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ICE HOUSES AND THE USE OF ICE ON THE DAIRY FARM.

By JOHN T. BOWEN, *Technologist*, and GUY M. LAMBERT, *Dairyman*, *Dairy Division*.

INTRODUCTION.

The principles involved in the proper care of milk and cream are very simple and easily understood. Notwithstanding this fact, much of the product delivered to creameries is improperly cared for and therefore is unfit to be made into butter. One of the most common causes of poor quality of butter is the lack of immediate, thorough cooling of the cream after separation. The Dairy Division has made a careful investigation of conditions existing on a large number of dairy farms where first-class cream is produced, and the data obtained show that, if properly cooled, cream of the best grade can be produced with but little extra labor or expense.

Dairymen in certain parts of New England are delivering practically all their product to the creameries while sweet, although the cream is often held on the farm from one to four days in summer and from one to seven days in winter. After it reaches the creamery it is pasteurized and shipped a distance of from 50 to 300 miles, where it is sold in the form of sweet cream. These results are accomplished by the liberal use of ice, nearly every farmer having stored large quantities in the winter for use in cooling milk and cream the following summer. These dairymen realize the importance of the use of ice and provide themselves with a suitable supply. They have followed this practice for several years, and most of them have provided a convenient source of supply, suitable houses for storing, and ice-water tanks for the immediate cooling of the milk or cream.

The expense connected with the liberal use of ice in this respect is so small and the results so satisfactory that the following data have been compiled for the consideration and benefit of those interested

NOTE.—The use of ice on the dairy farm for the keeping of milk and cream in the best marketable condition is discussed in this bulletin. Plans and specifications for ice houses are given. The bulletin is applicable to dairy sections where natural ice is obtainable.

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in dairying who have not had the opportunity to observe the advantages and profits to be derived from the use of ice on the farm. The variety of conditions shown and described in this paper will undoubtedly make it possible for the average dairyman in those States where natural ice is produced to select some plan or style that will meet his requirements at a reasonable cost.

COOLING MILK AND CREAM ON THE FARM.

Some creameries accept any kind of cream without regard to its condition when delivered, and they usually pay the same price for all grades of cream. In some dairy sections noted for the high quality of butter produced, the operators of creameries have found that in order to get the highest market price for their butter it is necessary to demand a good, clean, raw product, and they are now grading all cream and paying on a quality basis. As a result the producers are studying the situation more closely, as they realize that they must provide better facilities in caring for their product. Many creamery patrons who deliver sweet cream object to having it mixed with cream of inferior grades, so they find it to their advantage to deliver the product in individual cans.

During the summer months it is seldom possible to find ordinary well water which will cool milk and cream even to as low a temperature as 50° F. It is apparent, then, that some form of special cooling should be provided for this purpose; and as the natural cooling mediums are air and water, their capacities for absorbing heat will be compared.

The temperature of the air is usually too high for cooling milk and cream; consequently it becomes necessary to lower its temperature by bringing it into contact with some body colder than itself. Ice is generally used for this purpose on the farm. There are, however, the disadvantages that the circulation of the air is very slow and that its capacity for absorbing heat is very small. The specific heat of air is only 0.0177 per cubic foot; hence 53.6 cubic feet rising 1° in temperature are required to absorb sufficient heat to lower 1 pound of milk 1°.

The air, of course, must be brought in contact with the surface of the cans containing the milk, and unless provision is made for forcing a current over the cans the cooling will depend chiefly on the natural circulation, which is brought about by the difference in temperature between the comparatively warm air near the cans and the surrounding cold air. As the air in direct contact with the cans is warmed it rises, while the cold air in contact with the ice falls; hence the velocity of circulation depends upon the difference in weight of the respective columns of air, and as this difference in weight is very little, the circulation is slow.

When a can of milk is set into a tank of water to cool, the circulation is on the same principle as that of air, but the natural circulation of water takes place at an even slower rate than that of air. Water being one of the hardest of all substances to heat, its specific heat is taken as unity. Therefore, the specific heat of other substance is usually less than 1. As the specific heat of water is taken at 1, the raising of the temperature of 0.0152 cubic foot, or 0.95 of a pound, of water 1° will lower the temperature of 1 pound of milk 1°. In other words, 1 cubic foot of water rising 1° will absorb as much heat as 3,520 cubic feet of air for the same rise in temperature.

The time required to cool milk by placing the cans in moving water is less than when the water remains still, and the difference between the time required in cooling when the cans are placed in moving

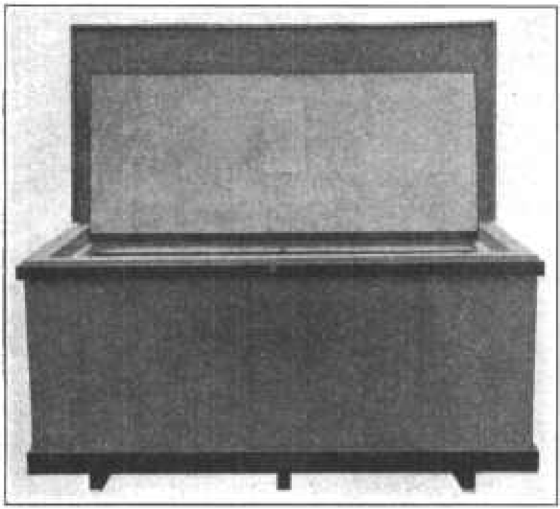


FIG. 1.—A good type of zinc-lined wooden ice-water tank.

water and in still air and moving air is even greater. Taking 1 as the time required to cool milk in moving water through a given range, the time required for the same operation when the cooling is brought about by placing the containers in still water, in still air, and in moving air is 1:1.2, 1:1.5, and 1:3, respectively. By moving air is meant an air blast from a fan, and the time of cooling will vary with the velocity of the air. The initial temperatures of the air and water are assumed to be the same. In either case if the milk is agitated the cooling goes on much faster.[1]

Unless good insulation is used and precautions are taken, it is not probable that the air in an ice-cooled refrigerator will remain much below 50° F. On the other hand, it appears that the temperature

[1] For further information on the cooling of milk by placing the can in moving water see Bulletin 98 of the United States Department of Agriculture.

of water in which the ice is constantly floated will usually remain as low as 40° F., and in many cases lower.

For the purpose of securing information from actual conditions, ice-water tanks of many different kinds and shapes, some with and some without insulation and tight-fitting covers, were examined on more than 60 farms. The average temperature of milk and cream which was held in these tanks was about 40° F., and in each instance the cream was sweet. The cost of these ice-water tanks varied from $5 to $20, depending on the size and whether the tank was made or was purchased from some supply house. There are very few farmers

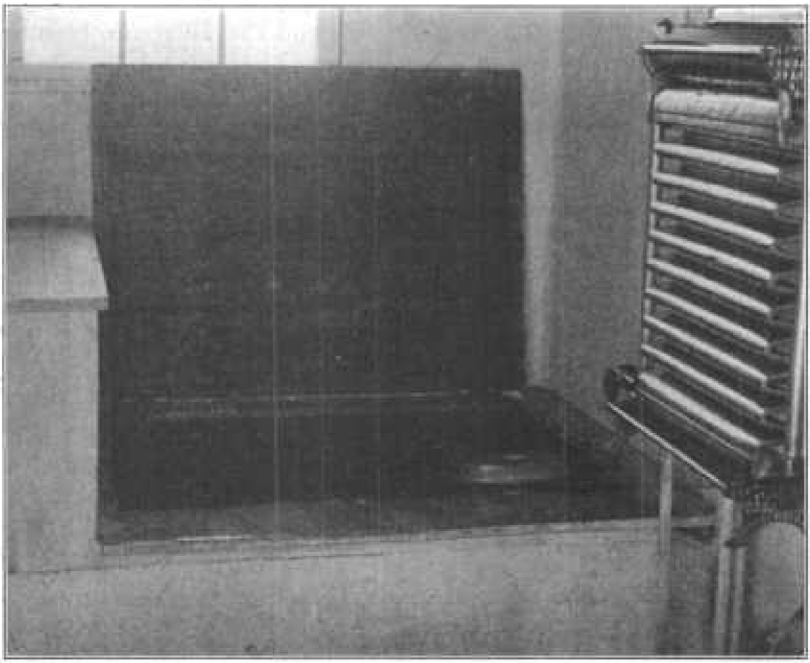


FIG. 2.—An inexpensive concrete ice-water tank.

who can not afford to provide themselves with some form of ice-water tank which will conform to their own ideas and the local conditions.

