PAGES

MISSING

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OFFICIAL PROCEEDINGS

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TORONTO, CAN., Oct. 27th, 1914

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MEETING OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA

COMMITTEE ROOM, HOTEL CARLS-RITE,

TORONTO, October 27th, 1914.

In the absence of the president, Mr. T. J. Walsh, the chair was taken by Mr. Geo. Baldwin, past president.

Chairman,—

Gentlemen: It is time for starting our meeting. As you have all had a copy of the minutes of the last meeting, it will be in order for some one to move that they be adopted. Moved by Mr. A. M. Wickens, seconded by Mr. Jas. Wright that the minutes of the previous meeting be adopted. Carried.

Chairman,—

The next order of business is the remarks of the president. I might say, gentlemen, that Mr. Walsh phoned me this afternoon that he would not be able to be here this evening on account of sickness—and he asked me if I would take charge of the meeting to-night, not knowing whether the vice president would be here.

Since our last meeting I am sorry to say that we have lost one of our very oldest members, Mr. Frank Campbell—most of you knew him, I suppose. There were quite a number of the club members attended the funeral. The executive got together and decided to get a wreath, which was supplied.

The next order of business is the introduction of new members:

NEW MEMBERS

Mr. R. J. Cottrell, Loco. Foreman, G.T.R., St. Thomas, Ontario.

Mr. Alan Beardshaw, Asst. Loco. Foreman, G.T.R., Mimico, Ontario.

Moved by Mr. A. M. Wickens, seconded by Mr. Jas. Wright, that they be accepted as members. Carried.

MEMBERS PRESENT

G. M. Smith
Geo. P. Kirby
A. E. Quinn
Jas. Reid
C. H. Stainton
R. Choyce
A. M. Smith
J. Callanan
J. B. Robb
C. DeGrouchy
G. H. Jones
G. D. Bly
C. D. Scott
Geo. H. Boyd
Fred. G. Smith
H. H. Wilson
W. Dennett
W. Wighton
J. Dewsbury
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E. Logan
J. Dodds
Thos. H. Martin
T. McKenzie
A. M. Wickens
T. B. Cole
L. E. Ireland
J. Choyce
Jas. Kelly
J. G. Platt
W. C. Sealy
J. McLintock
J. Anderson

Chairman,—

Mr. Taylor is here, and is ready to give us a paper to-night on Refrigeration, and I am sure you will be very much pleased after you have heard this paper.

REFRIGERATION AND COLD STORAGE

BY MR. A. R. TAYLOR

Engineer, Wm. Davies Company

INTRODUCTION

One of the objects of my writing this paper is to show the vast importance of this line of engineering. The United States are the greatest users of refrigeration in the world. When we look at their figures for 1913 it makes us open our eyes, the capital invested there is one hundred and fifty million dollars. The largest single ice making plant is in St. Louis, which produces one thousand two hundred tons per day. Armour & Company, Chicago, the largest packing house, has a capacity of two thousand eight hundred and six tons of refrigeration. The eggs produced there total up to four hundred and eighty-five million dollars per year, ninety-six million animals were slaughtered in the United States. Fish and fruit total up to quite a large sum. All good hotels have their own refrigerating plant.

If I have started a train of thought in the minds of the engineers that very much has yet to be learned about cold storage and refrigeration, I will have done something, for an inferior storage well handled is better than a first-class storage badly handled, insulation counts a lot, but I haven't touched on this. Heat and moisture are the two worst enemies of cold storage, and it is up to the engineer to be able to control them at will.

There are many books written on this subject, but the ones that appeal to me most are by Wallis-Taylor, Hal Williams, Ewing's "Mechanical Production of Cold", and Andel's "Refrigeration and Practical Cold Storage," by Cooper. Other writers, such as Redwood and Hans Lorenz, are too heavy for the ordinary engineer. I have only mentioned the absorption system in detail, the other systems such as De La Vergne, the Freck, the Vilter, the York and the Linde would take an evening to themselves.

Refrigeration and Cold Storage

In taking up the subject of Refrigeration and Cold Storage, perhaps it will not be out of place to give a brief history of the subject.

Refrigeration has been used at a very remote period.

