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REFRIGERANT MIXTURE AND METHOD OF REFRIGERATING CARS AND OTHER ENCLOSED SPACES THEREWITH

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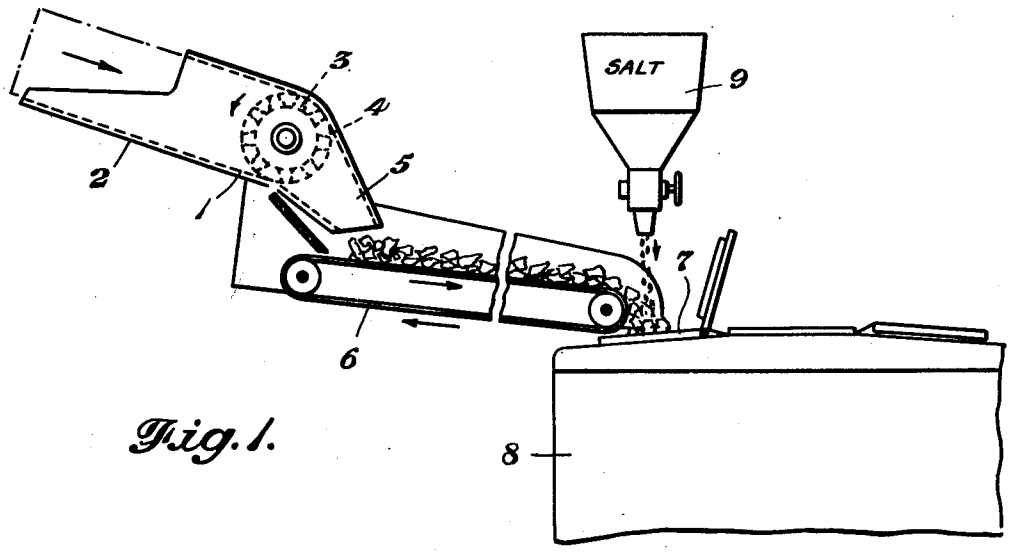
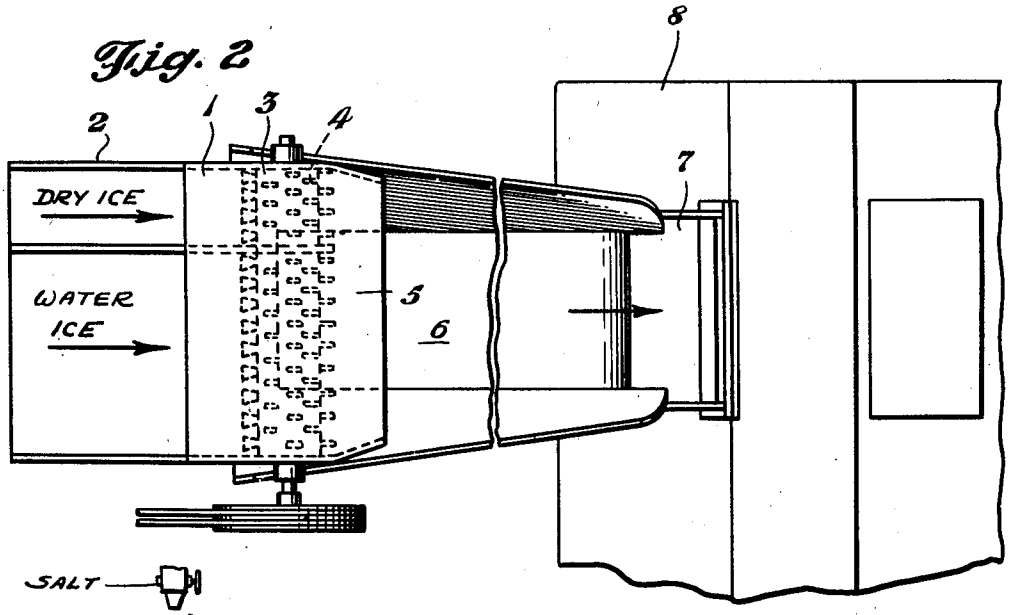


Fig. 1.

Fig. 2



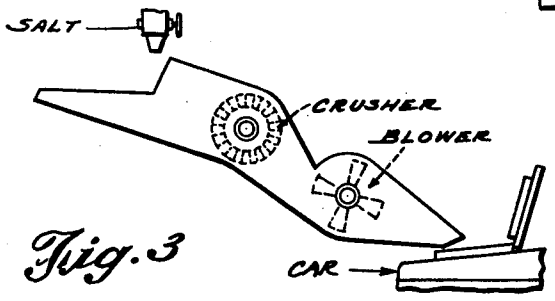


Fig. 3

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REFRIGERANT MIXTURE AND METHOD OF REFRIGERATING CARS AND OTHER ENCLOSED SPACES THEREWITH

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8 Claims. (Cl. 62—1)

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The present invention relates to a new refrigerant and method of refrigeration and is particularly useful in the refrigeration of foods and other perishables during transportation in cars, trucks, planes or ships to produce temperatures below 32° F.