A great many different styles of tanks are in use. Figure 1 shows a type of ice-water tank which has proved satisfactory. This style has double wooden walls and is lined with galvanized iron. It is also provided with two air spaces and two covers. With a little time, labor, and expense such a tank can be made on almost any farm. A can of cream placed in ice water in such a tank will remain sweet for several days. Many less expensive tanks were found in use that gave desired results.

Figure 2 is an illustration of a concrete tank which every farmer can construct at a small expense and which will answer most purposes.

Figure 3 is a photograph of a load of 2,160 pounds of sweet cream which had been gathered from 39 patrons over a route 24 miles long. The picture was taken on a Saturday morning when the outdoor temperature was 92° F. Some of the cream had been held from the previous Wednesday evening. At the time of delivery to the creamery the temperature of the cream varied from 55° to 60° F. Had the cans been jacketed this temperature would have been even lower.[1] If this load of cream had been old and sour and delivered subject

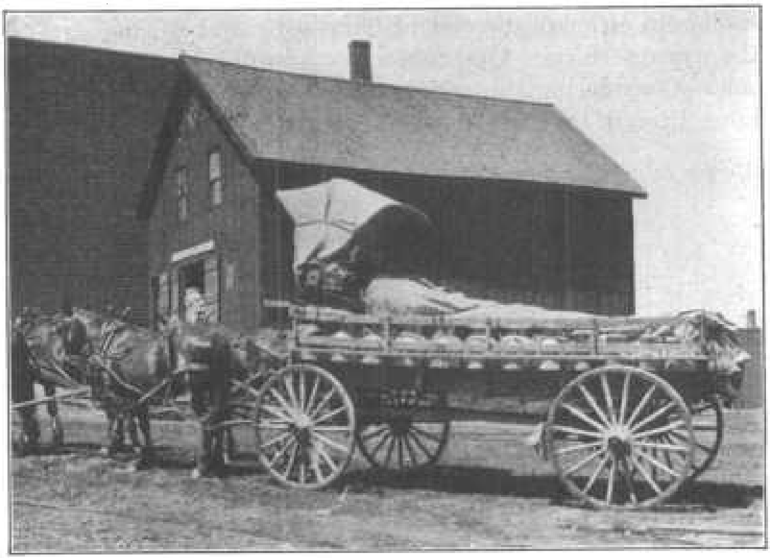


FIG. 3.—A load of cream that had been properly cooled by the use of ice water and remained sweet after a long haul in hot weather.

to a 4-cent premium per pound for butter fat in sweet cream, the loss on the load on a basis of 25 per cent fat would have amounted to $21.60. On the other hand, the ice used to cool the cream on the farm added very little to the cost of production.

THE COST OF ICE.

The cost of packed ice will vary according to the local conditions under which it is harvested, these conditions of necessity differing in almost every case. Our investigations show that ice has been cut at a price as low as 1 cent for a cake of 220 pounds, making the ice

[1] See Bulletin 98, United States Department of Agriculture, for data on jacketed and unjacketed cans.

cost, exclusive of hauling and packing, 9 cents a ton. The usual price, however, was found to average about 2 cents a cake, or 18 cents a ton. To find the total cost of storing ice, the charge for hauling and packing must be added; this brought the average to about $1 a ton. In some instances the original cost of the ice and the packing amounted to $2 a ton, but in these cases the storage houses were at long distances from the pond.

We wish to emphasize the fact that these results were not obtained under exceptional conditions, and it is safe to assume that the cost as stated above would be about the same in a large number of localities throughout the States in which natural ice can be produced. By taking the figures in the following table as a basis for calculation, it is possible to estimate the cost of harvesting and storing natural ice on the average farm. One cubic foot of solid ice weighs about 57 pounds. Considering this weight as the standard, and allowing for packing, 1 ton of ice will occupy approximately 40 cubic feet.

A table for estimating the number of cakes of various thicknesses required per ton of ice (size of cake, 22 by 22 inches).

Thickness of ice.	Number of cakes required per ton.	Cutting space required per ton.
Inches.		*Square feet.*
4	31.3	105.4
6	20.9	70.2
8	15.6	52.6
10	12.5	42.1
12	10.4	35.1
14	8.9	30.1
16	7.8	26.3
18	6.9	23.4
20	6.3	21.1
22	5.7	19.1

HARVESTING ICE.

Farmers who have a comparatively small quantity of ice to harvest will find that they need for equipment only two saws, two ice tongs, two ice hooks, and a pointed bar. Many farmers have found it very profitable to cooperate with three or four neighbors in filling their ice houses. In such instances each individual may use his own tools, or the complete outfit may belong to a cooperative association.

In marking the ice, a long plank may be used as a straightedge, or it may be used to guide the handsaw. In cases where a horse plow is employed, the attached gauge will serve to keep the additional lines straight. The advisability of cutting square or oblong cakes must be decided by the harvester. In compiling the foregoing table square cakes 22 by 22 inches were used merely because our investigations showed that the majority of farmers were storing cakes of that size.

After the ice cakes are broken apart, two men with ice tongs can with little difficulty pull a cake of ice from the water and load it on a wagon or sled. If desired, a slide and a table platform may be used and a horse employed for drawing the cakes from the water on to the platform, from which they may be easily loaded.

QUANTITY OF ICE REQUIRED.

Before building an ice house of any kind, the quantity of ice to be stored should be determined. The quantity needed for cooling purposes will necessarily vary according to the local conditions and can not in all cases be definitely stated, though it may be calculated approximately. After studying the conditions on a large number of farms and securing figures regarding the amount of ice used for cooling and keeping milk and cream in a sweet condition for from one to four days, the following facts were established:

(1) Ice-water tanks were in general used for cooling milk and cream.

(2) The quantity of milk or cream cooled in this manner varied in individual cases from 21 pounds to 336 pounds per day.

(3) The temperature of the milk and cream being held in such tanks averaged about 40° F.

(4) In each case a cake of ice was found floating in the water; which showed that there was a constant supply of ice in the tank.

(5) A total of 5,142 pounds of cream required approximately 6,020 pounds of ice per day, or an average of 1.16 pounds of ice per pound of cream to cool and hold until delivered.

These figures were secured from actual conditions and covered a period of six weeks, in which the temperature outdoors varied from 56° to 100° F.

Owing to the different conditions under which ice is handled, the location of the buildings in reference to protection and the quantity of ice packed, it is not surprising to note a large variation in shrinkage. In an examination of more than 100 farmers' ice houses the shrinkage was found to vary from 20 to 50 per cent, with an average of 27 per cent.

If the average cow produces 3,500 pounds of 3.7 per cent milk in a year, which is equal to 431 pounds of 30 per cent cream, it will require, according to the above figures, 431 times 1.16 pounds, or approximately 500 pounds of ice, to cool the cream produced by one cow and keep it in a good, sweet condition until delivered to the creamery. In addition to this amount, it will usually be advisable to store 500 pounds of additional ice, thus making a total of 1,000 pounds per cow. This amount is sufficient to cool the cream needed for household use and allow for reasonable waste. Therefore, on this basis a 20-cow dairy will require 10 tons of ice for cooling the cream.

