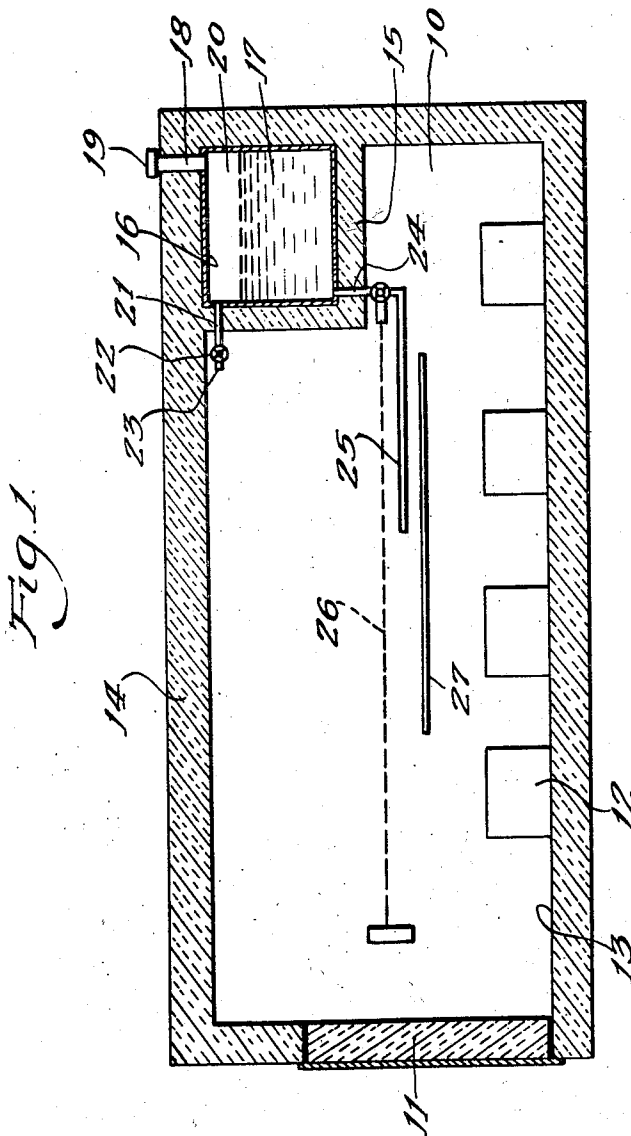


Filed Oct. 13, 1944

2 Sheets-Sheet 1

2,447,249



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Aug. 17, 1948.

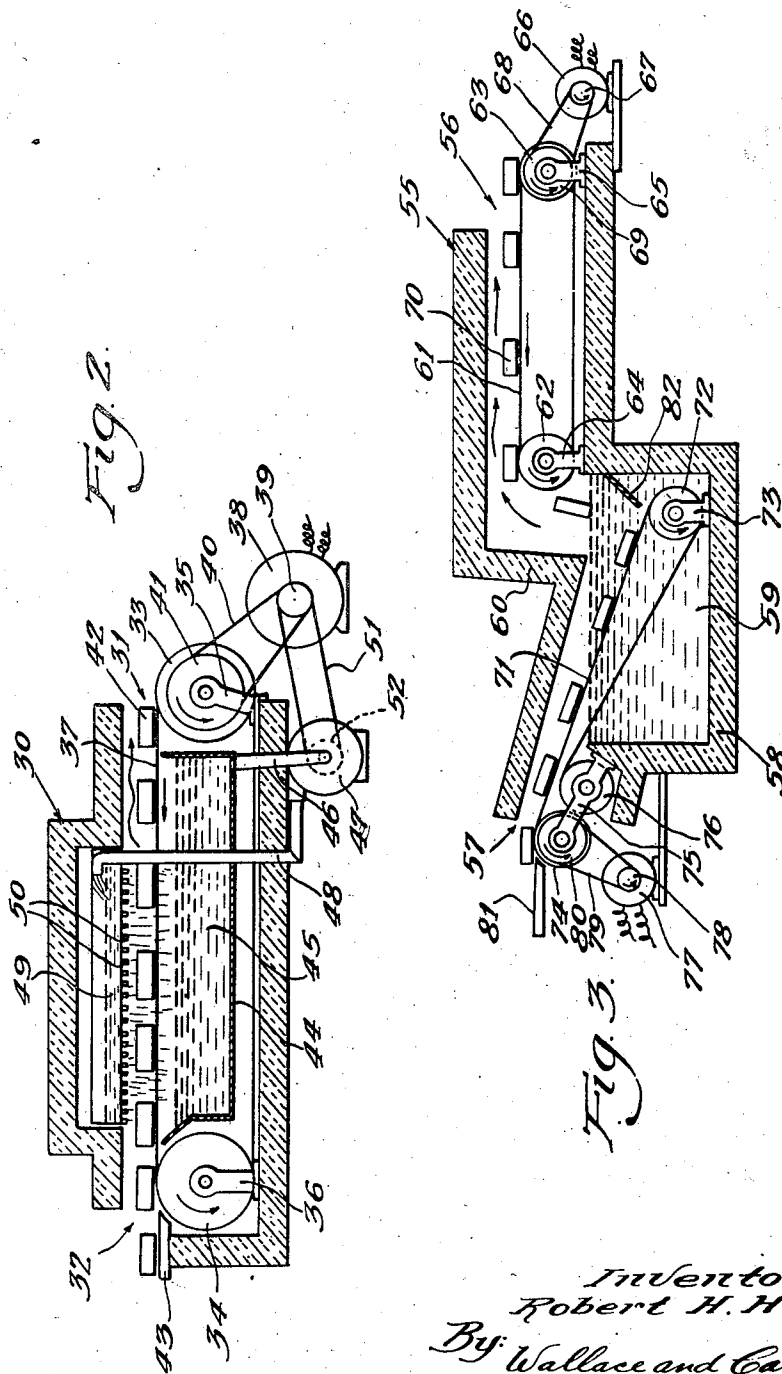
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2,447,249

