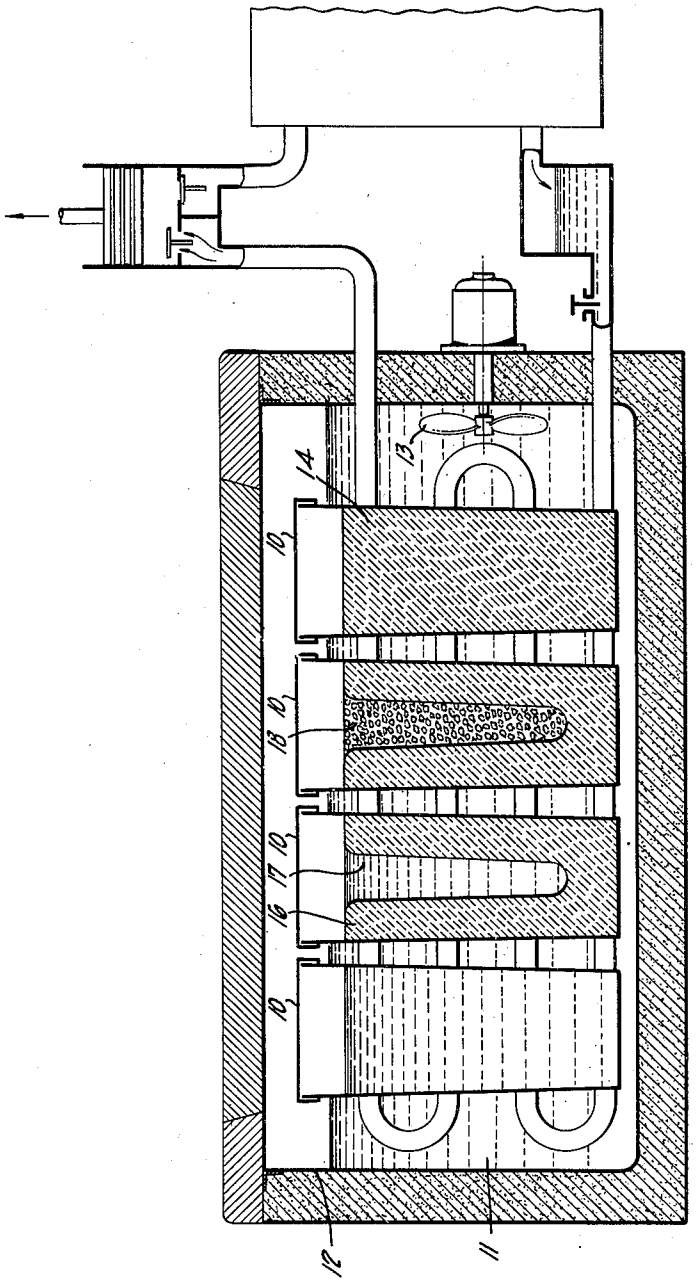
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METHOD OF MAKING ICE

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METHOD OF MAKING ICE

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This invention relates generally to a process and method for manufacturing ice, and particularly to a process and method for manufacturing ice by the can system.

In the past, ice has been manufactured in ice plants by one of two systems. The first system, generally known as the can system, is one in which water to be frozen is placed in suitable sheet iron cans which are then nearly submerged in cold brine. The brine is maintained at a low temperature by the evaporation of a refrigerant in a suitable container. The second system is known as the plate system of making ice and consists of a system in which a coil or plate is immersed in the water to be frozen. The coils or plates are arranged for the evaporation of a suitable refrigerant, or for the circulation of cold brine. The removal of the heat from the water in this manner causes the formation of a layer of ice on each face of the coil or plate.

It is an object of the present invention to improve the method of manufacturing ice by the can system in which, for a plant of a given size, a greater quantity of ice is produced at less cost.

Further objects and advantages of the present invention will appear from the following specification taken in conjunction with the accompanying drawing in which the figure is a diagrammatic showing of a can ice machine system incorporating my invention, in which four successive stages of the process are shown.