These figures are for cooling cream; if whole milk is cooled, considerably more ice will be required. Under average conditions it will take from two and a half to three times as much ice to cool the whole milk from 20 cows as it will to cool the cream from the same herd. Generally speaking, in the North it will take 1½ tons of ice for cooling the milk for each cow, and 2 tons per cow in the South. From 40 to 50 cubic feet are required for a ton of packed ice, consequently for 10 tons about 500 cubic feet of space will be necessary. As the amount of heat leakage will in a great measure be proportional to the exposed outside surface area of the house, it will be logical, from a business standpoint, to build a house that will approach as nearly as possible a cube in shape. In addition to the space 10 by 10 by 5 feet required for the 10 tons of ice, at least 12 inches should be allowed on each side and bottom for sawdust or other packing material, and at least 3 or 4 feet on top to allow space for packing and ventilation; consequently a 10-ton house should be built 12 by 12 by 8 feet.

THE FARMER'S ICE HOUSE.

It is our purpose to discuss only the different types of ice houses found in actual use, so that the dairyman may have an opportunity to study the advantages of each type and select the one best suited to his needs. Only a small number of the ice houses examined were built of new lumber. In many instances ice was stored in the cellar under the house or barn, or in the corner of some building, such as a woodshed, corncrib, or barn, or under the driveway leading to the barn, and occasionally it was simply stacked outdoors with no roof for protection. Where the ice was stored in cellars, open sheds, or in stacks, the loss from melting was comparatively large, depending on the ventilation, drainage, and care in packing. Where the cost of harvesting ice is a small item, dairymen often say that it is less expensive to store ice in such places than to go to the expense of building an up-to-date ice house. Where ice is simply stacked outdoors and covered with some form of insulation, it is necessary to put up from 30 to 50 per cent more than the amount previously allowed, so as to provide for the heavy shrinkage.

The ice should be stored as near the milk house as possible, in order to save labor in removing it to the milk tank. A great many dairymen find it an advantage to have the milk room in one end of the ice house, as in figure 4. In this way the cost of a separate tank house is eliminated. The small amount of time and labor required to transfer the ice to the cooling tank generally acts as an added incentive for the free use of ice. It is highly important that the milk room, whether combined with the ice house or standing alone, be located so that objectionable odors will be avoided.

In comparing the different methods of storing ice, it was found that where the cost of ice was comparatively high it was advisable to spend enough money in building and insulating the ice house to protect the ice from melting as much as possible, but in cases where the cost of the ice was small it appeared that the owners were often justified in building a cheaper storage with a relatively high loss of ice from meltage. The dairyman therefore should consider both the cost of construction and the cost of the ice in selecting the type most suitable for his requirements.

Some farmers store their ice in roughly constructed bins. One of this sort was seen, made by placing large posts of irregular sizes 3 feet in the ground and about 4 feet apart, and upon these were

FIG. 4.—Farmer's ice house with milk room.

nailed a miscellaneous lot of boards; no roof whatever was provided. The shrinkage was reported to be from 30 to 50 per cent. Ice might be stored in this manner for some purposes, but this method is not recommended for a dairy farm. Furthermore a bin of this sort is very unsightly and is an indication of slack methods in farming. Where ice is cheap and building material high, it might be permissible as a temporary arrangement; but it is not so economical a method as may appear at first sight, for the cost of the ice lost in the shrinkage would generally amount to more than the interest on the cost of constructing a serviceable ice house.

An instance was observed in which a corner of a woodshed, about 12 feet square and 10 feet high, had been converted into an ice shed. This corner of the woodshed had been roughly boarded up and about 14 inches of sawdust placed around the ice on all sides, top, and bottom. The cost of the building was very little and the shrinkage was reported at about 20 per cent. The owner stated that softwood sawdust is a much better insulator than hardwood sawdust.

The ice house in figure 4 measures 15 by 20 feet on the outside and is 8 feet high. At the front or south end a room 15 by 6 feet is partitioned off and used for a milk room. The remaining space, 15 by 14 feet by 8 feet high, after allowing for 6 inches of wall, 12 inches of sawdust on the sides, 12 inches on the bottom, and 18 inches on the top, will provide space for about 17 tons of ice. This house is built on high, sloping ground where the soil is porous; consequently the drainage is satisfactory. The foundation is made of concrete (mixture, 1 to 6), 1½ feet wide at the bottom and sloping gradually until the top measures 8 inches. The sills which rest on the foundation are 6 by 6 inches, upon which are erected 2 by 6 inch studding with 24-inch centers. On the top of the studding rests a 2 by 6 inch plate, and the studs are sheathed inside and outside with rough boarding. The outside is then covered with weatherboarding. The roof has a two-thirds pitch and is constructed of 2 by 4 inch rafters, 24-inch centers, boarded and covered with shingles. In each gable is located a slat ventilator, 2½ by 1½ feet, which with the high pitch of the roof allows for an abundance of free circulation of air over the ice. The milk room is provided with two glass windows 3½ by 2 feet, one in each end. The milk room is provided only with a movable ice-water tank, 3½ by 4 by 3 feet, in which are placed the cream cans. A rope and pulley which are fastened to the ceiling are used in transferring the ice from the ice house up and over the wall and lowering it into the tank. The material and labor for constructing this combination milk and ice house amounted to $125. The shrinkage on the 100 cakes in storage was estimated at about 15 to 20 per cent. The ice in this house cost 2 cents a cake, exclusive of hauling and storing.

ICE-HOUSE CONSTRUCTION.

The details of ice-house construction depend to a great extent on local conditions, size of house, and the difficulty of obtaining ice. These factors govern the amount of money that is practicable and desirable to put into such a building. Where ice is expensive or difficult to obtain, a better constructed and insulated house is advisable. In some States where natural ice is plentiful and can be cheaply harvested and stored, it appears that the cheapest structure possible has been considered satisfactory, and the question of the ice melting has been given very little thought. In most cases, also, it appeared that better results could have been obtained with the same expenditure of time and money if more attention had been given to the construction and workmanship.

Generally the construction of an ice house is a question of economy. The cost of harvesting and storing, interest on the money invested, repairs, and depreciation on the building should offset the saving in the melting of ice; beyond this it is not good policy to go.

Some typical designs of farm ice houses have been prepared; and while there is a difference of opinion among men of experience as to the exact details in the construction of such buildings, it is believed that if the instructions and designs given herein are followed satisfactory results will be obtained.

The location of the house should be such as to shield it as much as possible from the wind and from the direct rays of the sun.

INSULATION.

The function of an ice house is to prevent the outside heat from passing into the interior and melting the ice; therefore the problem is to minimize the passage of heat by interposing in the walls a material or a construction which will resist its transfer from the outer to the inner side of the building. There is no material known that will entirely prevent the passage of heat; however, there are materials which offer a high resistance and are termed nonconductors or insulators. The best insulators appear to be those that contain the greatest amount of entrapped air confined in the smallest possible spaces. Formerly it was the practice in constructing buildings for the storage of ice or for cold-storage purposes to provide a series of air spaces some of which were as much as 12 inches wide, the supposition being that they were dead-air spaces. As a matter of fact, however, as the air in contact with the cooler surface fell while that in contact with the warmer surface rose, it produced a circulation tending to equalize the temperature of the sides of the air space. Therefore an air space 1 inch wide is practically as good as one 12 inches wide. Air circulation is valuable, however, between the insulated ceiling and the roof of an ice house in order to break up the heat radiation through the roof.