METHOD OF REFRIGERATING AN ARTICLE BY CONTACT
WITH A VAPORIZABLE REFRIGERANT

Filed Oct. 13, 1944

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,447,249

METHOD OF REFRIGERATING AN ARTICLE
BY CONTACT WITH A VAPORIZABLE RE-
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Application October 13, 1944, Serial No. 558,566

2 Claims. (Cl. 62-173)

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This invention relates to a method of and an apparatus for refrigeration.

In the art of refrigeration several methods of producing the desired low temperature in the articles have been used. One common method of refrigeration entails the use of water ice and where a temperature below the freezing point of water is required, a salt is mixed with the water ice to attain the required low temperatures. Another method entails the use of solidified carbon dioxide gas and placing the such Dry Ice in contact with or adjacent to the article to be refrigerated. A third method involves the use of sealed containers of frozen brine, commonly known as "cold cans," the containers being likewise placed in contact with or adjacent to the article. A fourth method comprises extracting heat from the article by mechanical means operating in the vicinity of the article.

The above-mentioned refrigerating methods are subject to certain limitations, particularly when the problem is to refrigerate articles in transit. While water ice is nearly ideal for relatively higher refrigerating temperatures, e. g. above 40° F., it is not satisfactory for lower temperatures since salt must be added to lower the melting point of the ice and this involves additional expense. In addition, the brine which results is quite corrosive to the vehicle structure and in the case of railroads, to the various switches and controls along the right-of-way. Dry Ice eliminates the corrosive features of brine, but it is quite expensive and furthermore is not readily controllable as to the temperature produced. "Cold cans" are not as expensive as Dry Ice, but they must be returned for refreezing, which involves handling and hauling unfrozen cans perhaps for considerable distances. Mechanical refrigeration, though satisfactory from the standpoint of creating and holding a desired temperature, creates maintenance problems both in the form of periodic servicing and breakdowns en route.

The principal object of this invention is to provide a method of refrigerating articles which is free from most of the limitations of the methods outlined above. More specifically, the object of this invention is to provide a refrigerating method which involves the use of a refrigerant in fluid form, the refrigerant being moved relative to and in direct contact with the articles to be refrigerated and the desired temperature being maintained by regulating the quantity of fluid moved relative to the article.

Another object is to provide apparatus for re-

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frigerating articles, the apparatus including means for effecting relative movement between a quantity of refrigerant and the articles to be refrigerated.

5 In general, this invention comprises utilizing liquid air as the refrigerant, a supply of the liquid air being placed in a receptacle in a chamber and then either moving the articles through the chamber in contact with the liquid air, or regu-
10 lating the flow of liquid air into the chamber, the temperature being varied by altering the quantity of the liquid air used and the time during which the articles are exposed to it. There are three forms of the method by which this inven-
15 tion may be carried out. In the first, the liquid air is placed in a receptacle in an enclosed chamber near the top thereof and the articles to be refrigerated are placed upon the floor or else-
20 where near the bottom of the chamber. The liquid air is then sprayed into the chamber thereby effecting a relative movement between the liquid air and articles. The sprayed liquid
25 air changes to a gaseous state and circulates around the articles, either in the gaseous state or as a mixture of spray and gas. This form is
30 most useful in refrigerating vehicles, rooms or warehouses. A thermostatic control may be incorporated in the spraying device to maintain an even temperature.