The method of producing ice by means of the can system may be shown diagrammatically in the figure by the four stages of the process illustrated. This figure does not necessarily represent the simultaneous condition of adjacent cans in the brine tank. In this system, the water to be frozen is placed in suitable sheet iron ice cans 10 which are then nearly submerged in a bath of cold brine 11 which is retained by a brine tank 12 generally made of steel. The brine 11 is maintained at a temperature of between 3° to 30° F. by means of the evaporation of a suitable standard refrigerant such as ammonia. The water in the can 10, being exposed only to the pressure of the atmosphere, will freeze at a temperature of 32° F. and the cold brine, at a temperature such as 15° F., will absorb heat required to cool the water from its original temperature to freezing temperature, that is 32° F. The brine

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also absorbs the latent heat of fusion of the water; the heat to cool the ice to the temperature of the brine 11; the heat from the ice cans 10; the heat transmitted by the tank 12; and the heat to cover the other losses. The brine 11 is kept in constant circulation in the tank 12 by means of a propeller agitator 13 and the purpose of this circulation is not only to equalize the temperature of the brine at all parts of the tank, but also to increase the heat transmission by the greater velocity of the brine.

As soon as the water in the cans is cooled to 32° F., ice will begin to form on the surfaces of the can 10. The rate of freezing is rapid at first and becomes progressively slower as the thickness of the layer on the inner walls of can 10 increases. If the can 10 is left in the cold brine 11 long enough, the water will entirely solidify forming a homogeneous block of ice 14 as shown in Figure 1. The cans 10 of ice may then be removed from the brine and other cans filled with water may be inserted in their places, thus making the process of ice production continuous.

Due to the fact that brine absorbs heat as previously indicated, means must be provided for removing this heat just as fast as it is absorbed in order to maintain its temperature constant. This is usually accomplished by submerging an evaporator for the refrigerant directly in the brine.

As is well known to those skilled in the art, the freezing time or rate for a given thickness of ice as compared to the freezing time of ice of another thickness varies approximately as the square of the thickness, assuming all other factors remain constant. In other words, the freezing time required to freeze ice 4 inches and 6 inches thick varies as the ratio of 16 to 36; also the freezing time is inversely proportionate to the temperature between the brine and the freezing water. Assuming therefore for the purposes of illustration that the layer of ice 16 built up on the inner walls of the ice cans 10 follows the laws above set forth, it is obvious that the center core portion 17 will be the last to freeze and that the time consumed in the freezing of the last 4 inches will greatly exceed the time consumed in the freezing of the first 4 inches of thickness of ice on the inner walls of the can 10.

When a layer of ice 16 has been formed on the

walls of the can 10 substantially as shown in Figure 1, there is a core in the center of the block of ice being frozen which is filled with water at a temperature of 32°. At this point, I should explain that in this and the following examples I am assuming that the can 10 is approximately 11 inches wide, 22 inches long and 50 inches deep. I should also explain that the width of the core 17 to which I refer in this and any other examples herein is 4 inches, as shown in the figure.

I propose to withdraw the water from the core 17, leaving a shell or layer of ice 16 in the interior of the ice can 10 generally as shown in the figure. I then propose to fill core 17 with crushed ice or snow 18 and add only sufficient water thereto to completely fill the voids or spaces between the particles of ice or snow. The ice or snow which is introduced into the core 17 is, of course, at approximately 32° F. The water which is introduced is also introduced at a temperature of 32° F. whereby there is no melting of either the block of ice 16 or the ice 18 put into the core 17. It is obvious therefore that the new contents of the core 17 will freeze in a lesser period of time than would the contents of the core if the same were entirely water at 32°, for the reason that there is only a small quantity of water to be frozen.

In tests which I have made I have discovered that approximately only 5% of the filler of the core 17 need be water at a temperature of 32° F.