It has been the practice heretofore in such refrigeration to load the refrigerant bunkers in such transportation media with ice in blocks or crushed to relatively large size, or a mixture of both, and then add a salt such as rock sodium chloride or calcium chloride to reduce the temperature of melting. Air from the compartment containing the food or product to be refrigerated naturally circulates over or thru the ice and salt or such circulation is some times forced or induced by a fan or blower. The quantity of salt in the ice mixture will vary up to 30%, depending on the temperature desired.

Large refrigerator carriers such as refrigerator cars are warm at prevailing air temperatures prior to use and the sensible heat is so great that a car must be precooled to a useful refrigeration temperature prior to use in view of the great length of time required to cool the car to avoid spoilage of the perishable product while the car is being cooled.

The most common method of refrigerator car precooling is to load the bunkers with ice and salt, allowing it to stand 24 to 30 hours in order to come down to loading temperature and while doing this, most of the ice load is melted and runs off as cold brine, requiring reicing either after 12 hours, or after 24 hours, and usually both, depending on the sensible heat, the quality of insulation of the car and the outside temperature. After the car is loaded it is continuously reiced in transit in 24 hour periods and sometimes less.

I have discovered that the salt-icing above described is made several times more efficient by precooling the ice and salt with another refrigerant such as a homogeneous mixture of Dry Ice as or immediately before it is loaded into the bunkers in such manner that most of the Dry Ice is dissipated in the heat exchange and thereby allowing a substantially full bunker of cold ice and salt with minor residual quantities of Dry Ice to be used at one loading. Thus in effect enough refrigeration is stored in a mixture of ice and salt by heat exchange with Dry Ice to have all of the refrigerating effect of the Dry Ice without utilizing the bunker space required for the Dry Ice. In effect the ice is precooled substantially below the temperature which would normally be produced by the ice and salt mixture so that the full bulk of ice and salt is available for low temperature refrigeration without the usual loss in coming down to temperature after being placed in the ice bunker.

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It requires about 70 B. t. u. to cool a pound of water ice down to the temperature of Dry Ice (—109° F.) which is the heat that would be absorbed by approximately 0.28 pound of Dry Ice on perfect heat exchange. Some heat is absorbed from the crusher, hoppers and chutes so that a little higher proportion may be used i. e. up to 33%. In actual practice, it may be desirable to use only enough Dry Ice to avoid melting of the ice and salt, that is, enough to bring the ice and salt mixture a little below its normal minimum temperature. For example, 25% ice and salt mixture normally capable upon considerable subsequent melting of developing a temperature of approximately zero degrees F. may be mixed with only enough Dry Ice to reduce it immediately to zero degrees F. In practical operation considering various heat losses to the handling equipment from 5% to 33% of Dry Ice, would be used and a normal quantity of salt would be added, depending on the ultimate temperature to be maintained.

Most efficient heat exchange between the ices is effected by finely grinding them both together as described in my abandoned copending application Ser. 442,236 according to the proportions selected herein. The ices may be disintegrated together by feeding both ices to a grinder from a common hopper and then further pulverizing by dropping the ground mixture on the blades of a blower rotated at high speeds, the ice dust or snow being blown out thru a hose into the bunker wherein salt is continuously added or the salt may be added to the ice hopper during the crushing. In such ice immediate maximum heat exchange is effected and the extreme low temperature of the ice is immediately effected. However, such ice can be used only when over head car bunkers of the brine tank type are available or where an ice blancket is to be applied directly over the food since such fine ice will not be retained in a large mesh basket screen type container of the end bunker type cars without further use of finer screening to retain it and it has the further disadvantage that it will retard air circulation thru the ice mass where such circulation is necessary for efficient refrigeration. For improving air circulation, the ices may be mixed in larger lumps

of roughly 1 to 4 inches in diameter, by grinding together to such size, however it is desirable to reduce the size to the smallest adequate to allow air circulation. The ices may be separately ground and then mixed and where this practice is followed, it is possible to grind the Dry Ice finer than the water ice. Where Dry Ice is available as a snow it may be mixed in this condition with water ice in suitably sized lumps or may be fed to the hopper wherein water ice cakes are being crushed. In any case, it will be appreciated that the Dry Ice must be evenly distributed thruout the water ice.