The crudest form in refrigeration is found in the ancient plan of cooling water by evaporation, that is, by exposing water to the night air in shallow porous vessels. The vessels placed on a bed of straw in an exposed position filled with water to be frozen and in the morning provided the night be clear is found covered with ice. (Year 1755.)

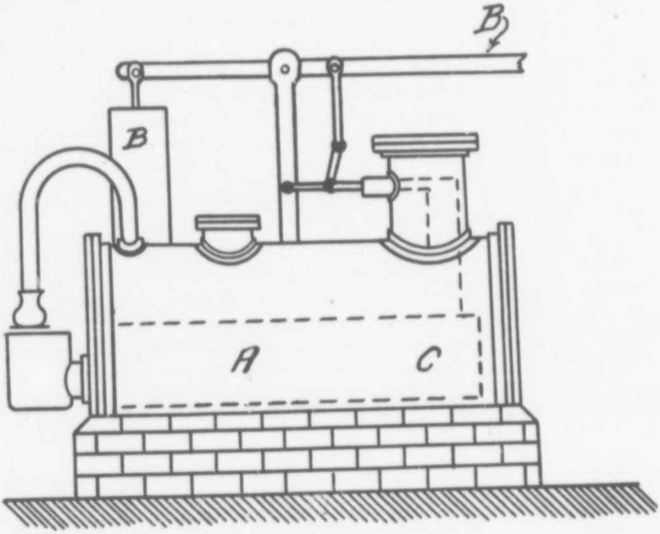
Dr. Cullen is the first we have any trace of who discovered that the evaporation of water could be facilitated by the removal of atmospheric pressure, and he introduced a vacuum machine. This apparatus was the foundation of all the others for cooling off liquids by their own evaporation in vacuo.

Water was invariably employed for the process.

Water has a boiling point of 212° Fahr. at atmospheric pressure. A latent heat of vapour of 966.6 and a tension of vapour of 0·623 and having so high a boiling point it requires a vacuum of .089 per square inch to boil at a temperature of 32° Fahr., and consequently a vacuum at the very least as high as this must be maintained to produce ice by the vacuum process.

The next step we come to is in 1777, when Nairne found that by the introduction of sulphuric acid into a receiver for the exhaust, the aqueous vapour could be absorbed from the rarifed air, and by taking advantage of this he was enabled to construct a machine wherein he got rid of the vapour that rose from the water, and that prevented it from forming a permanent atmosphere and hindering the continuity of the operation.

Attempts were made by Leslie in 1810, Valance in 1824, Kingsford in 1825, but Edmound Carre produced the first freezing machine to be of any commercial value. I have here a cut of his machine which was used in Paris. It consists of a



cylinder containing a charge of sulphuric acid, marked A. An air pump B, so arranged that it could be connected to the mouth of the carafe, and an agitator, C, which is so coupled to the air pump lever that it will be operated during the working of the pump, to keep the sulphuric acid in the cylinder in motion, and absorbing the vapour rising from the water; so much for Mr. Carre's invention.

An improved form of Mr. Windhauser's compound vacuum and sulphuric acid machine was made in 1881, and used in a dairy in Bayswater, London, England. It was capable of producing twelve to fifteen tons of ice per twenty-four hours. In the year 1755, when Dr. Cullen was experimenting, he found by removing atmospheric pressure that there were other liquids which boil at low temperatures, and would evaporate below the freezing point of water.

In the year 1834, Jacob Perkins was the first to introduce the compression of a volatile liquid for refrigeration purposes, and from this has sprung all those machines that work on compression principles.

The system of absorbing heat and thus producing cold is a well-known law in physics, that is, that all gases during the process of passing from a liquid to a gaseous state, are bound to absorb a certain amount of heat.

