porous material will indicate the importance of the use as an insulator of a material containing minute interstices filled with still air.

Transmission of heat through a porous material is the result of the combination of conduction, radiation and convection. Conduction occurs mainly between the contacting solid portions of the porous material. In porous materials these contacting portions are small, in a granulated material they are points, rather than surfaces, and form a small part indeed of the total volume of the material. Convection is very small in a finely granulated material, or in any material where the interstices holding the air are very small and very numerous. The volume of air within such a material is so minutely sub-divided and the contents of its air cells so small that the convection between them, though not entirely prevented, is greatly reduced, and ceases to be important. The surface resistance of the granular material to the movement of the air, prevents in a large measure, heat at the surface of the material being removed by air passing freely over it in close contact with it.

The resulting insulating material becomes substantially a body of still air cells with non-conducting partitions. Still air is the best insulating material known. Air has a thermal conductivity of 0.0005 C. G. S. units, or hardly ½ of any solid material and much less than carbon dioxide gas.

Describing the general structure of my device; the inner carton is surrounded by a layer of insulating material with a large number of minute air spaces, and a small volume of material relative to the total volume occupied. This material is chilled by the carbon dioxide gas that is evaporated from solid carbon dioxide. The gas given off from the solid carbon dioxide is intensely cold, and as the solid dioxide is positioned to bring this gas into immediate contact with the insulating material the latter becomes intensely cold also and prevents the transmission of heat from the outside to the inner container.

This material not only acts as an insulator, as is well known, but also compels a considerable time to elapse in heat interchange between the outside air and the cold insulating material, before the insulating material is raised to a higher temperature. This action may be very aptly called a storage of cold in the insulation.

Owing to the low thermal conductivity of this material, the convection currents and radiation are reduced to a minimum. The finely divided condition of the insulating material and the larger number of air spaces produces a great deal of surface resistance to the motion of the air. The gas in the pores of the insulating material (carbon dioxide or air) when its temperature rises, expands but does not empty the pores, and hence prevents the passage into the insulating material of any air heated from the outside. The position of the solid carbon dioxide may vary. It may be positioned in nearly any part of the space between the walls of the inner and outer carbon. Many materials that have a finely divided granular structure may be utilized such as mineral wool.

The material I have used most as an insulator and which I prefer is a diatomaceous earth, such as Kieselguhr. This substance comes in commerce under various trade names. Usually it comes in powdery form (though it can be made into a slab form) which, although it has proven hitherto that the powder is likely, unless closely confined, to contaminate the material to be insulated, I have found especially useful in just this form. It acts as an almost perfect insulator when chilled by the carbon dioxide gas given off from the solid carbon dioxide, and also when infiltrated by the gas. It is inexpensive, is easily packed between the walls of the inner and outer carton, can be densely packed, can be applied under conditions where other more rigid materials cannot be used and the solid carbon dioxide can be placed within the carton without any cover or separate container for the solid carbon dioxide. Convection currents and leakage of gas through the edges and corners of the containers is minimized also.

The physical structure of the Kieselguhr particle and that of other diatomaceous earths is particularly adapted to this use. A large proportion of these earths consist of the fossilized shell structures of diatoms which were minute shell fish. This shell structure comprises an immense number of minute air cells. Kieselguhr and other diatomaceous earth products also can be procured in a form where the granular structure is maintained, but the mass of the material is procurable in a sufficiently substantial block or slab form which can also be used as is described below.

I will now proceed to describe in detail three different structures in which my invented device may be embodied.

Fig. 1 is a sectional elevation of the first form which my device may take, taken on the line 1—1 of Fig. 3. Fig. 2 is a horizontal section on the line 2—2 of Fig. 1. Fig. 3 is a plan view of the same. All these figures refer to the first structure of my device. Fig. 4 is a side elevation of a structure embodying my device as used with an insulating material in slab form. Fig. 5 is a view of a slab of surface covered granular material. These two figures illustrate the essential parts of the second structural form of my device. Fig. 6 is a side elevation with the coverings for the granular material shown in dotted outline and Figs. 7 and 8 and 9 various forms these coverings may take; these last four figures illustrate the third kind of structural embodiment of my device. Fig. 10 is a plan of a modified form of container. Fig. 11 a section on line 11—11 of Fig. 10.

In the structure illustrated in Figs. 1, 2 and 3, the inner package 1 holds the refrigerated material, such as ice cream. Around this package is placed Kieselguhr or other diatomaceous mineral wool, or other material that has a minutely cellular or interstitial structure. The piece, 3, of solid carbon dioxide is placed at any desirable point where the evaporated carbon dioxide gas will reach and chill the insulating material.

A sheath, 9, encloses the insulating material and forms the sides and bottom of the package. I have shown it as placed just beneath the inner package, 1. A cover, 4, having attached to it a portion of the insulating material, 5, covers the package which may be completely closed ordinarily. The loose material forming the insulation becomes finally more or less penetrated by the carbon dioxide gas. The freely divided and loose insulating material will accommodate itself to any shaped containers, and requires no particular shape in the latter. The carbon dioxide

gas drives out the air in the insulating material very slowly but chills it very thoroughly and quickly and it and the air circulate in the body of the insulating material to a very slight extent, and hence convection is almost absent. The result is a body of still air in the insulating material only a small portion of which is replaced by substantially still carbon dioxide gas even when the package has been in use for some time.

Instead of the loose insulating material shown in Figs. 1, 2 and 3, slabs or bricks or blocks of this material may be used, as indicated in Figs. 4 and 5. These slabs 7, 7, may be placed within the outer container. They can be moulded to form a complete enclosure for the inner container and may be waterproofed. For such a purpose the use of sodium silicate or a similar material which does not impart odor to the material contained in the inner container is very desirable. They may be coated on their surfaces with a coating of any material that will eliminate the possibility of any dust rising from the surface of the block. A coating, as above described, on the faces may substantially close the interior of the slab against the infiltration of gaseous carbon dioxide.