No entrance or exit of air should be allowed to take place in a room where ice is stored, especially at or near the ground line, as the cold currents of air at the bottom will filter through. If the walls and foundations are kept absolutely tight at the bottom, an opening at the top has but little effect, as the warm air entering will remain at the top of the room. When it is necessary to remove ice from the house, the door should be kept open as short a time as possible, and where a covering material is used the ice should be carefully covered. In a properly insulated house a great advantage is that no covering is required. The ice is packed on the floor of the room, depending on the insulated walls and floor for protection from the outside heat. But in the cheaper houses it is better to cover the ice with some material, such as sawdust or mill shavings. A layer of the insulating material should be placed directly on the floor and the ice stacked thereon; there should also be a layer packed between the ice and the walls. Ice should never be placed directly on the ground, soil being a fairly good conductor of heat, especially when wet, as the floors of all ice houses are sure to be. The larger percentage of waste, however, is due to the entrance of heat through the insulation of the walls and floor; consequently they should be carefully constructed.

As sawdust and shavings are shown in some of the typical designs, it is not to be understood that they are the best insulators for this class of buildings. They are used because they are cheap and can be had in any part of the country, and if kept dry are good insulators. It is a very difficult problem, however, to keep them dry, and when they are to be used great care should be exercised in the construction of the walls in order to keep out the moisture.

Planing-mill shavings are better than sawdust for insulating purposes; they are elastic, do not settle readily, and do not absorb moisture so readily as sawdust; and, most important, are free from dirt, bark, or chips. When used as filling for walls or ceiling, they should be well packed into place to prevent settling.

Sawdust has in the past been used to a great extent in rural districts for insulating walls of small cold-storage buildings, due to the fact that it is available in most country districts and usually without cost. It is not a very satisfactory material for insulating purposes, however, as it is always more or less damp. Furthermore the dampness not only destroys its insulating value, but it favors the growth of mold and rot, first in the sawdust itself and then in the walls of the building. The rotting and the consequent heating cause the sawdust to settle and leave open spaces which further weakens the insulation. When sawdust is to be employed it should be thoroughly dried before use.

There are several makes of commercial insulators that are a great deal better than either shavings or sawdust and are cheaper in the end, but their initial cost is somewhat greater. They are nearly uniform in their insulating value, and moisture has but little effect upon them. They are practically fireproof, occupy but little space, and will retain their efficiency indefinitely. To get the best results, however, they should be installed by experienced men.

DRAINAGE.

Provision should be made for thorough drainage. In houses that have the floor below the level of the ground, sufficient drainage usually can be obtained through the soil, especially if the soil is porous. It may be necessary, however, with a clay soil, to excavate a foot or two and fill in with cinders or gravel, and to place a 3-inch porous tile under the floor. This drain should be properly trapped or sealed to prevent warm air from entering the building through the floor. In place of the tile a satisfactory drain may be constructed in houses having a ground floor by digging a ditch under the floor of the house and filling the same with broken stone or gravel, well packed into place. This drain should be led out with sufficient fall to carry away the water.

All floors should be sloped downward toward the center of the room to prevent the ice from falling against the walls of the building and in houses having water-tight floors to carry the water to the drain.

VENTILATION.

There is bound to be more or less melting of ice, no matter what the construction of the building may be, and this will cause moisture to settle on the walls and ceiling of the room. If the building is of wood construction the moisture is absorbed by the wood, and rot and decay follow. Therefore wooden houses should be provided with means of ventilation which can be controlled at will. The ceiling of such houses should be sloped up to the center in order to assist the circulation and carry the warm, moisture-laden air to the ventilator. In those houses in which some form of commercial insulation is used that will take a cement finish on the interior no ventilation is considered necessary. The building should be so constructed that there will be a circulation of air through the outer walls and at the eaves to the ventilator on the roof, as these air currents tend to break up the heat radiation through the walls and roof.

WATERPROOFING.

It is of the utmost importance that brick, concrete, and wooden buildings be waterproofed. Brick and concrete work may be rendered waterproof by painting the outside of the wall with white lead and oil or by coating the walls with a preparation of paraffin or asphalt, or by some of the patented compounds. The preparation containing paraffin or asphalt should be applied hot, and the walls should also be heated previously to application.

There are on the market several water-excluding paints and compounds for preserving wood. Creosote is considered one of the best preservatives, provided the wood is thoroughly impregnated with it, but on account of its odor it should not be used in houses where food products are stored.

GENERAL SPECIFICATIONS FOR VARIOUS TYPES OF ICE HOUSES.

POLE ICE HOUSE—UNINSULATED (PLAN E 5—FIG. 5).

Floors.—To consist of 12 inches of coarse gravel tamped into place as shown in drawing.

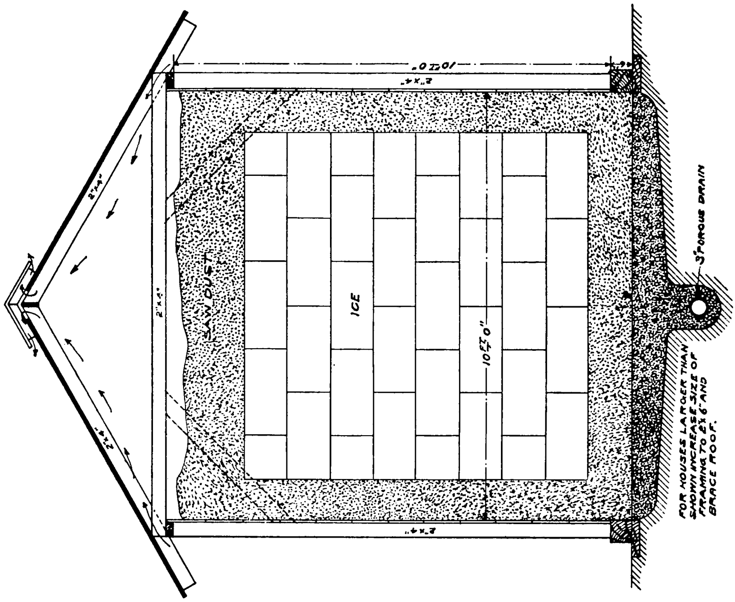


FIG. 6.—Framed ice house, uninsulated.

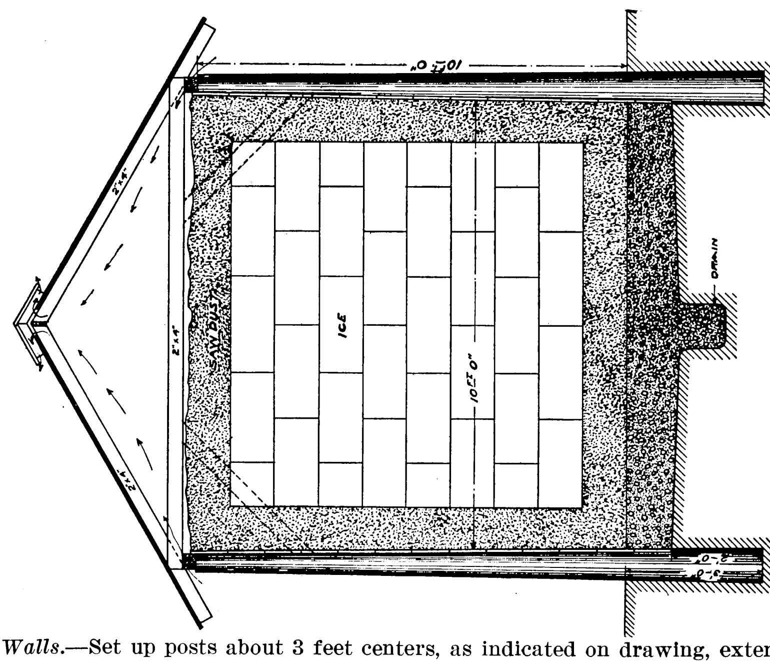


FIG. 5.—Pole ice house, uninsulated.