30 In the second form, the articles to be refrigerated are mounted upon a conveyor, rack or the like and are inserted into a chamber beneath a spray of liquid air emanating from a perforated container placed over the conveyor. This form
35 is useful for quick-freezing the articles, that is, for frozen foods and the like which must be frozen quickly and then transported in a frozen state. When a conveyor is used, the temperature
40 of the articles is a function of the speed of the conveyor and quantity of liquid air used in the spray per unit time.

The third form is similar to the second, except that the articles are immersed in the liquid air instead of being sprayed with it.

45 In the latter two forms the liquid air is continuously changing its state from liquid to gaseous, and the cold air thus formed is passed over the articles as they enter the chamber to pre-cool them and thus decrease the length of time
50 needed to freeze them and the quantity of liquid air used in the process.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the
55 accompanying drawings which, by way of illus-

tration, show preferred embodiments and the principle thereof and what I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principle may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is a cross-section through a chamber in which one form of this invention is utilized;

Fig. 2 is a cross-section through an apparatus utilizing another form of the invention; and

Fig. 3 is a cross-section through a chamber utilizing still another form of this invention.

Referring to Fig. 1, the chamber 10 there shown is provided with a door 11 in one wall thereof through which articles to be refrigerated are passed. The articles are shown at 12 resting upon the floor 13 of the chamber and spaced from one another to permit circulation of the refrigerant around them. The articles may be mounted on stands (not shown), if desired, to permit circulation of the refrigerant around all sides thereof. Near the top 14 of the chamber and preferably at or near a corner is an insulated receptacle 15 lined with a suitable substance 16 such as steel which will not deteriorate upon contact with a refrigerant at -300° F. Receptacle 15 is almost completely filled with liquid air 17 through a pipe 18 passing through the top of the chamber. Pipe 18 is closed by a cover 19 to retain all of the gaseous refrigerant within the receptacle. The gaseous refrigerant occupies the space 20 and is emitted into the chamber through a conduit 21, a valve 22 and a suitable nozzle 23.

The bottom of receptacle 15 has a pipe 24 leading therefrom to one or more branches 25 from which the liquid air may be sprayed into the chamber either upon a tray 27 from which it evaporates into the chamber or directly into the chamber or onto articles placed therein.

In Fig. 2, the chamber is shown at 30 having openings 31 and 32 at opposite ends thereof. Within chamber 30 and extending substantially from one open end to the other is an endless belt conveyor comprising a pair of drums 33 and 34 mounted on supports 35 and 36 respectively and an endless belt 37 passing around both drums. A motor 38 drives drum 33 by means of a drive pulley 39, a belt 40 and a driven pulley 41. The direction of rotation of motor 38 is such that drum 33 rotates counterclockwise as viewed in Fig. 2 which causes the upper or load side of conveyor belt 37 to move to the left. Articles to be refrigerated such as packages 42 are placed upon the conveyor belt 37 through opening 31 in chamber 30 and are removed through opening 32. A platform 43 positioned near drum 34 receives the packages as they come off conveyor belt 37.

Directly below the load side of conveyor belt 37 is a receptacle 44 in which is stored a quantity of liquid air 45. A pipe 46 communicates with the interior of receptacle 44 and conducts the liquid air to a pump 47, the outlets or high side of which is connected to a riser 48 which empties into a tank 49 located above conveyor belt 37. The bottom of tank 49 is perforated or it may be provided with a plurality of nozzles 50 which direct the liquid air upon the articles 42 as they pass through the chamber. A belt 51 and pulley 52 connected to pulley 39 of motor 38 supply the motive power for pump 47. The cold air resulting from the gasification of the liquid air may

pass out of chamber 30 through opening 31, thereby serving to pre-cool the packages 42 before they are sprayed by the liquid air.

In the modification shown in Fig. 2, the rate of freezing is very rapid since the article to be frozen, viz. packages 42 come in direct contact with the liquid air. The depth of freezing can, of course, be regulated by the speed with which the packages are passed through the chamber, and this speed may even be such that the packages are merely cooled. Thus the temperature of the packages as they leave the chamber may be regulated by regulating the speed of the conveyor. It is understood, of course, that suitable means is provided to render pump 47 a constant volume pump, since the quantity of liquid air leaving tank 49 is constant. It will be noted that the liquid air, after it leaves conveyor 37 drains back into receptacle 44.