The substitution of crushed ice or snow 18, or both, and a small quantity of water at a temperature of 32° greatly hastens the production of a solid block of ice. For example, actual tests show that a block of ice 11 inches thick can be produced by my method, that is, with the introduction of crushed ice or snow into a 4-inch core, in the same length of time now required to freeze a block of ice 7½ inches thick by the standard procedure. Speeding the production of a solid block of ice in a given plant means increased production of ice with the same equipment or decreased consumption of power for the production of the same quantity of ice by the use of the same equipment. There are several ways in which my invention may be used, as shown in the following examples. As a standard for the following examples, I have taken a plant which may be generally described as follows, and which I will hereafter refer to as "the standard plant":

Number of cans in tank	432
Weight of each block of ice	313
Tons produced daily	45
Number of blocks of ice produced each 24-hour period	300
Freezing time for block of ice ____hours	34.5
Number of cans per ton of ice produced per 24 hours	9.6
Tons of refrigerant required per ton of ice	1.6
Brine temperature ____degrees	12
Ammonia saturation temperature ____degrees	6.5
Ammonia suction pressure	20.75
Split (difference between brine and ammonia temperature)	5.5
Ammonia liquid temperature (from condenser) ____degrees	78
Kilowatt hours of power consumed per ton of ice produced (net including auxiliaries)	54

Example No. 1

In the first example of a way of adapting my invention to the above standard plant, I propose

to produce the same daily net tonnage, to-wit, 45 tons per day, as was produced in the standard plant. In this example, the filler 18 of snow or crushed ice used to fill the cores 17 is the product of the plant and is taken from the increased total or gross capacity of the plant. In order to fill the cores with the production of the plant, it is necessary to crush approximately 22% of the plant's total production for this purpose.

	Example	Standard Plant
Number of Cans in tank	432	432
Weight of each block of ice	313	313
Tons produced daily	45	45
Number of blocks of ice produced each 24-hour period	300	300
Freezing time for block of ice ____hours	34.5	34.5
Number of cans per ton of ice produced per 24 hours	9.6	9.6
Tons of refrigerant required per ton of ice	1.6	1.6
Brine temperature ____degrees	20	12
Ammonia saturation temperature ____do	14.5	6.5
Ammonia suction pressure	28.25	20.75
Split (difference between brine and ammonia temperature)	5.3	5.5
Ammonia liquid temperature (from condenser) ____degrees	78	78
Kilowatt hours of power consumed per ton of ice produced (net including auxiliaries)	45.6	54

From the above it will be seen that by withdrawing the water in the 4-inch core and substituting crushed ice and a small amount of water therefor, the freezing time is reduced as above pointed out. Specifically, it will be noted that the brine temperature may be allowed to rise from 12° to 20° whereby 18.75% less compressor capacity is required and a 15% savings in power is obtained.

Example No. 2

In the second example of a way of adapting my invention to the above standard plant, the filler 18 of crushed ice or snow is to be taken from the total or gross production capacity. In this instance, the former compressor capacity is to be used to meet new operating conditions created by the availability of greater can capacity. In this example, the plant produces 52 tons of ice per day with the brine temperature being allowed to rise to 19.5°.

	Example	Standard Plant
Number of Cans in tank	432	432
Weight of each block of ice	313	313
Tons produced daily	49	45
Number of blocks of ice produced each 24-hour period	330	300
Freezing time for block of ice ____hours	25.7	34.5
Number of cans per ton of ice produced per 24 hours	8.72	9.6
Tons of refrigerant required per ton of ice	1.6	1.6
Brine temperature ____degrees	19.5	12
Ammonia saturation temperature ____do	13.5	6.5
Ammonia suction pressure	27	20.75
Split (difference between brine and ammonia temperature)	6	5.5
Ammonia liquid temperature (from condenser) ____degrees	78	78
Kilowatt hours of power consumed per ton of ice produced (net including auxiliaries)	46	54

The advantages of the utilization of my invention as pointed out in this example are shown by the increased tonnage of ice produced and also the decrease in power consumed, in this instance 15% less than in the standard plant.