Walls.—Set up posts about 3 feet centers, as indicated on drawing, extending 3 feet in the ground, and capped by a plate made up of two pieces of 2 by 4. Sheathe the inside with 1-inch boards. The posts and boards below the ground line should be treated with some preserving compound.

Ceiling.—No ceiling is provided.

Roof.—The same type of roof may be employed as with the framed houses.

Doors. —A door may be provided by cutting out the boards between two posts in the end of the house and closing the same by placing short boards across the opening on the inside and packing sawdust against them to hold them in place.

Drainage.—Drainage to be provided for by sloping the floor toward the center of the house so that the water will tend to run to the center. A ditch is dug as indicated and filled with gravel and small stones. This ditch is led outside to a suitable point, where there is a sufficient fall to carry away the water. If advisable, a 3-inch porous drain tile may be provided as shown for the uninsulated frame house. This drain should be properly trapped, however, to prevent the entrance of warm air.

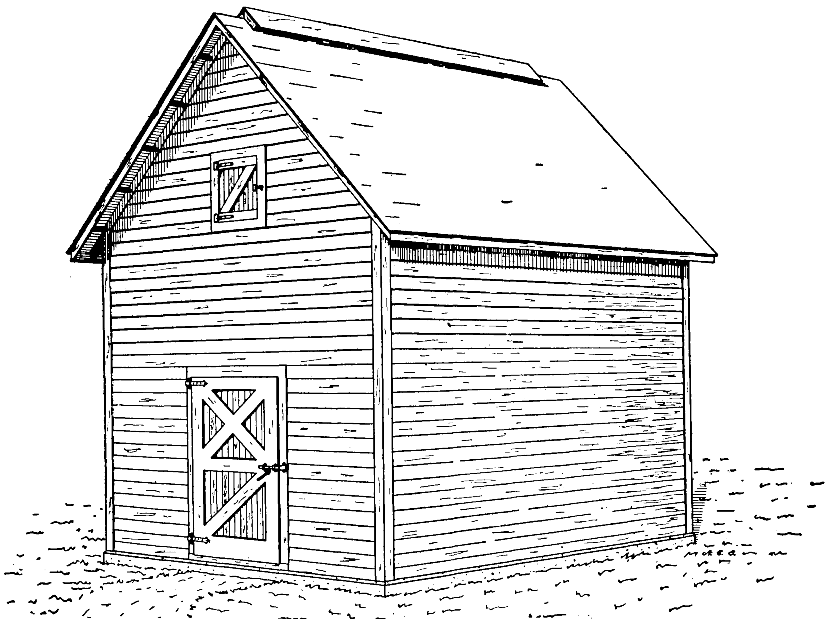


FIG. 7.—Wooden ice house, insulated with sawdust or mill shavings. (Perspective view.)

FRAMED ICE HOUSE—UNINSULATED (PLAN E 6—FIG. 6).

Floor.—To consist of 12 inches of coarse gravel tamped into place as shown on drawing.

Walls.—On a 2 by 10 inch mud sill place 6 by 6 inch sills. Set up 2 by 4 inch studs spaced about 2 feet centers, and on the inside of these nail 1-inch boards. The studding to be capped by a 2 by 4 inch plate as indicated. The mud sills and sills should be treated with creosote.

Ceiling.—No ceiling is provided.

Roof.—The same type of roof may be employed as in the insulated framed house.

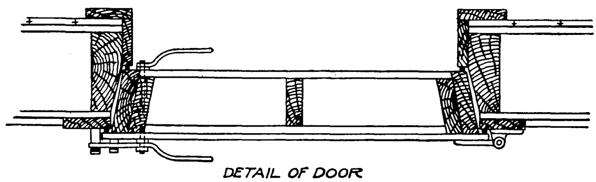
Doors.—A door may be provided as suggested for the pole ice house.

Drainage.—To be provided for by sloping the floor toward the center of the house so that the water will tend to run to the center. A ditch is dug as indicated and a 3-inch porous drain tile laid, being packed around with small stones and gravel. The tile should be led outside and efficiently trapped to prevent the entrance of warm air.

WOODEN ICE HOUSE INSULATED WITH SAWDUST OR MILL SHAVINGS (PLANS E 7 AND E 8—FIGS. 7 AND 8).

The drawings illustrate a house with and without milk room.

Framing.—All framing used should be dry, square-edged, sawed fair and full to the sizes given, and should not contain any of the following defects: Worm



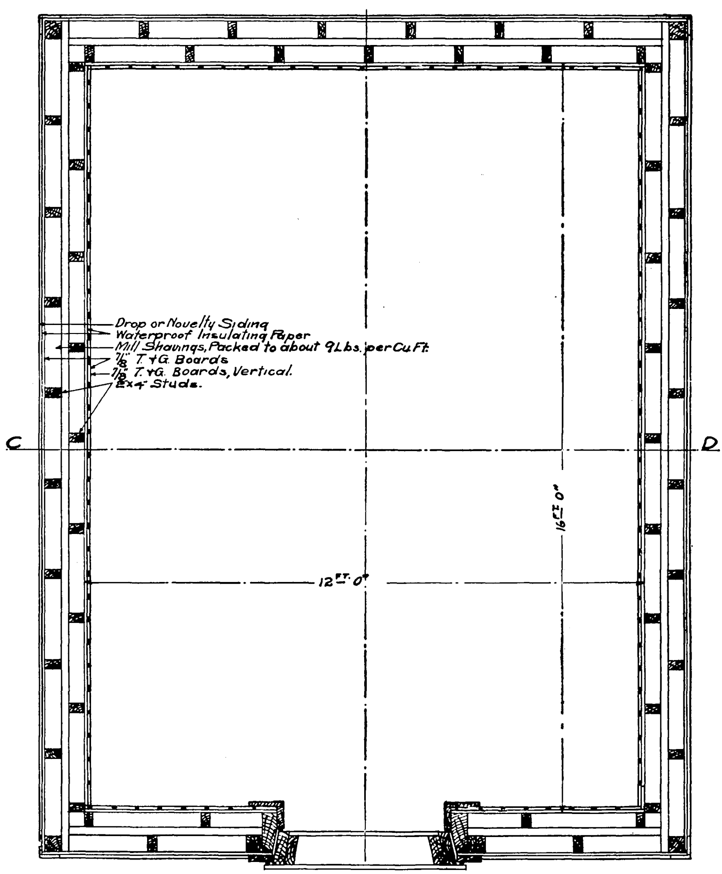


FIG. 7*a*.—Wooden ice house, insulated with sawdust or mill shavings. (Ground plan of fig. 7.)

holes, shakes, heart pith, warped, twisted, or unevenly sawed lumber, rotten, or unsound knots. Sizes to be as shown on drawings.

Boards.—All boards used should be thoroughly dry and sound and free from loose knots, heart centers, shakes, or splits, and should be dressed and tongued and grooved. Unseasoned boards should be carefully avoided.

Papers.—All paper used should be heavy waterproofed insulating paper, not the ordinary building paper. Double thickness of paper should be used in all cases, each layer lapping 6 inches over the preceding one. The layers should extend continuously around all corners, and breaks should be carefully covered.

