April 20, 1937. E. DU BOIS 2,078,129

REFRIGERATING APPARATUS

Filed March 16, 1931

Fig. 1.

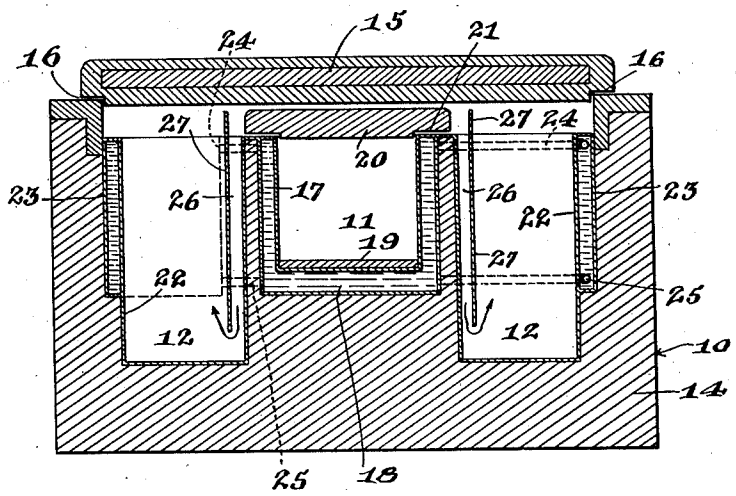
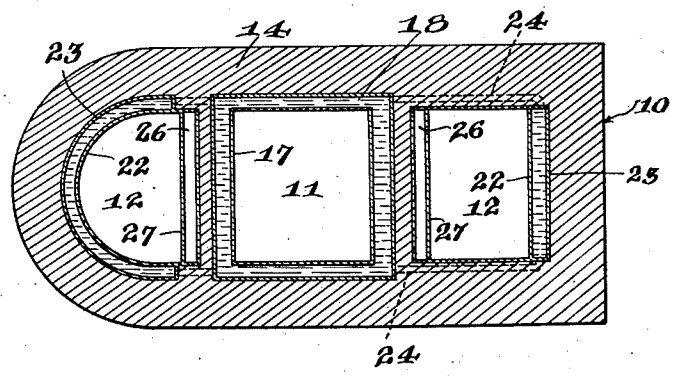


Fig. 2.



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REFRIGERATING APPARATUS

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12 Claims. (Cl. 62—91.5)

This invention relates to certain improvements in refrigerating apparatus; and the nature and objects of the invention will be readily recognized and understood by those skilled in the arts involved in the light of the following explanation and detailed description of the accompanying drawing illustrating what I at present consider to be the preferred embodiment or mechanical expression of my invention from among various other forms, arrangements, embodiments, combinations and constructions of which the invention is capable within the spirit and the scope thereof.

More particularly my present invention deals with the utilization of solid carbon dioxide and similar or equivalent characters of refrigerant, in those types of refrigerating appartus such as employed to refrigerate car bodies and the like, and such as used in refrigerating a plurality of refrigerating spaces or chambers from a single or centralized location of the refrigerant, such for example as presented by and found in the arrangements of ice cream refrigerating and preserving cabinets having a plurality of separate ice cream refrigerating compartments or spaces which are to be refrigerated from a single or central source and location of the refrigerant, such as solid carbon dioxide.

With such types and arrangements of refrigerating apparatus where a refrigerant such as solid carbon dioxide is used, it is highly desirable for efficient refrigeration and conservation of the materials, such as ice cream, to be refrigerated, that the low or refrigerating temperature within the refrigerating compartments or spaces be kept at an even and equal temperature, and within as near as possible to approximately one degree (1°) of temperature to the desired or required cold or refrigerating temperature at which the refrigerating compartments are to be maintained. Heretofore, it has been found in practice exceedingly difficult to secure and maintain such conditions, due to the fact that the refrigerant used, such as solid carbon dioxide, to generate the refrigerating and cooling effect is not stable under normal conditions of pressure and temperature, and the rate of evaporation or sublimation thereof increases as the difference betwen the refrigerant temperature and the surrounding temperature increases.

My present invention holds as one of its main aims the provision of an arrangement of refrigerating apparatus in which the desired conditions of even and equal temperature in the refrigerating chambers is obtained by and from the efficient utilization of the refrigerating effect of the solid carbon dioxide refrigerant and the cold gases evolved from its sublimation, and by the efficient distribution of the refrigeration equally throughout the refrigerating chambers or spaces, through the medium of a non-freezing or low freezing point liquid for transferring the cold from the solid carbon dioxide to the refrigerating chambers.