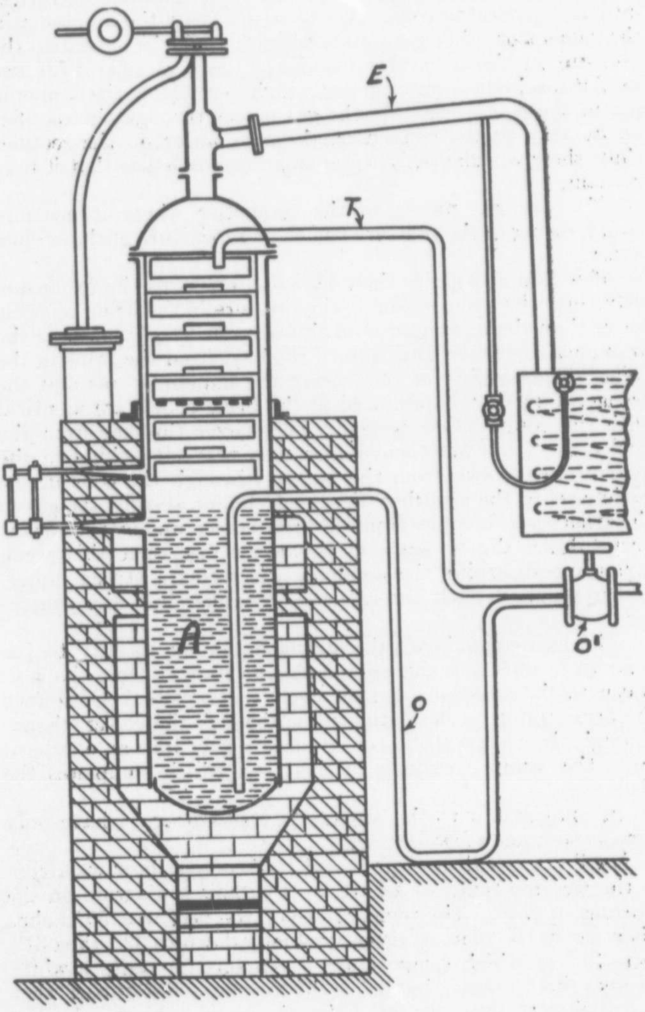
Mr. Perkins intended to use sulphuric ether in the compressor which he patented, but the experiments were made with a liquid produced by the distillation of india rubber, but of which nothing definite can be learned. It was the intention of Perkins to establish an ice factory in the river Thames, by putting some of these machines in barges, and driving them by paddles which were to be turned by the ebb and flow of the tide. The ether machine is now obsolete because of its being so highly inflamable.

The three principal refrigerating agents are ammonia, carbon dioxide, and sulphur dioxide.

All gases have been liquified, hydrogen is one of the most difficult gases to liquify, this has been done by Professor Dewar, and his experiments show that it boils at atmospheric pressure 440° below zero, he claimed it was by far the coldest liquid known. But Professor Kamerlingh Onnes, of Leyden, six years ago announced that he had liquified helium, the most intractable of all gases, its boiling point is 456° below zero, this is astonishingly near the absolute zero mark which is 460° below zero Fahr.

I will now take ammonia gas which seems to be the most used for refrigerating purposes, its boiling point at atmospheric pressure is 28.5° below zero, its composition is one part nitrogen to three parts of hydrogen, it is easily liquified at a pressure anything above ninety pounds per square inch, this is the first step called the compression side, the second step is the condensing side where the gas circulates through water cooled pipes, gives off its latent heat, and liquefaction takes place, a third is the expansion side, wherein the liquified gas can re-expand, and perform its work of cooling by extracting heat from its surroundings. The absorption machine consists of a generator, an analyzer rectifier, condenser, a cooler, an absorber, an exchanger, and an ammonia pump.

I have here a blue print showing part of one of the first ammonia ice making machines in which aqua ammonia is used. A, is the aqua ammonia; E, is the ammonia gas going over to the condenser; O, is the weak liquor line going over to absorb the expanded gas, and T, is the rich liquor being pumped back to the generator. A fire was kept burning (the same as a boiler) under the generator, and this drove off the ammonia gas from the water, and up through the trays of the analyzer, up through the gas line E. A safety valve was placed on the top in case the pressure got too high, and a pipe led from it into a vessel filled with water which absorbed the escaping gas. The absorption machine up to the present time has had a number of inventions added to it, steam coils, invented by Stanley, are used instead of fire.



A separate analyzer invented by Reece in 1867 is used. An exchanger invented by Mort in 1870 is another attachment.