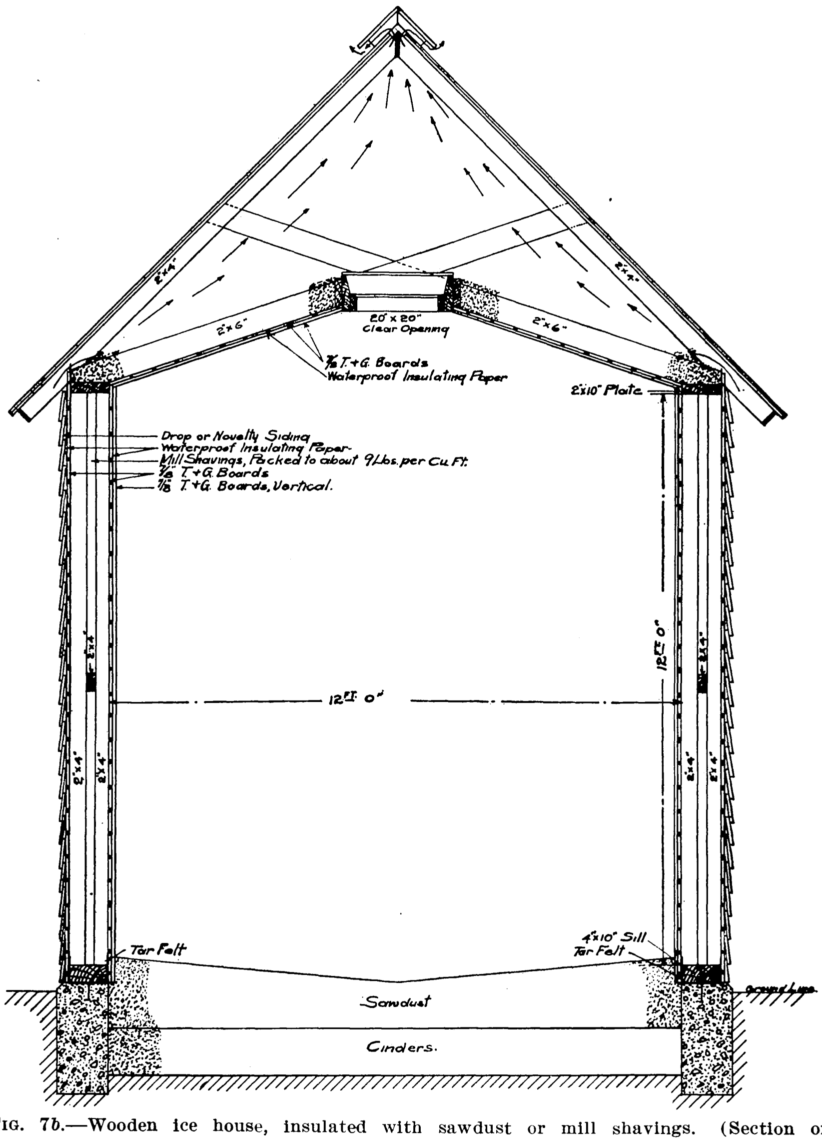


FIG. 7*b*.—Wooden ice house, insulated with sawdust or mill shavings. (Section on *C–D* of fig. 7*a*.)

Insulation.—When shavings or sawdust are used they should be thoroughly dry and free from dirt, chips, and bark, and well packed into place. When commercial insulation is used and installed by the manufacturers it is usually under guaranty that the insulation will not transmit more than a certain amount of heat under given conditions.

Cinders.—Coal cinders should be used where obtainable to cover the ground area of building, in preference to sand or gravel.

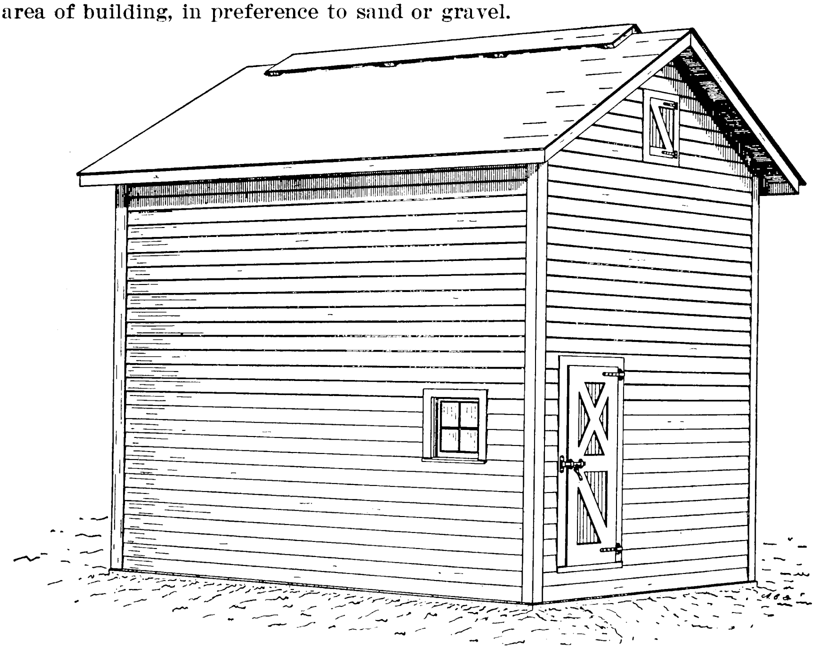


FIG. 8.—Wooden ice house, insulated with sawdust or mill shavings. (Perspective view.)

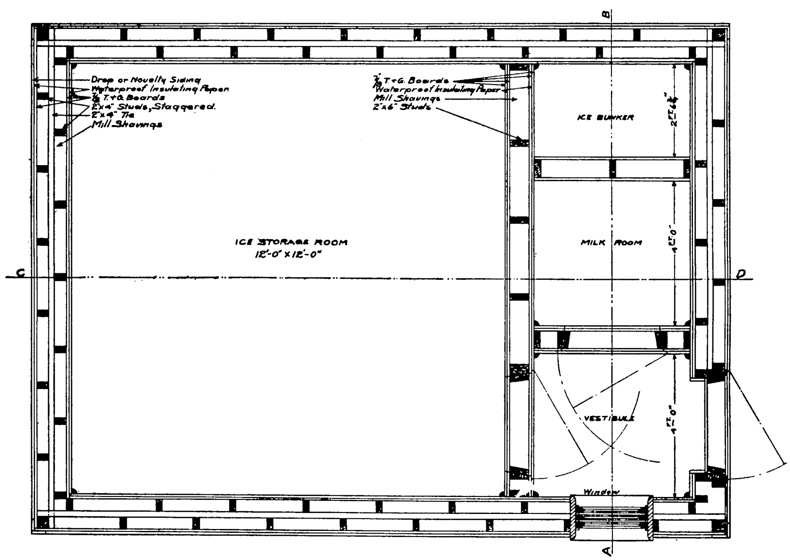


FIG. 8*a*.—Wooden ice house, insulated with sawdust or mill shavings. (Ground plan of fig. 8.)

Excavating and grading.—Excavate for floor and foundations sufficient to get a solid and firm footing. Grade entire floor to level shown and roll and tamp until firm and solid.

Foundations.—Footings should be of stone or concrete of size shown on drawings and of sufficient depth to insure a solid foundation.

Carpenter work.—All work to be executed in a substantial workmanlike manner.