Example No. 3

In the third example of a way of adapting my invention to the above standard plant, I propose that the crushed ice or snow 18 be furnished from

an outside source but that the brine temperature can be allowed to rise to 19.75% and the same compressor capacity is used in freezing tank.

	Example	Standard Plant
Number of Cans in tank	432	432
Weight of each block of ice	313	313
Tons produced daily	59	45
Number of blocks of ice produced each 24-hour period	394	300
Freezing time for block of ice ____ hours	26.5	34.5
Number of cans per ton of ice produced per 24 hours	7.45	9.6
Tons of refrigerant required per ton of ice	1.6	1.6
Brine temperature ____ degrees	19.75	12
Ammonia saturation temperature ____ do	13.75	6.5
Ammonia suction pressure	27.25	20.75
Split (difference between brine and ammonia temperature)	6	5.5
Ammonia liquid temperature (from condenser) ____ degrees	78	78
Kilowatt hours of power consumed per ton of ice produced (net including auxiliaries)	46	54

The advantages of the use of my invention as illustrated in the above example are obvious. The increase of 14 tons of ice per day represents an increase of 31% over the output of the standard plant. In addition, I show the use of approximately 14% less power per ton of ice than consumed in the standard plant.

Example No. 4

In the fourth example of a way of adapting my invention to the above standard plant, I propose that the temperature of the brine be held at 12° by addition of greater refrigerating effect and that the filler of cracked ice or snow be produced in the plant and taken from gross production capacity, in which event 22% of the gross production capacity is used in the cores.

	Example	Standard Plant
Number of Cans in tank	432	432
Weight of each block of ice	313	313
Tons produced daily	76	45
Number of blocks of ice produced each 24-hour period	506	300
Freezing time for block of ice ____ hours	16	34.5
Number of cans per ton of ice produced per 24 hours	5.7	9.6
Tons of refrigerant required per ton of ice	1.6	1.6
Brine temperature ____ degrees	12	12
Ammonia saturation temperature ____ do	6.5	6.5
Ammonia suction pressure	21	20.75
Split (difference between brine and ammonia temperature)	5.5	5.5
Ammonia liquid temperature (from condenser) ____ degrees	78	78
Kilowatt hours of power consumed per ton of ice produced (net including auxiliaries)	50	54

By using my invention the output of the plant is increased 31 tons per day or 69% over the tonnage produced in the standard plant. It will be noted that the power per ton of ice is slightly less than the power per ton of ice required by the standard plant. I am assuming that the efficiency of the added refrigerating effect is the same as the original refrigerating effect.

Example No. 5

In the fifth example of a way of adapting my invention to the above standard plant, the filler of cracked ice or snow is produced from an outside source. Further refrigeration effect in the way of more compressor capacity and a greater

number of ammonia coils or brine cooler is added to hold the temperature of the brine at 12°.

	Example	Standard Plant
Number of cans in tank	432	432
Weight of each block of ice	313	313
Tons produced daily	97	45
Number of blocks of ice produced each 24-hour period	648	300
Freezing time for block of ice ____ hours	16	34.5
Number of cans per ton of ice produced per 24 hours	4.45	9.6
Tons of refrigerant required per ton of ice	1.6	1.6
Brine temperature ____ degrees	12	12
Ammonia saturation temperature ____ do	6.5	6.5
Ammonia suction pressure	21	20.75
Split (difference between brine and ammonia temperature)	5.5	5.5
Ammonia liquid temperature (from condenser) ____ degrees	78	78
Kilowatt hours of power consumed per ton of ice produced (net including auxiliaries)	50	54

Utilization of my invention in the above example shows an increased production of 52 tons of ice per day or a 115% increase over the production of the standard plant. As in the previous example, the power consumed per ton of ice produced is slightly less than the power per ton of ice produced in a standard plant.

From the foregoing, it will be obvious that by using my invention in a standard plant there are two general profits to be obtained. The first advantage is the increased production of greater quantities of ice with no increase in compressor capacity or power consumption. The second advantage is derived from the production of the same quantity of ice as before with the same or a lesser expenditure for plant capacity and power consumption.