I will now endeavour to describe how an absorption machine works. The generator is filled with sufficient aqua ammonia to cover the steam coils, and the water is then turned on the condenser also on the rectifiers, the steam being gradually turned into the generator coils. As the steam heats the ammonia in the generator, the generator pressure, which indicates the pressure in the generator, condenser, and rectifier, will rise until it reaches a point sufficiently high to condense the ammonia gas in the condenser. As the gas passes through the rectifier on its way to the condenser, the cool water on the rectifier chills the gas sufficiently to separate any moisture that it may contain.

The dry gas passes to the condenser where it becomes liquid, owing to the pressure and the temperature of the cooling water.

This liquified gas is then allowed to pass to the expansion valve into the brine cooler. The pressure in the brine cooler is lower than the condenser, and this drop in pressure causes the ammonia to expand and absorb the heat from the brine in the coils. The method of condensing the ammonia gas and the refrigeration that is produced in the brine cooler are identical with the compression system. To recover this gas from the cooler the weak ammonia liquor that was left behind in the generator is drawn from the bottom through the coils in the exchanger to the absorber, this weak liquor absorbs the gas in the absorber as it comes from the brine cooler, and by this means keeps down the pressure in the cooler, in turn this weak liquor by absorbing the ammonia gas forms a strong liquor, and is pumped back through the exchanger into the generator.

The exchanger heats the strong liquor on its way to the generator, and cools the weak liquor on its way from the generator to the absorber, and the cycle is complete. Of course, the brine pump is circulating brine through the cooler, thence through the rooms to be cooled, discharging into an overhead tank, the pump suction is in this tank which completes the cycle.

In coming now to the produce in cold storage, I have only time to mention a few of them.

I will start with beef first, and to show you how we arrive at the freezing point of an article, I submit a diagram on the freezing of beef. The temperature of the beef was 55° Fahr., when put in the room, it drops gradually down to 32°, then 31°, then 30°, at which temperature it remains for quite a while, we take this to mean that 30° is the freezing point of beef, then it straightway drops to 20° Fahr. the room taking a drop of 5° above zero.

Beef should not be piled away in storage rooms until thoroughly frozen, as it is apt to stick together, get mis-shapen, and thus loose its commercial value, if by any chance flakes of frost should accumulate on the surface of the beef during the process of freezing, through the opening of the door and allowing the warm air to enter, don't try to brush this frost off with the hand, as the heat of the hand will melt it forming a skin of ice on the surface of the meat which is not desirable.

The above also applies to pork, lamb, etc., it is always best to have these products covered separately in bags or cloth of some kind. All this stuff is best frozen in a zero temperature, or below, provided that the animal heat is taken out in a chill room first.

CHEESE IN COLD STORAGE

There is such a variety of opinions as to what temperature cheese should be kept at in cold storage. In fact, the temperatures ranges from 30° to 50° Fahr.

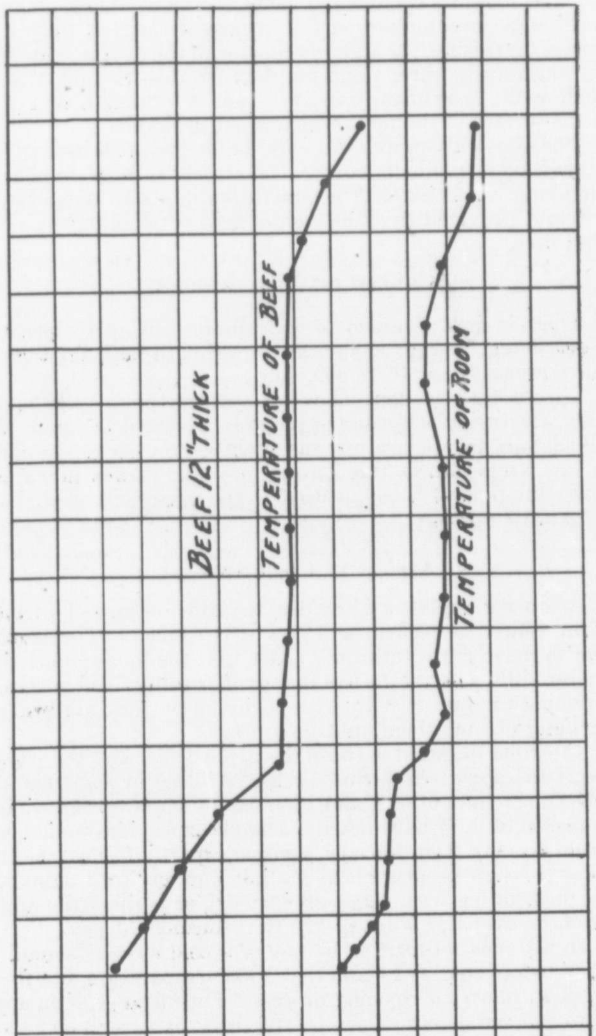
Cheese that is kept above a temperature of 50° molds badly, the curing or ripening process is hastened so much, that bad flavours are apt to injure the quality of the cheese; by carrying low temperatures this curing process is slowed down, and allows the rennett which is used in the manufacture of cheese to fulfill its mission.