Walls.—Set up double rows of 2 by 4 staggered with one 2 by 4 tie, as shown on drawings, and cover outside with one course of ⅞-inch tongued-and-grooved boards. Place on the outside of this two layers of waterproofed insulating paper and then a good quality of drop or shiplap siding. For inside of room place directly on studs one course of ⅞-inch tongued-and-grooved boards, then two layers of waterproofed insulating paper, and finish with one course

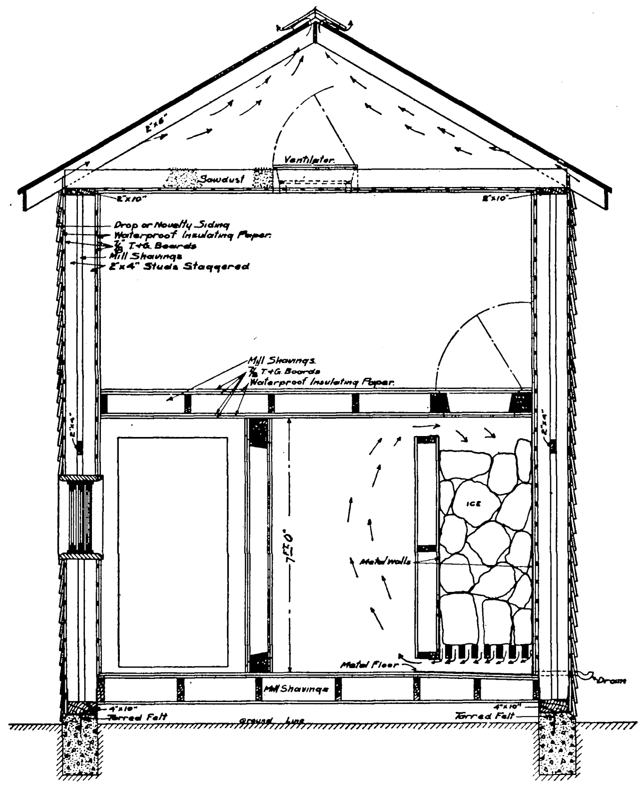


FIG. 8*b*.—Wooden ice house, insulated with sawdust or mill shavings. (Section on *A–B* of fig. 8*a*.)

of ⅞-inch tongued-and-grooved boards. Paper to extend continuously around the corners and lap 6 inches.

Ceiling.—Ceiling to be constructed as shown on drawings, with one course of ⅞-inch matched boards nailed to joists, then two layers of waterproofed insulating paper, following by a course of ⅞-inch tongued-and-grooved boards.

Roof.—Roof to be sheeted with 1-inch rough board and covered with good quality of shingles laid 4½ inches to weather and securely nailed. Or some one of the patented roofings may be used.

Doors.—Doors to be constructed as shown on detail drawings, of a good quality of seasoned lumber. Commercial doors can be bought at a reasonable price and will probably give better satisfaction than those constructed by an inexperienced carpenter.

Drainage.—Provide for thorough drainage by filling in a floor about 12 inches deep with cinders or gravel, and if necessary provide a 3-inch porous tile drain. Drain to be properly trapped to prevent warm air from entering room.

Ventilation.—Provide ventilation as shown on drawings.

FRAMED ICE HOUSE WITH COMMERCIAL INSULATION (PLAN E 9—FIG 9.)

Floors.—Excavate to a proper depth, depending on the character and lay of the soil, and lay a base of 4-inch concrete. Cover this with hot asphalt and lay directly on this 3 inches of good commercial insulation with all joints fitted. Cover this with another layer of hot asphalt followed by a 2-inch layer of concrete. Finally finish with ½-inch Portland cement mortar. Floors to have an incline toward the drain of 1 inch in 4 feet.

Walls.—Set up 2 by 6 inch studs, as shown, and cover these on the outside with drop or novelty siding. On the inside cover studs with one course of ⅞-inch

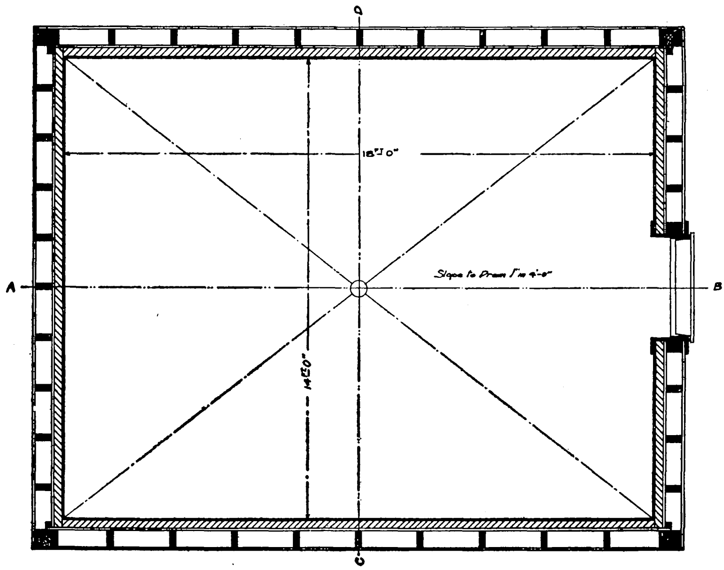


FIG. 9.—Framed ice house with commercial insulation. (Ground plan.)

tongued and grooved boards followed by a layer of water-proofed insulating paper. Afterwards securely nail directly on the wall 3 inches of good commercial insulation, followed by ½-inch Portland cement finish. The space between studs to be provided, as shown, with an opening at the top and bottom for the circulation of air.

Ceiling.—To have one course of ⅞-inch tongued-and-grooved boards nailed directly to the joists, then covered with one course of waterproofed insulating paper followed by 2 inches of good commercial insulation nailed directly to ceiling. Finish with ½-inch Portland cement plaster. For additional protection a layer of dry sawdust, from 6 to 12 inches thick, may be placed on top of the ceiling.

Roof and doors.—The same type of roof and door may be used as on the other wooden houses.

Drainage.—The floor to slope toward the center 1 inch in 4 feet, and a 3-inch glazed-tile drain to lead from the center of the floor to a convenient point outside the building where sufficient fall may be had to carry off the water. The drain to be properly trapped to prevent warm air from entering room.

SMALL CONCRETE ICE HOUSE (PLAN E 10—FIG. 10.)

The building may be constructed of solid concrete or of concrete blocks. The foundation trenches should be dug 10 inches wide and 2½ feet deep and filled with concrete proportioned 1 part cement, 2½ parts sand, and 5 parts broken stone. Above the ground level the walls may be made either of concrete blocks laid up in a 1 to 2 cement-sand mortar or of solid concrete. For the solid walls above the ground level the concrete should be proportioned 1 bag of Portland cement to 3 cubic feet of sand and 5 cubic feet of crushed rock, or 1 part cement to 6 parts bank-run gravel.

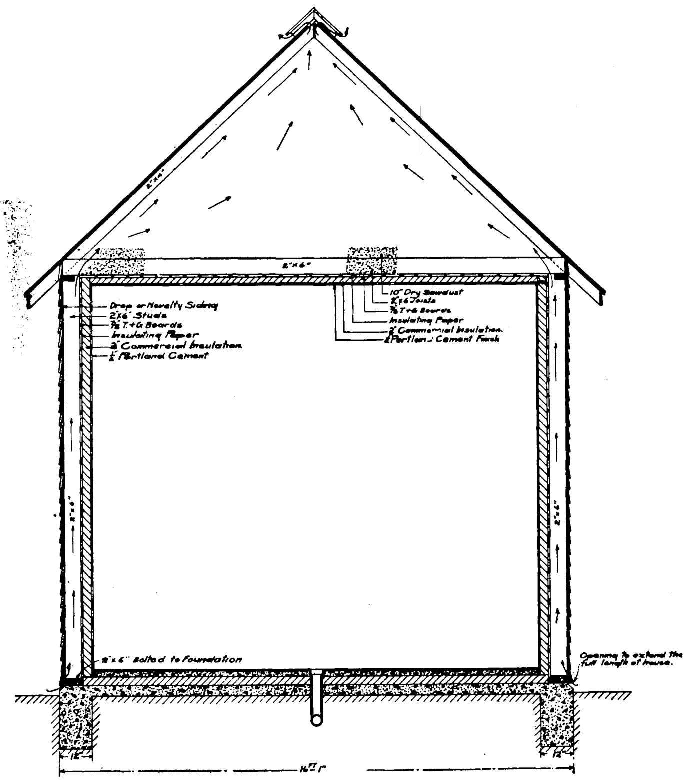


FIG. 9*a*.—Framed ice house with commercial insulation. (Section on *C–D* of fig. 9.))