A third structural form where the insulating material is contained in bags, rolls, pads or similar receptacles is shown in Figs. 6, 10 and 11. Figs. 7, 8, and 9 illustrate forms of bags and pads. These bags may be made of water proof material. In order to prevent the bags or other containers for the insulating material from breaking especially when the inner container is made of metal, a reinforcement is usually placed on the side that will contact with it. Two particular forms of this construction of the bags are shown in Figs. 7 and 8 and 9 respectively. Referring to one form:—10 is a thin paper bag, having a U shape, when open, for filling. Into this is placed the insulating material until the bag is filled sufficiently; the bag's top is then closed, preferably by sewing, then it may be placed with the outer container 91, (see Fig. 6) or (see Figs. 8 and 9) a long bag, 22, may be filled with Kieselguhr or other insulating material. It is then pressed flat upon a heavy cardboard, 11, to which it is cemented or glued. This bag may be extended lengthwise in a form, 22, and sewed together by crosswise rows of stitches, 23, leaving a narrow space, 24, between them, across which a cut can be made, dividing the material into pads, 19, in which but little cardboard will protrude beyond the insulating material, and practically all the pad will act as an insulator. The resistance of these bags or rolls offer to the infiltration of the carbon dioxide varies with the material used in them but the resistance will in all cases be more than that offered by powdered Kieselguhr.

The pads, 19, can be placed in packages shown in Figs. 10 and 11 around the inner container 16. The heavy cardboard will usually be adjacent to the inner container and their arrangement conveniently may be as shown in Figs. 10 and 11. A pad, 12, of like structure may be placed over the inner container and a pad, 20, below the solid carbon dioxide, 3. The content, 14, of the inner package is kept well refrigerated. In this form of refrigerating package, the refrigerant, 9, will to some extent chill the pads, 19, and particularly the pad, 12, through chilling the material, 14. This action occurs to a lesser extent in the other forms of my device.

Insulating material may act as a refrigerant or merely as an insulator according to the circumstances. If the body of this insulating material is at a lower temperature than the material in the inner receptacle, the heat interchange between it and the material in the inner receptacle will lower the temperature of the material in the inner receptacle. When the insulating material is maintained at the same temperature as the material in the inner receptacle, which can often be accomplished, no heat interchange between them occurs, and the material I have designated as insulating material, becomes a complete shield for the inside material, within the inner container.

The invention may be embodied in many different structural forms of which the three above mentioned are, in my opinion, the best; each of the three embodies in a slightly different form, the main idea that the most efficient refrigeration is secured by using still air held against movement by the smallness of the size of the interstices in which the air is retained. I, therefore, declare I do not limit myself to anything less than the limits of the claims in this full meaning.

I claim

1. A throw away refrigerator container, comprising a receptacle for the material to be refrigerated, and for solidified carbon dioxide, and a surrounding mass of diatomaceous earth, the cells of which are of such size and configuration as to be comparatively impenetrable by the sublimed carbon dioxide gas but comparatively penetrable by air, whereby the cells may be filled or surrounded by relatively stationary, insulating air.

2. A throw away container, comprising an inner receptacle for the material to be refrigerated, an outer receptacle in which is positioned a piece of solid carbon dioxide ice, and a mass of diatomaceous earth, the cells of which are of such size and configuration as to be comparatively impenetrable by the sublimed carbon dioxide but comparatively penetrable by air positioned in the outer receptacle, said cells being filled with relatively stationary air, thereby insulating and refrigerating the material to be refrigerated.

3. A throw away container comprising an outer receptacle and an inner receptacle, the outer receptacle containing near its bottom a piece of carbon dioxide ice, and above said ice diatomaceous earth, the cells of which are of such size and configuration as to be comparatively impenetrable by the sublimed carbon dioxide but comparatively penetrable by air, and the inner receptacle containing the material to be refrigerated; the cells of the diatomaceous earth being filled with comparatively stationary air.

4. A throw away refrigerating container as defined in claim 1 wherein the receptacle containing the solid carbon dioxide is substantially closed.

5. A throw away refrigerating container, wherein is a receptacle for the material to be refrigerated and an outer receptacle surrounding the inner receptacle and packed with diatomaceous earth, the cells of which are of such size and configuration as to be comparatively impenetrable by the sublimed carbon dioxide but comparatively penetrable by air, whereby the cells may be filled by relatively stationary air, said outer receptacle being provided with vents whereby the gaseous carbon dioxide may be voided from the container without penetrating the mass of the diatomaceous earth.

6. A throw away refrigerating container, comprising a receptacle for the material to be refrigerated and for solidified carbon dioxide and a

surrounding loose mass of diatomaceous earth, the cells of which are of such size and configuration as to be comparatively impenetrable by sublimed carbonic dioxide but comparatively penentrable by air whereby the cells may be filled with relatively stationary insulating air.

7. A throw away refrigerating container comprising a receptacle for the material to be refrigerated and for solidified carbon dioxide and a surrounding insulating enclosure for the receptacle for the material to be refrigerated composed of solidified diatomaceous earth, the cells of which are of such size and configuration as to be comparatively impenetrable by carbon dioxide and comparatively penetrable by air, whereby the cells may be filled with relatively stationary insulating air.

8. The device defined in claim 7, wherein the enclosure is covered with a water proofing material.

9. The device as defined in claim 7, wherein the solidified diatomaceous earth is provided with a sealing coating.

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