A further feature and object of the invention is found in the design and arrangement of a refrigerating apparatus for utilizing and practicing the foregoing characeristics of the invention and for securing the highly efficient refrigerating results therefrom, which apparatus is of a compact and efficient design and construction.

With the foregoing general objects and results in view, as well as certain others which will be readily recognized and apparent from the following explanation, the invention consists in certain novel features in design and in combination and arrangement of parts and elements thereof, as will be more fully and particularly referred to and specified hereinafter.

Referring to the accompanying drawing in which similar reference characters refer to corresponding parts throughout the several figures thereof:

Fig. 1 is a view, more or less diagrammatical, in vertical longitudinal section through an ice cream refrigerating cabinet embodying features of the invention.

Fig. 2 is a view, more or less diagrammatical, in horizontal section through the cabinet of Fig. 1.

I have selected as an example of a possible embodiment and expression of my invention, and have disclosed in the accompanying drawing, a refrigerating apparatus of the so-called ice cream refrigerating cabinet type in which a plurality of separate ice cream refrigerating compartments or chambers are refrigerated from a refrigerant such as carbon dioxide, disposed at a central location with respect to the refrigerating compartments within the cabinet. This example, however, is not intended by way of limitation to the type of refrigerating apparatus disclosed, but the invention is to be considered as and does include the incorporation of the broad principles and features thereof as exemplified by the embodiment shown, in other types of refrigerating apparatus for various uses in which a refrigerant such as carbon dioxide is employed for refrigerating a plurality of chambers or spaces.

In the illustrated embodiment, referring to the accompanying drawing, a cabinet or container 10 is diagrammatically disclosed as including a central compartment or refrigerant receiving space

11 therein opening through the top of the cabinet, and the separate ice cream receiving and refrigerating compartments 12 therein spaced from opposite sides of the refrigerant compartment 10 and opening through the top or upper side of the cabinet. The interior of the cabinet is provided with the insulating material or suitable insulating construction 14 which surrounds and extends between compartments 11 and 12, and also between the compartments and the side and bottom walls of the cabinet, as diagrammatically shown in the drawing. The upper side of the cabinet 10 above the open upper ends of the compartments 11 and 12, is open for access therethrough to the compartments, as well as to provide a space within the cabinet above the compartment upper ends (see Fig. 1). A removable and well insulated cover or lid 15 is provided for normally closing the open upper side or top of the cabinet, and it is to be here noted referring to Fig. 1 of the drawing, that cover 15 when in closing position on the cabinet forms a joint 16 thereabout with the engaged surfaces of the cabinet which is such as to permit passage and escape of carbon dioxide gas therethrough, for a purpose to be described and explained hereinafter.

The solid carbon dioxide or refrigerant receiving chamber or space 11 in cabinet 10, is formed in the present example by a double walled, open top container 17, preferably formed of galvanized iron or other suitable metal, the double walls of which provide a reservoir that is substantially filled with a non-freezing or low freezing point liquid 18, as a brine or other suitable solution, such for example as acetone, acetate and the like. The brine solution 18 between the double walls of container 17 is cooled by the solid carbon dioxide when placed in compartment 11 through direct transmission where the carbon dioxide is in contact with the metal walls of container 17, as by resting in direct contact with the inner bottom wall. On the contrary if the bottom of the container 17 is covered with an insulating material mat, such as a plate of wood 19 diagrammatically illustrated in Fig. 1, so that direct contact of the solid carbon dioxide with the metal bottom of the container is prevented, the brine solution 18 is then not so intensively or effectively cooled. By having the insulating member removable, and by providing a plurality thereof so as to vary the thickness of insulating material used in the container 17, the effective regulation of the brine cooling and refrigeration throughout the entire apparatus is obtained. The upper, open end of the solid carbon dioxide container 17 is normally closed by a removable cover 20, which rests upon the upper edges of the container, but permits of escape of gas through the joints 21, from the compartment 11, as solid carbon dioxide sublimes and evaporates in the compartment.