In building up the concrete walls movable forms are used for holding the wet concrete in place until it hardens. These forms should be 3 feet high and extend entirely around the building. After filling the forms with concrete it should be allowed to stand for a day in order to harden, when the forms may be loosened, moved up, and again filled.

During the construction of the walls ⅜-inch reinforcing rods should be used, spaced 18 inches apart, running in both directions. Stagger the rods by placing half of them 3 inches from the outside edge and the other half 3 inches from the inside edge of wall. Embed two rods, or an old wagon tire cut in two and straightened, in the concrete 2 inches above the door opening.

For holding the plates on top of the walls sink a ½-inch bolt 10 inches long head down 6 inches into the concrete.

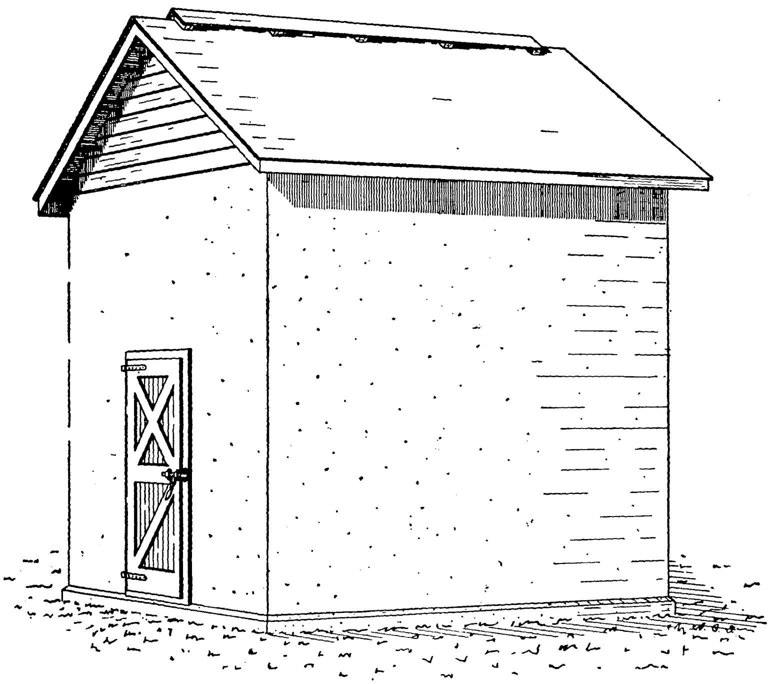


FIG. 10.—Small concrete ice house. (Perspective view.)

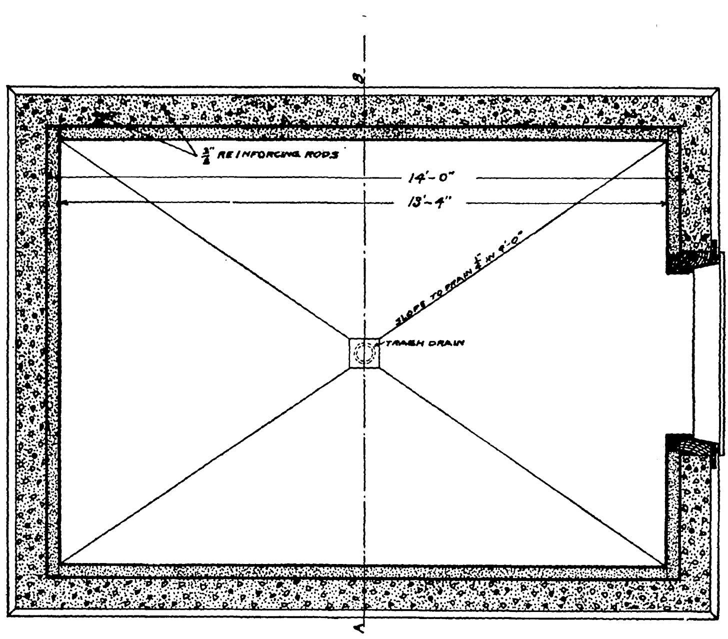


FIG. 10a.—Small concrete ice house. (Ground plan of fig. 10.)

Lay a 4-inch concrete floor on the natural ground and on top of this lay 3 inches of cork-board insulators embedded in hot asphalt followed by 2 inches of concrete sloped 1 inch in 4 feet to trash drain. The floor should be finished with ½-inch Portland cement plaster.

The cork-board insulation should be erected on the walls and ceiling in a ½-inch bed of Portland cement mortar, mixed in the proportion of 1 part of Portland cement to 2 parts of clean, sharp sand. All vertical joints should be broken and all joints made tight. A ½-inch Portland cement finish to be applied to the walls and ceiling as well as to the floor.

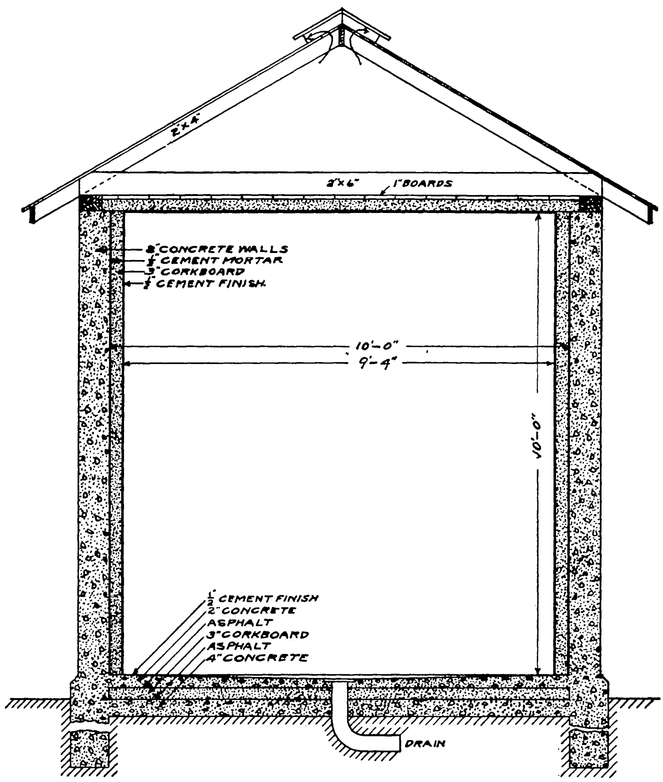


FIG. 10*b*.—Small concrete ice house. (Section on *A–B* of fig. 10*a*.)

In many cases it will be cheaper to crib the walls to their full height instead of using sectional forms, as a part of the form lumber can be used in the roof and ceiling and the remainder can generally be used to advantage on the farm.

GENERAL SUMMARY.

(1) Wherever ice is abundant the cost of harvesting and storing is usually very small.

(2) If a stream of water is available, a small ice pond can generally be constructed on the farm by building a dam.

(3) In building an ice house care should be taken to provide for proper drainage and ventilation. The drain should be efficiently trapped to prevent air from entering the house through the drain.

(4) The efficient insulating of ice houses is of the utmost importance, consequently great care should be exercised in the selection and installation of the insulating material.

(5) About 40 cubic feet of space should ordinarily be allowed for a ton of ice. A cubic foot of ice weights about 57 pounds.

(6) Under general conditions about 1 pound of ice will be required to cool and keep 1 pound of cream in good condition until delivered to the creamery when deliveries are made three times a week.

(7) When storing ice about 50 per cent more should be packed than is actually needed. This amount allows for a heavy shrinkage and for household uses.

(8) The dairy farmer should provide annually one-half to 1 ton of ice per cow for cooling cream only and 1½ to 2 tons per cow if whole milk is cooled, depending upon the locality and other factors.

(9) If a cake of ice is kept floating in the water surrounding the cream cans when the ordinary cooling cans are used, the temperature will remain at about 40° F.

(10) Good ice-water tanks can usually be constructed for from $5 to $20.

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