It is also desirable to evenly distribute the salt thruout the composition. Where relatively large lumps of ice are used, the conventional practice of throwing the salt on the ice in a layer which will melt evenly down thru the ice mass may be continued, but where the ice is finer, the salt is more desirably evenly mixed therewith. Inasmuch as the salt is generally not effective at the low temperature first produced in the mixture with the Dry Ice, the salt may be added to the hopper while the ices are being crushed or may be distributed thruout or over the ice mixtures as or after it is poured into the bunkers. It is also suitable to add salt to the water ice and thereafter grind or mix the salt ice with Dry Ice. As used herein and in the claims, the term "salt" is intended in the generic sense to include various salt type freezing point depressants such as sodium chloride, calcium chloride and others known in the art.

Reference is made to the drawing herewith which illustrates the practice of this invention wherein;

Fig. 1 is an elevation of an icing system showing fragmentary portions of a refrigerator car, crusher, and chutes for applying the ice refrigerant thereto and,

Fig. 2 is a plan view of the same.

Fig. 3 shows diagrammatically the combination of a crusher and blower mounted above the bunker of a car for blowing refrigerant therein. This figure also shows the salt hopper mounted to supply salt prior to crushing.

The drawings show, diagrammatically, a conventional ice crusher 1, having a hopper 2, for receiving predetermined quantities of ice and Dry Ice which may be placed therein, either manually or by conveyors, chutes, etc. (not shown), and feed the same to a conventional crushing drum 3, having teeth 4, projecting therefrom to break the ice into desired size. The crushed ice and Dry Ice passes through a spout 5, onto a chute or conveyor 6, and thence to a hatch opening 7, of a conventional refrigerator car 8. Mounted either at any suitable point along the conveyor 6, or directly over the hatch opening 7, is a salt hopper 9, for desired addition of salt to the ice passing therebeneath. Alternatively as shown the salt may be added at the hopper 10 to the refrigerant prior to crushing. Alternatively the chute or conveyor 6 may be replaced by entirely enclosed ducts or may be removed entirely and the crusher mounted directly above the hatch opening 7 to deliver crushed ice and Dry Ice directly by gravity through the spout 5 into the bunkers or with the aid of a blast of air generated in part by the rapidly rotating crusher or with an auxiliary blast of air from other blowers which may be used or not as desired, to enhance propulsion of the crushed refrigerant.

The following examples will illustrate the practice of this invention.

Example I

An overhead ice bunker refrigerator car, whose normal capacity is 9000 lbs. of ice and 2250 lbs. of salt, is iced by grinding in a blower ice machine, consisting of a grinder and a rapid rotating high speed blower, which receives the ground ice and macerates it to a snow, blowing it out through a hose, 8500 lbs. of water ice and 2250 lbs. of Dry Ice, evenly distributed therewith to the hopper. The ice product is a fine dry fluffy snow blown out of the tube with great velocity and extremely low temperature due to heat exchange between the ices. As the snow is blown into the bunkers, 2250 lbs. of large crystal rock salt is evenly mixed therewith. The temperature of the car prior to icing taken as an average of various points in the interior is 63° F. The outside temperature of the air thruout the test ranged from an 85° F. high in the hotter part of the day to plus 52° F. low at the coldest part of the night for the duration of the test. Consistently warm weather was available except during one 12 hour period when it rained. These temperatures were taken in the shade and the car temperatures reported are an average of 12 different readings taken simultaneously from thermocouples supported near the top, floor, center, sides, ends and doors of the car, the temperatures being read from the outside by leads from the thermocouples. Two hours after icing, the temperature of the bunkers was lower than minus 40° F. The following table shows the temperatures in the car as recorded during the test.