Each of the refrigerating compartments 12 is of a greater depth or length than the depth of refrigerant container 17, in the specific example hereof although the invention is not essentially so limited, and each is formed by a container 22 of iron or other metal or material of good heat conductivity. At the side of each container 22 opposite container 17, a reservoir 23 is formed and provided to a depth from the upper end thereof substantially equal to the depth of container 17, and such reservoir 23 is filled with a non-freezing or low freezing point solution or liquid such as fills the reservoir of the refrigerant container 17. The upper end of each reservoir 23 is connected and placed in communication with the upper portion of the reservoir for container 17, by the pipes 24, and the lower end or bottom of each reservoir 23 is connected and placed in communication with the lower or bottom portion of container 17 reservoir by the pipes 25, as will be clear by reference to Fig. 1 of the drawing. Thus, provision is made for circulation of the non-freezing or low freezing point liquid, such as a brine solution 18 from the lower ends of refrigerant container 17 reservoir to the lower ends of the refrigerating chamber reservoirs 23 through pipes 25, and back to the upper ends of container 17 reservoir from the upper ends of reservoirs 23, by the pipes 24.

Within each refrigerating compartment 12, a carbon dioxide gas flue or passage 26 is formed vertically extending along the inner side walls of the containers 22, by the provision of a vertical wall 27 in each container extending completely thereacross adjacent but spaced from the inner side wall thereof and terminating at its lower end spaced above the bottom wall of the container. The upper ends of walls 27 extend upwardly a distance above the upper open ends of containers 22, and within the space in the cabinet above the compartments 12, but terminating short of and spaced from the cabinet cover or lid 15, all as clearly shown in Fig. 1 of the drawing.

In operation and use of the refrigerating cabinet 10, the refrigerant compartment 11 is supplied with a quantity of solid carbon dioxide and closed by the cover or closure 20. The ice cream in suitable cans or receptacles (not shown) or any other material to be refrigerated and conserved, is placed in a compartment or compartments 12, after which the cabinet cover or lid 15 is placed on the cabinet in closing position. The solid carbon dioxide (not shown) in compartment 11 absorbs heat from the brine 18 in the container 17 reservoir through the heat conducting walls thereof and intensively cools and lowers the temperature of the brine 18. The brine in container 17 reservoir is of course at a much lower temperature than the brine in reservoirs 23 which is warmed or has its temperature raised by the heat absorbed from compartments 12 which are cooled thereby, and hence a phenomena similar to a thermal syphon is established, and a continuous circulation of colder brine which is more dense flows through lower pipes 25 to and displaces the warmer and higher density brine in the lower ends of reservoirs 23, where it is warmed in proportion as it cools compartments 12, and flows through upper pipes 24 back to container 17 reservoir, in which it is again cooled by the solid carbon dioxide in compartment 11.

The velocity of this brine circulation is dependent upon the differences in temperature which produces a density differential at different points in and along the path of circulation. The velocity of the circulation is also dependent upon the resistance in the pipes 24 and 25, and hence this velocity and the rate of refrigeration of compartments 12 is readily controlled and regulated by placing variable orifices, control valves and the like in the circulation pipes 24 and 25, which control is contemplated by and included within the scope of my invention. Different temperatures can be produced and maintained in the separate compartments of the apparatus, such temperatures being directly dependent upon the cross sectional areas of the pipes through which the brine flows to such compartments. A non-freezing or low freezing point solution, such as the

brine hereof, is chosen having a high specific heat, so that refrigeration transmission thereby is very high, and further so that the variation of temperature resulting from recharging with refrigerating materials are to a certain degree equalized.

As the solid carbon dioxide with which refrigerant compartment 11 is charged, evaporates or sublimes, the carbon dioxide gas evolved escapes from compartment 11 through the spaces in the joints 21 between cover 20 and container 17, into the space in the cabinet 10 below cabinet cover 15. This gas being cold and having a high density drops and flows downwardly into and through flues or passages 26 into and collects at the lower ends of compartments 12, but as it warms up in compartments 12 the gas rises and dissipates its thermal energy and finally escapes to atmosphere through the joints 16 between the cabinet and its lid or cover 15. Thus, the cold carbon dioxide gas has a circulation through the refrigerating compartments and the cabinet, such as to have a general cooling effect on the entire refrigerating apparatus.