The modification shown in Fig. 3 differs from the modification shown in Fig. 2 in that the packages are immersed in the liquid air instead of being sprayed by it. Referring to Fig. 3, the refrigerating apparatus is comprised of a chamber 55 having open ends 56 and 57. Adjacent open end 57 is a well or tank 58 which is formed by building the floor of chamber 55 at a lower level at end 57 than at end 56. Well 58 is filled with liquid air 59 which as it changes from liquid to gaseous state rises and flows toward end 56. The roof of chamber 55 may be depressed at 60 to form a dividing wall and constrain a portion of the gasified refrigerant to travel in the direction of open end 56.

Two conveyors are used. The first operates entirely outside the liquid air well 58 and comprises an endless belt 61 passing over drums 62 and 63 mounted on supports or stands 64 and 65, respectively, with a motor 66 connected by a pulley 67 and belt 68 to a pulley 69 on drum 63 for driving the conveyor belt 61. The direction of rotation of motor 66 is such that the load side of conveyor belt 61 is moved to the left as viewed in Fig. 3. Thus opening 56 constitutes the entrance or loading end of the chamber. The articles 70 to be frozen are moved through the cold air escaping from well 58 and are thus pre-cooled. The articles drop into the liquid air 59 when they leave conveyor 61.

The second conveyor operates partly in the liquid air 59. It is comprised of an endless belt 71 passing around a drum 72 mounted on a stand 73 at the bottom of well 58, and around a drum 74 mounted on a stand 75 angularly disposed with respect to the sides of well 58. Stand 75 is located outside well 58 so that the end of belt 71 supported thereby is likewise outside the well. A second drum 76 also mounted on stand 75 serves to raise the slack side of belt 71 over the edge of well 58. A motor 77 connected by a pulley 78 and belt 79 to a driven pulley 80 on drum 74 supplies the motive power for belt 71. The direction of rotation of motor 77 is such that the drive side of conveyor belt 71 is moved to the left as viewed in Fig. 3, thus causing the articles which drop into the liquid air 59 and upon conveyor belt 71 to be moved through open end 57 upon an unloading platform 81 exterior of the well. A guide plate 82 above drum 72 constrains the articles to fall upon conveyor belt 71. As in the Fig. 2 form, the temperature of the articles may be regulated by regulating the speed with which they move through well 59.

In all three forms, since the temperature of liquid air is about -300° F. a wide range of

temperatures is available. This has many advantages over refrigerating arrangements now in use including those employing Dry Ice as the refrigerating medium. While the power required to produce refrigeration at the temperature of liquid air, i. e., the power required to liquify air, is theoretically twice the power required to produce a quantity of Dry Ice having the same heat abstracting capacity, the raw material for liquid air is free whereas the carbon dioxide used to form Dry Ice must be manufactured. The liquid air is easily handled and conveyed by tanks and pipes, whereas Dry Ice must be formed into blocks, wrapped and then carried to the place where it is to be used. It is well established that the most rapid heat transfer between substance existing in different phases, e. g. liquid and gaseous phases, is between a surface and a boiling liquid, which situation obtains in the foregoing examples when the articles are immersed or in contact with the liquid refrigerant.

It is understood that the foregoing description is merely illustrative of the preferred embodiments of this invention and that the scope of this invention is not to be limited thereto but is to be determined by the appended claims. It is to be understood further that although liquid air is admirably suited to the refrigerating methods disclosed herein, said methods are readily adaptable to other liquid refrigerants which possess the physical property of liquifying at extremely low temperatures and passing in a gaseous state while still at a low temperature.

Thus, while I have illustrated and described preferred embodiments of the invention, it is to be understood that these are capable of variation and modification and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. The method of refrigerating an article which comprises providing a refrigerant which is adapted to pass from liquid to gaseous states, said refrigerant being provided in a chamber in both liquid and gaseous states, precooled the article with the gaseous refrigerant while moving the article through a portion of the chamber, then continuously wetting the article with the liquid refrigerant during its movement throughout the remaining portion of the chamber and regulating the final average temperature of the article by the speed at which it is moved through the refrigerant.

2. The method of refrigerating an article which comprises providing a refrigerant which is adapted to pass from liquid to gaseous states, said refrigerant being provided in a chamber in both liquid and gaseous states, precooled the article with the gaseous refrigerant while moving the article through a portion of the chamber, flowing the liquid refrigerant over the article during its movement throughout the remaining portion of the chamber and regulating the final average temperature of the article by the speed at which it is moved through the refrigerant.

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