Time	Hours	Temp., °F.
		Degrees
2 p. m.	0	62
4 p. m. (half iced)	0	51.7
5 p. m. (completely iced)	0	42.7
6 p. m.	1	38.3
7 p. m.	2	33
8 p. m.	3	30
9 p. m.	4	27.6
10 p. m.	5	25.5
11 p. m.	6	23.7
12.01 a. m.	7	22.4
1 a. m.	8	21.8
2 a. m.	9	20.8
3 a. m.	10	19.8
4 a. m.	11	19.7
5 a. m.	12	18.7
6 a. m.	13	18.5
7 a. m.	14	18.2
8 a. m.	15	17.4
9 a. m.	16	16.9
10 a. m.	17	16.8
11 a. m.	18	16.2
1 p. m.	20	16.7
3 p. m.	22	17.4
5 p. m.	24	18.7
7 p. m.	26	19.9
9 p. m.	28	20.4
12.01 a. m.	31	21.1
3 a. m.	34	21.01
6 a. m.	37	21.02
9 a. m.	40	19.8
12.01 p. m.	43	19.5
3 p. m.	46	19.7
6 p. m.	49	20.1
9 p. m.	52	21.1
12.01 a. m.	55	21.1
3 a. m.	58	20.5
6 a. m.	61	21.2
9 a. m.	64	20.2
12.01 p. m.	67	19.7
3 p. m.	70	19.0
6 p. m.	73	18.7
9 p. m.	76	18.0
12.01 a. m.	79	17.8
3 a. m.	82	17.2
6 a. m.	85	17.1
9 a. m.	88	18.0
12 p. m.	91	19.1
3 p. m.	94	20.5
6 p. m.	97	22
6 a. m.	109	20.5
6 p. m.	121	21.7

Thus the data shows that a single car load of

ice and salt in the bunkers, chilled with Dry Ice brought a warm car down to subfreezing temperature in three hours after icing and to a minimum temperature 18 hours after icing and maintained a typical ice-salt subfreezing refrigeration temperature of approximately 18° F. for over 5 days, by contrast this car normally iced with 9000 pounds of ice and 2250 lbs. of salt would require at least 24 hours to attain this temperature and would need to be reiced at least every 24 hours with half of this quantity of ice and salt in normal use.

Example II

Example I is repeated except that the bunkers were filled with ice and Dry Ice broken in a coarse crusher, the size ranging from a dust to 4 inch diameter lumps and mixed with salt as it is poured into the bunkers. In this case with comparable outside temperatures, the average car temperature was brought down to 15° F. in 14 hours after icing and an overall average temperature of 15° F. was maintained for 75 hours, thus showing that the rougher ice while giving a lower temperature due to improved air circulation through the ice bunkers, does not last quite so long.

Example III

Ice which has been mixed with 30% of salt and allowed to attain an extreme low temperature of 0° F. is ground with 25% of Dry Ice (approximately the same weight proportions of the previous examples) to an egg lump size and poured into ice bunkers of the above described car under comparable conditions to the above examples. In this case the car was precooled to a minimum temperature of 10° F. in 12 hours and maintained this temperature for 82 hours.

Example IV

Separately crushed ice and Dry Ice to a lump size of 4 inches in diameter or less are evenly mixed in a proportion of 2200 lbs. of Dry Ice to 8500 lbs. of water ice and salted with 2200 lbs. of salt applied as an even blanket of salt over the ice mixture in the bunkers of the above described car. A minimum temperature of 17° F. was obtained and maintained over a period of 70 hours.

Various modifications of the present invention will occur to those skilled in the art and it is intended that the examples given be considered illustrative and not limiting except as defined in the appended claims.

I claim:

1. Method of salt icing the ice bunkers of a refrigerator comprising evenly mixing a major proportion of fragments of water ice with minor proportions of Dry Ice and salt in any sequence and adding the mixture to the ice bunkers.

2. Method of salt icing a refrigerator car comprising filling the ice bunkers with a substantially even mixture of salt, water ice and Dry Ice.

3. Method of salt ice refrigeration comprising finely comminuting a mixture of a major proportion of water ice and a minor proportion of Dry Ice, blowing the same into a refrigerator and applying salt thereto.

4. Method of forming an ice-salt mixture comprising substantially evenly mixing fragments of Dry Ice in the proportion of 5 to 33 parts by weight, water ice in the proportion of 100 parts by weight and salt in the proportion of 5 to 30 parts by weight.

5. Refrigerant comprising evenly mixed fragments of water ice, Dry Ice and salt, the water ice being in major proportion.

6. Refrigerant comprising evenly mixed fragments of water ice in the proportion of 100 parts by weight with fragments of Dry Ice in the proportion of 5 to 33 parts by weight with salt in the proportion of 5 to 30 parts by weight.

7. Method of refrigeration with ice and salt comprising forming a crushed mixture of ice and Dry Ice and conveying the same to the ice bunkers of a refrigerator by blowing the same into the ice bunkers and applying salt to the refrigerant at any stage.

8. Method of salt icing the ice bunkers of a refrigerator comprising filling the same with a charge of water ice, salt and a volatile refrigerant having the characteristics of being volatile at a temperature below the normal eutectic temperature of water ice and salt and rapidly reducing by volatilization the mixture of ice and salt to a temperature below which the water ice and salt mixture normally melts.

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