The invention as above described thus insures even and equal refrigerating temperatures in the several independent refrigerating compartments by the circulation of the non-freezing and low freezing point solution cooled by the refrigerant, to the refrigerating chambers, and the maintenance of the desired temperatures in such compartments, all while assisting the refrigerating effect by a circulation of the cold refrigerant gases through the refrigerating compartments. Obviously, the broad principles and features of the invention are equally applicable to embodiment in various kinds and types of refrigerating apparatus for the efficient utilization of the refrigerating effects of refrigerants such as solid carbon dioxide and the equal distribution of refrigeration to a refrigerating compartment or compartments.

It is also evident that various other modifications, variations, substitutions, eliminations and additions might be resorted to without departing from the spirit and scope of my invention, and hence I do not wish to limit myself in all respects to the exact and specific disclosures hereof.

Desiring to protect my invention in the broadest manner legally possible, what I claim, is:

1. In refrigerating apparatus of the type utilizing solid carbon dioxide as a refrigerant, in combination, a solid carbon dioxide receiving container, a refrigerating container, said receiving container thermally insulated from the refrigerating container, a low freezing point liquid in thermal relation with said containers for thermosyphonic circulation of the liquid cooled by sublimation of solid carbon dioxide in the refrigerant container to the refrigerating container, and of the warmer liquid from the refrigerating container back to cooling thermal relation with the refrigerant container, and means for directing the cold carbon dioxide gas of sublimation from the refrigerant container through the refrigerating container.

2. In refrigerating apparatus of the type utilizing solid carbon dioxide as a refrigerant, a heat insulated cabinet structure, a refrigerant container of heat conducting material within said cabinet for receiving solid carbon dioxide, said container having an open top and a removable closure therefor, a refrigerating container of heat conducting material within the cabinet, a low freezing point fluid reservoir in good thermal relation with said refrigerant container, a low freezing point fluid reservoir in good thermal relation with said refrigerating container, conduits connecting and placing said reservoirs in communication for thermosyphonic circulation of fluid therethrough, the refrigerant container providing an outlet for carbon dioxide gas therefrom into the cabinet above said refrigerating container, and means for directing the carbon dioxide gas downwardly through the refrigerating container.

3. In refrigerating apparatus of the type utilizing solid carbon dioxide as a refrigerant, a heat insulated cabinet structure having an open upper side normally closed by a removable cover, a refrigerant container in said cabinet having an open upper end normally closed by a removable cover, said refrigerant container formed of heat conducting material, a low freezing point fluid reservoir in good thermal relation with said container, a refrigerating container of heat conducting material within said cabinet having its upper end opening into the cabinet space beneath the cabinet cover, a low freezing point fluid reservoir in good thermal relation with said refrigerating container, the reservoirs of said refrigerant and refrigerating containers connected and in inter-communication for thermosyphonic circulation of fluid therebetween, said refrigerant container providing for escape of carbon dioxide gas therefrom into the cabinet space above the refrigerating containers, and means for causing circulation of the carbon dioxide gas downwardly and then upwardly through the refrigerating container, the cabinet structure providing for escape of gas therethrough from the refrigerating container to atmosphere.

4. In the art of refrigerating by the utilization of solid carbon dioxide as a refrigerant, those steps consisting in cooling a low freezing point fluid by placing solid carbon dioxide in heat exchange relation therewith, causing thermosyphonic circulation of the cooled fluid to and passing the same in heat exchanging relation with a space to be refrigerated at a point thermally insulated and remote from the solid carbon dioxide, and simultaneously passing the cold carbon dioxide gas evolved by the sublimation of the solid carbon dioxide, through the space to be refrigerated.

5. In the art of refrigeration by the utilization of solid carbon dioxide as a refrigerant, those steps which include cooling a low freezing point fluid by placing solid carbon dioxide in heat exchange relation therewith, causing thermosyphonic circulation of the cooled fluid in that exchanging relation with a space to be refrigerated that is thermally insulated from the solid carbon dioxide, and conducting the cold carbon dioxide gas evolved by the sublimation of the solid carbon dioxide to the space to be refrigerated in heat exchanging relation therewith.

6. In a refrigerating system of the type utilizing solid carbon dioxide as a refrigerant, a chamber for receiving solid carbon dioxide, a chamber to be refrigerated thermally insulated from said receiving chamber, a low freezing point fluid in heat exchange relation with said chambers for thermosyphonic circulation of the fluid between the chambers by sublimation of solid carbon dioxide in the receiving chamber, and means for conducting the cold carbon dioxide gas of sublimation from the receiving chamber to and in heat exchange relation with the chamber to be refrigerated.