APPLES IN COLD STORAGE

In storing apples, a great deal depends on how the fruit is grown, how it is picked, and how it is packed. The packers seem to have got it into their heads that the more apples they can force into a barrel the less chance of bruising them in transit, forgetting the fact that by forcing the lid on they are bruising them and making them unfit for storage.

The great question between the apple dealer and the storage man is the apple scald, this disease develops in some class of apples more than others, and I am not prepared to say what is the reason of it. I have asked one apple expert his opinion, and he said keeping them too cold, another expert informed me that it was through keeping them too hot, but my own opinion is that the fruit has been carelessly handled, or perhaps the apples have been over ripe when picked thus causing a decay.

To my idea all fruit to be put in a cold storage should be picked before ripe, as I claim that a low temperature, not freezing, slows down the ripening process. For instance, if an apple has to run ten days to ripen on the trees, by being picked and put in cold storage, this ripening process can be slowed down to probably ten weeks, if on the other hand, the fruit is allowed to remain on the tree and fully ripen, there is nothing to slow down, and the fruit having reached the end of its life dies and decays, my opinion is that this applies to all fruits and veget-


BEEF 12" THICK
TEMPERATURE OF BEEF
TEMPERATURE OF ROOM
60
50
40
30
20
10
0

ables, with the exception of potatoes. These have to be fully ripened before storing, the temperature never being allowed to touch freezing point, which would ruin them owing to the moisture they contain, stored in a dark place or the eyes will start looking out.

EGGS IN COLD STORAGE

One of the most difficult things to store are eggs. To freeze an egg is to crack the shell; the freezing point of eggs is 28°, that is when the frost crystals appear in the inside of the egg. I have been asked the question why should eggs be carried at so low a temperature as 30°. My only explanation is, that in freezing anything the bacteria in the article is held perfectly still, and so long as it is kept so, no damage can result. We cannot freeze the bacteria of an egg, but we carry as low a temperature as safety will allow, therefore the bacteria of the egg is less active than at a higher temperature, consequently the egg will keep longer and come out of storage in better condition.

A temperature of 45° will stop incubation. When incubation is taking place, the tread of the egg, which is situated in the yoke, gradually moves to the side, and when it reaches the shell adheres to it, then the egg is what is termed "spent".

A great deal depends on how the eggs are candled, nothing but the best of eggs should be kept for storage.

HUMIDITY

Humidity in egg rooms has to be watched very closely, as too much causes fungus to grow on the shell. The eggs absorb this and becomes musty and rotten. If the air is too dry the egg gives up its moisture and shrinks. To keep the moisture down, unslacked lime is used which absorbs the moisture from the air. The proper humidity point is determined by the temperature, every degree has its own humidity point; for instance, if an egg room is carried at 28°, we can have a humidity point of 85°, carried at 30° the humidity point 78°, carried at 40° humidity point 56°.

If the temperature is 28° we can have a humidity point of 85°; this does not mean that you have 85 per cent. moisture, if you can grasp that. It is 85 per cent. of what the air could hold.

Mr. A. M. Wickens,—

If the air holds all the moisture it can carry the humidity is 100°, and at different temperatures, you get the different amounts of humidity it will carry.

