Thesis.

Practical Problems in Cold Storage.

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Practical Problems in Cold Storage.

In a study of cold storage one finds an endless task, as one subject is taken up and studied it leads to other problems.

Madison Cooper, an eminent authority on cold storage, says that there are four chief uses of cold storage and from his book on Practical Cold Storage these uses are taken.

1. To prevent premature decay of perishable products.
2. To lengthen the period of consumption and thus greatly increase production.
3. To enable the owner to market his products at will.
4. To make possible transportation, in good condition, from point of production to point of consumption, irrespective of distance.

Cold storage makes it possible to produce fruits, meats, eggs and butter and other products far from the point of consumption and enables the producer to carry them from a time of surplus until they are needed. This allows a greater variety of food at all seasons of the year.

Cold storage is then not only a financial gain but a social advantage as well, as it provides fruits and other products out of season.

The most natural form of cold storage and the one most frequently used is a cave or cellar. The use of a cellar for storing household supplies is familiar to everyone.

In the temperate zone at a depth of a few feet the temperature is uniform the year around at about 55° to 60° F.

The next form of refrigeration is by means of ice. Products are placed in

direct contact with the ice or are cooled by air which has been cooled with ice.

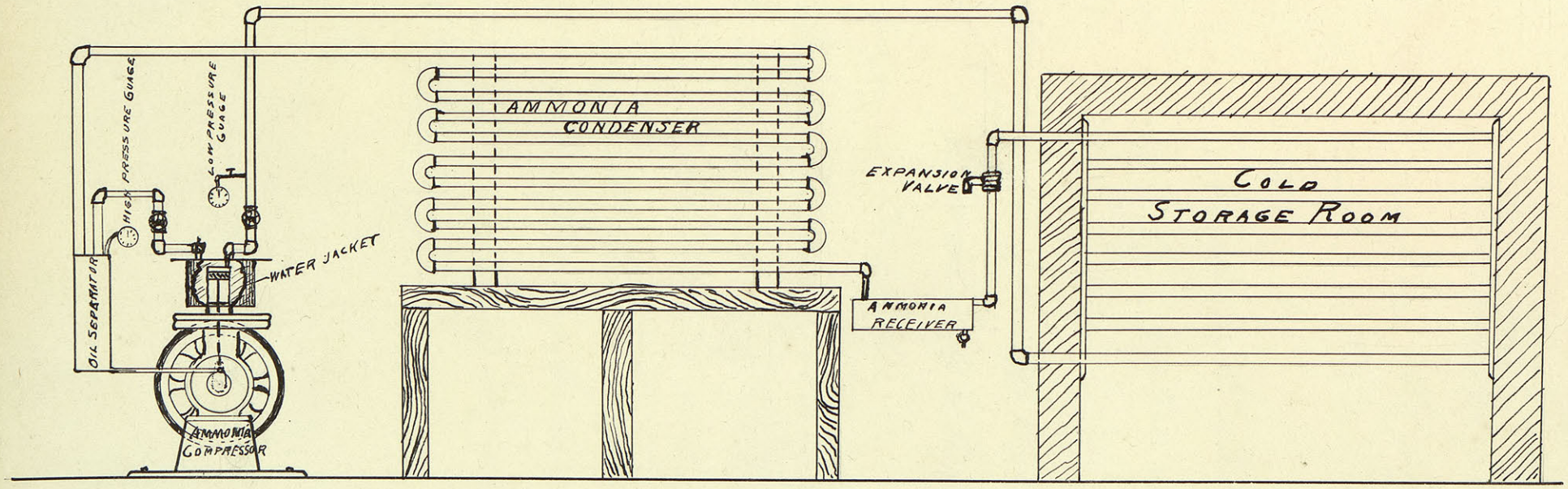
There are several systems of mechanical refrigeration but the one mostly used is the ammonia compression system as illustrated by the drawing on the following page.

The ammonia gas is compressed in the compressor which raises the temperature of the gas. It is forced over into the condenser where it is cooled by water passing around the pipes containing the ammonia. The oil which is forced out of the compressor cylinder with the gas is taken out with the oil trap.

In the condenser the ammonia gas is collapsed and it passes out into the ammonia receiver and thence into the pipes in the ice vat or into the storage room as the case may be.

The pipes leading from the condenser to the storage or cooling room must be heavily insulated to prevent

The Ammonia Compression System



the gas from absorbing heat before reaching the place to be cooled.

When the gas reaches the pipes that are not insulated it immediately absorbs heat and is volatilized.

It is drawn back into the compressor by means of a suction valve and the process is repeated.

The efficiency of a plant will depend on several things, among which are;

Freedom from leaks

Temperature of the cooling water; the lower the temperature of the cooling water the lower will be the back pressure and the nearer equal the two pressures can be brought the less work is necessary using only the latent heat for expansion.

The first method of mechanical refrigeration used was by means of compressed air. The air is compressed which cools it then it is allowed to expand in the chamber to be cooled. Later machines use either ammonia gas or carbon dioxide These gases can be liquified practically while air can only be liquified under special conditions.

In the majority of plants ammonia is used but much care is necessary in the use of of ammonia as it is very volatile and wastes rapidly. The decomposition of ammonia is due largely to overheating owing to the high temperature that it reaches during its compression. The temperature of ammonia during compression should not go over 300° F.

Leaks will often be found around the compressor heads as the gas here is under great pressure and will find every possible egress. The compressor heads are surrounded

with water, as the ammonia and water mix they form a scale that stops the drain pipes.