7. In refrigerating apparatus of the type utilizing solid carbon dioxide as a refrigerant, a normally closed heat insulated structure providing a space therewithin, a refrigerant container of heat conducting material within the space in said structure, said container having a removable top closure, a low freezing point fluid reservoir in thermal relation with said refrigerant container, a refrigerating chamber within the space in said heat insulated structure, said refrigerant container and reservoir thermally insulated from the refrigerating container, a low freezing point fluid reservoir in thermal relation with said refrigerating chamber, said reservoirs in communication for thermosyphonic circulation of fluid therebetween, the refrigerant container providing an outlet for carbon dioxide gas of sublimation therefrom, and means for conducting such gas from the container into heat exchange relation with the refrigerating container.

8. In the art of refrigerating by the utilization of a solidified gas refrigerant, the steps of; cooling a low freezing point liquid by placing a solidified gas refrigerant in heat exchange relation therewith; circulating the cooled liquid in heat exchanging relation with a space to be refrigerated that is thermally insulated from the refrigerant; and circulating the cold gases evolved by the evaporation of the solidified gas refrigerant in heat exchange relation with the space to be refrigerated.

9. The combination in refrigerating apparatus of the type utilizing a solidified gas as a refrigerant, of a solidified gas receiving container having a heat conducting material wall and provided with an outlet for evaporation gases, a low freezing point liquid reservoir in good thermal relation with the heat conducting wall of said container, a refrigerating container having a heat conducting wall, a low freezing point liquid reservoir in good thermal relation with the heat conducting wall of said refrigerating container, conduits placing said reservoirs in communication for circulation of low freezing point liquid therebetween, a body of low freezing point liquid in said reservoirs and conduits with the level of the liquid maintained above the highest points of communication between the reservoirs and said conduits; with means for controlling transfer of heat from the liquid in the refrigerant container reservoir to a solidified gas in the refrigerant container to maintain the temperature of the liquid at a point to prevent stoppage of liquid flow between the reservoirs by freezing of the liquid.

10. In refrigerating apparatus adapted to utilize a solidified gas refrigerant, a refrigerant containing structure including a wall of heat conducting material adapted for heat transfer relation with a charge of refrigerant in said structure, said refrigerant containing structure having an opening for charging the structure with refrigerant and a removable closure for said opening, a body of low freezing point liquid in heat transfer relation with the heat conducting material wall of said refrigerant containing structure, and means for controlling and maintaining a desired rate of heat transfer from the body of low freezing point liquid through said heat conducting wall to the refrigerant, including a plate member of predetermined heat insulating characteristics removably interposed between said heat conducting wall and a charge of refrigerant in the containing structure to variably control the temperature of the body of low freezing point liquid by removing or interposing said heat insulating plate member from and to position between such wall and the refrigerant.

11. In refrigerating apparatus, a thermally insulated cabinet structure, a refrigerant container of heat conducting material within said cabinet for receiving a solidified gas refrigerant, said container thermally insulated and having an open end normally closed by a removable closure, a refrigerating container within the cabinet separate and thermally insulated from the refrigerant container, separate low freezing point fluid reservoirs sealed from but in heat exchange relation with said refrigerant container and said refrigerating container, respectively, means placing said reservoirs in communication to form a closed fluid circulating system, and a low freezing point fluid substantially filling said circulating system for circulation in heat exchanging relation between the refrigerating container and a refrigerant in the refrigerant container.

12. In refrigerating apparatus, a thermally insulated cabinet structure, a refrigerant container including a wall of heat conducting material for receiving a solidified gas refrigerant, said container thermally insulated and providing for escape of refrigerant gas therefrom, a refrigerating container within the cabinet separate and thermally insulated from the refrigerant container, a low freezing point fluid circulating system in thermal relation with and between the refrigerant container and the refrigerating container, said system including a reservoir in thermal relation with the heat conducting wall of the refrigerant container, a reservoir in thermal relation with the refrigerating container, fluid conduits placing said reservoirs in communication for circulation of fluid therebetween, and said system substantially filled with a low freezing point non-volatile fluid for circulation thereof to transfer heat from the refrigerating container to the refrigerant in the refrigerant container.

ERNEST DU BOIS.