Mr. A. R. Taylor,—

That is the idea. Suppose you have a temperature of 30°, you have a humidity point of 78°. With a temperature of 40°, a humidity point of 76°. At the point which is 40° we will say it contains $7\frac{1}{2}$ grains of water. With the temperature at 30°, and a humidity point of 78°, it only contains $2\frac{1}{2}$ grains of moisture. What I want to show you is this; the lower the temperature the higher the humidity point, but the less moisture although more per cent.

Mr. G. Baldwin,—

I think we have listened with a great deal of interest to Mr. Taylor's paper. If there are any questions the members would like to ask, I am sure Mr. Taylor will only be too pleased to answer them.

Mr. H. H. Wilson,—

I would like to ask the speaker what effect would cold storage have on a non-sterile egg. I mean an egg where the rooster has not been in the flock.

Mr. A. R. Taylor,—

You will find an unfertile egg is the same as keeping an egg in too cold a temperature in cold storage. If you keep it too cold, you cook the yoke; what I mean by that is the yoke becomes hard and the white becomes watery. I have had an egg that has not been actually frozen, but on opening it the yoke falls out "flap," and is round like a ball, which never seems to thaw out.

Mr. H. H. Wilson,—

What I had in mind—is there any advantage to be gained by keeping the rooster away from the hens?

Mr. A. R. Taylor,—

I know that the white of an egg can become very watery when unfertile, if kept too long.

Mr. P. F. McCarthy,—

I would like to ask the speaker if they have ever tried keeping the storage rooms below actual atmospheric pressure. It seems to me there might be something in this.

Mr. A. R. Taylor,—

I do not recollect of this ever having been tried. I do not know if it would be possible. You have got to go in and out of your egg room so often, as eggs are so delicate you have got to keep your eyes open, watching the temperature, etc. In cold-storing eggs I do not think this possible. From my own experience it is not possible to carry an egg over seven months. The eggs laid in April, May and June are the best eggs for cold storage, because the weather is neither extremely cold or extremely warm when they go in. Take a July or August egg and you cannot keep it any length of time because the air has begun to take hold of it and decomposition has begun to take place. If you get the eggs right from the hen they are all right.

As far as keeping off atmospheric pressure, I do not think that this would do any good. It is the bacteria you want to get hold of. When the yoke is cooked it will not thaw out again but will remain hard.

Eggs that are slightly cracked are of course of no use for refrigeration. They are not, however, thrown away, but are placed in a bucket by the egg candler, one at a time until he has a bucketful, when they are placed in storage and frozen. This is what is known as eggs in bulk and are sold to cake makers.

I do not think that reducing the atmospheric pressur would help out.

Mr. P. F. McCarthy,—

What made me ask was this. At a very low temperature we get an unusually high barometer, and with a high temperature a very low barometer. I thought it might be possible to reduce the egg room to atmospheric pressure, and keep it sealed, and this would enable you to regulate your barometer As for going in and out to observe the temperature, with the chart arrangements they now have you can sit in your office and stay away from your egg room for a week and you can see the temperature, etc., day by day. I think it should be possible to seal your egg room if reducing the humidity would help any.

Mr. A. R. Taylor,—

You can very well reduce the humidity points. The humidity points I gave you there were where the air will not take on or give up moisture. I gave you the highest humidity point the egg can carry. It is better to keep it a little below that. If you have a temperature of 30° and a humidity point of 78° do not get it any higher. The great thing is that when you have whiskers on your eggs you cannot get them off. You will never save an egg once you get fungus on it, as the egg absorbs it.

Mr. H. H. Wilson,—

Is there any advantage in setting an egg on the small end.

Mr. A. R. Taylor,—

This is a point I have been trying to think out myself. Some men claim that by setting the heavy end down the yoke is comfortable because it has got this air chamber beneath it. On the other hand if you set the egg with the small end down the yoke is cramped, but nowadays time is money and if the egg candler has got to watch which end he is putting down when he is handling them, it means a whole lot of money.

Mr. F. G. Smith,—

In regard to the air chamber end of the egg, if the inside of the egg is heavier than air, would not the air rise to the top.

Mr. A. R. Taylor,—

The air remains underneath at the thick end.