Generally speaking, ice produced in accordance with my process is a better product in that the same does not shatter or crack resulting from strains which are frozen into the ice. Shattering and cracking of blocks of ice may result in a loss of up to 5% of the total plant capacity in some instances. However, ice made in accordance with my process will, it is recalled, utilize cracked ice or snow which is already frozen and therefore already expanded, leaving little or no expansion to occur in the core. A more solid block of ice is obtained with fewer strains therein.

When the ice is made in accordance with my invention or process it may be made at a higher freezing temperature, resulting in a saving in equipment and compressor capacity. A smaller investment is required, that is, a smaller investment per ton of ice produced.

In addition, less operating and labor expense per ton of ice is required inasmuch as, in the examples above given, little or no more additional labor is required than in the standard plant referred to herein. In addition, maintenance and replacement costs per ton are likewise reduced.

It will be obvious that utilization of my process may eliminate chemical treatment in many localities. It will be recalled that the higher the freezing temperature the less pure the water need be and, conversely, the colder the freezing temperature the more pure the water need be to produce a satisfactory product. In the event the ice is made in brine at a high temperature, therefore, less pure water is required.

The water taken from the core 17 may be reused in the freezing process, either in the block of ice with the crushed ice 18 placed in the core, or as a source of water to be placed in the cans 10 in the first steps of the operation, or in any

other way that appears practical or proper in the operation of any specific plant.

It will also be appreciated that the frozen material 18 placed in the core may be either crushed ice or snow as indicated or may be ice in any form, such as flakes, etc., to meet optimum conditions.

In all of the foregoing, I have assumed that the shell of ice in the can is sufficiently thick to leave a four inch core. I appreciate that experimentation in a specific plant may show that a larger or smaller core may be desirable to meet optimum conditions, in which event the shell of ice 16 may be frozen thicker or thinner as desired without departing from the spirit of my invention. In any case, the percentage of filler in relation to the finished block may be varied to meet optimum conditions.

I claim:

1. In a method of making ice by the can system, the steps of, first, forming a shell of ice on the inner walls of said can, second, withdrawing the unfrozen water from the said shell of ice and third, replacing the same with a mixture of crushed ice and water.

2. In a method of making ice blocks in which a quantity of water to be frozen is placed in a can, the steps of, forming a shell of ice on the inner walls of said can by heat transfer through the walls of said can, withdrawing the inner core of unfrozen water from said shell of ice, replacing the same with a mixture of ice and water and then freezing said mixture to form a solid block of ice integral with the shell.

3. In an improved method of making ice blocks, the steps of, placing water to be frozen in a container, immersing said container in a heat absorbing medium, allowing a coating of ice to form on the inner walls of said container, withdrawing the unfrozen water from within said coating of ice and replacing said water with ice and water and retaining said container, shell, and ice and water mixture in said heat absorbing medium until said shell and said ice and water have formed a homogeneous block of ice.

4. In an improved method of making ice in which water to be frozen is placed in a can which is immersed in brine and a layer of ice is formed on the inner walls of said can, the improvement consisting in the steps of withdrawing unfrozen water from within said layer of ice before a homogeneous cake of ice is formed and replacing the same with a mixture of ice and water and retaining said can and mixture in said brine until a homogeneous cake of ice is formed.

5. In an improved method of making ice blocks in which water to be frozen is placed in a can partially immersed in cold brine and a layer of ice is formed on the inner walls of said can, the improvement consisting in the steps of withdrawing the inner core of said unfrozen water from said layer of ice before a homogeneous cake of ice is formed and replacing the same with a mixture, the major portion of which is cracked ice and the minor portion of which is water, and retaining said can, said layer of ice and said mixture in said brine until a homogeneous cake of ice is formed.

FREDERICK J. BOBBY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,271,879	Felt	July 9, 1918
1,321,954	Voorhees	Nov. 18, 1919