Mr. J. G. Platt,—

This meeting seems to have drifted into the discussion of eggs in cold storage which seems to be one of the hardest things to keep in refrigeration. In regard to keeping eggs when they have been cracked. In our country, the United States, there were some of these people who paid a heavy fine for selling these eggs in bulk. It became quite a question how to tell whether an egg was newly-laid, and one of our clever inventors patented a machine to attach to the hen, and when she laid an egg the date, etc., would be stamped on it. What I would like to ask about is this—natural ice seems to last longer than artificial ice, in our little home refrigerators. Is there any explanation for this?

Mr. A. R. Taylor,—

A whole lot depends on how the ice is made. Ice that is made in cans is often apt to be feathered and in that case it is not so good for refrigeration. Natural ice is sawn into blocks consequently it is more solid.

Mr. P. F. McCarthy,—

I would like to ask Mr. Taylor to explain the difference between the compression and the absorption systems.

Mr. A. R. Taylor,—

In absorption machines we use aqua-ammonia. We employ heat to drive off the ammonia gas; this causes the gas to create a pressure of, say, 150 lbs. per square inch. The cooling water causes this gas to liquefy and is ready for refrigerating purposes.

The compressor takes the gas and compresses it to say 150 lbs. per square inch and the cooling water liquefies the gas and is ready for refrigeration purposes. Anhydrous ammonia is used with the compression machines.

Mr. John Porter,—

I notice Mr. Taylor states that the freezing point of beef is 30 degrees. I have always understood that it was 38. I would like to hear Mr. Taylor give his authority for this statement.

Mr. A. R. Taylor,—

My authority is the Howard Lectures which were delivered in the Old Country in 1908 or thereabouts.

In my paper I made no mention of the cold-storing of butter. The freezing point of butter is somewhere between 90 and 92 degrees. This is when the butter is between oil and a solid. Below 90 it becomes firmer and firmer. Zero is the best temperature for butter. It is very liable to get air struck. The colder you keep it the less liable it is to get air struck. The same applies to beef having a freezing point of 30°; by holding it low you are more certain of keeping it.

Mr. G. D. Bly,—

I have listened with a great deal of interest to the paper, and the discussion concerning, eggs, butter, etc. I think that perhaps if we got down to the ice-making machines and away from the eggs and butter, it would be better. I would like to ask the speaker why in the first place they started out with the absorption machine then to the compression machine and back to the absorption machine again. It seems to me it is a good deal like the electric generator; they started out with the alternating current, changed to the direct, and now we are using the alternating again.

Mr. A. R. Taylor,—

You will understand from the diagram that I have here (Cut No. 1.) that this only shows part of the first ice-making machine. The other part of it is a simple expansion coil placed in some uncongealable liquid. Therefore part of the machine was on the absorption plan and the other part is a direct expansion machine.

Mr. G. D. Bly,—

I believe that in one of the big cold storage plants in Detroit they are using the exhaust steam from the electric generator in connection with their absorption machine and they are getting excellent economical results. I think from talking to different people that the absorption machines are coming into use again.

Mr. A. R. Taylor,—

I would judge that good results would be obtained with an electric generator on an absorption machine.

Mr. T. B. Cole,—

Are there any plants that you know of using the carbon dioxide you spoke of.

Mr. A. R. Taylor,—

I do not know of any refrigerating plants of this kind on land, but I understand they are used on war ships and ocean liners. The war ships use it in hot climates in their rooms where they carry high explosives. The Board of Trade in the Old Country have a law regarding ammonia machines; they must be away from the engine rooms as a burst ammonia pipe would be likely to suffocate the men that are working in the engine room and stoke hole. Carbon dioxide machines are therefore more in favor as with a burst in the pipe men could get out without much difficulty.

Mr. G. D. Bly,—

I think that this matter has been discussed thoroughly.

Therefore I take pleasure in moving that a hearty vote of thanks be extended to Mr. Taylor.

Seconded by Mr. P. F. McCarthy. Carried.

Mr. A. R. Taylor,—

I am only too pleased that you have listened so long to me.

Chairman,—

I hope, gentlemen, that there will be a good turn-out at the next meeting. Mr. L. R. Arnett, Manager, the Siche Gas Company, will give us a paper.

The meeting adjourned at 10.20 p.m.