The presence of ammonia in the water can be detected by the Von Haas ammonia detector which is as follows: Take a tumbler of water from around the compressor head and drop into this about 6 drops of the detector. If the water turns red it contains ammonia.

Leaks may also occur at the condenser but the most important leak is at the stuffing box, this is due to poor packing. This leak can be detected by litmus paper.

Leaks may be caused by pumping a vacuum on the system, in this case air will enter the pipes and must be expelled as it becomes dangerous.

Brine leaks into the pipes it will absorb ammonia. Too high pressure will decompose ammonia, the temperature can be held down by using more cooling water.

If a system could be perfected so that there were no leaks, 600 to 750 lbs. of ammonia would run a 25 ton machine for 10 months but since there are many leaks even in the best plants two or three cylinders will be required in this time.

The first thing to be considered in a storage room is its shape; the more nearly it approaches a cube the better it is for then the ratio of radiating surface to cubical content is smallest.

Where the room is used for storing for long periods the ceiling can be 10 to 12 feet high but if the goods stored are to be changed often a 7 foot ceiling is better for then storing is easier.

The most important feature of a cold storage room is its insulation. No matter how good the machinery within if the insulation is poor the house will not do good work.

Perfect insulation is impossible

if it were possible a room would only need to be brought to the desired temperature once as it could be held at that temperature.

To do good work it is necessary to keep the cold storage room at a constant temperature and this is not possible with poor insulation.

Cooper gives the following requirements for a good insulating material

1. It should be odorless.
2. It should have the minimum capacity for moisture, and in case it should become damp, it should not rot or ferment.
3. It should be vermin proof and give no inducement for rats or mice to nest within it.
4. It should not be liable to disintegrate or to produce spontaneous combustion
5. It should be of light weight.
6. It should be reasonably cheap and economical of labor so as not to be prohibitive

of general use.
8. It should lend itself to practical application in general work.

The following are the insulating materials most commonly used:

1. Straw and chaff, these are used mostly on farms, they are cheap but do not last long.

Sawdust is an excellent insulating material when it is dry but it absorbs moisture readily and then deteriorates rapidly as it will rot and heat when it becomes wet.

Shavings are better than sawdust as they will not rot or settle down.

Mineral wool is one of the best insulating materials as it is about 90% air space.

Cork is a good filler, it is clean, odorless durable and does not rot or absorb moisture readily. Cork contains numerous air spaces and should be packed firmly when used in walls. Granulated cork is mixed with pitch and used

in sheets. This is the most common way of using cork.

Hair felt, often called Natures Insulation, is one of the most indestructible and best insulator made. This felt is made from cow hair as it comes from the tanner, after all foreign material has been removed.

The following table of poor heat conductors is taken from Cooper.

Limestone	14.8	B.T.U.	Cork	1.15	B.T.U.
Glass	6.	"	Coke	1.3	B.T.U.
Sand	2.2	"	Charcoal	.63	"
Oak	1.7	"	Straw	.56	"
Fir	.75 to 1.4	"	Woodashes	.5	"
Walnut	.83 to 1.4	"	Canvass	.41	"
Indiarubber	1.36	"	Cotton	.32	"

One thing necessary in a cold storage room is good ventilation. The nature of the goods stored and the size of the room are factors which should determine the amount of ventilation.

Rooms containing frozen meat of

any kind need more ventilation than any other rooms.

There are some objections to ventilation 1st Cost of cooling the fresh air that would be admitted. If the air is changed once in two weeks the cost in cooling this air in one year would be quite an item.

2nd The delay caused by "laying off" rooms to change and recool the air, such rooms being out of use.

3rd. That the air within a cold storage room is purer than air from without.

If the stored products give off no odors no change of air may be necessary but the presence of odors is common.

Fish, for instance, should be stored by themselves. If they are stored for only a short time they should be cleaned and sprinkled with fine salt and then layered with ice and held below freezing to keep the ice from melting as the water will soften the flesh and aid decomposition.

For long storage fish should be frozen rapidly to a low temperature as soon as possible after taking from the water, either with or without cleaning. As soon as they are frozen hard the fish are taken out and dipped into clean cold water until they are covered with ice. They can then be boxed and stored.

Lemons will impart an odor to eggs and these two should not be stored near each other.

If the walls of a cold storage room are kept dry there is no danger of odors staying in the rooms but if the walls are wet it is impossible to be rid of odors.

Lime and calcium chloride can be used as absorbents and will assist in purifying the air of a room. Lime can be sprinkled on the floor but calcium chloride absorbs enough water to ~~dissolve~~ it so it should be placed in a pan so arranged that it will drain.

Too liberal ause of calcium chloride may bring bad results by drying the air too much. Lime prevents the growth of fungus diseases.

There is much contention at present in regard to the storage of undrawn fowls. Some cities and states have adovcated laws prohibiting the storage of undrawn fowls.

Practical evidence however shows that undrawn birds keep better than drawn birds and those who advocate the passage of such laws do so from ignorance of the conditions.

When the bird is undrawn it is hermetically sealed but if it is drawn the interior decays.

Birds have been kept four years, undrawn, in good shape.

Cold storage of chickens is necessary as they are sold by the farmers in the fall and the supply exceeds the demand but in the spring and summer the reverse is true.

The following experiment by J. T. Bird, Chemist in the U. S. Department of Agriculture, shows clearly the advantage of undrawn poultry for storage. Two turkeys were hung in a room at about the temperature of the outer air; after seven days ~~the~~ an odor came from the drawn bird and after nine days the decay was marked; the undrawn bird was still sound.

The next day the flesh was removed from the breasts of both birds and digested in water and the juice tested with litmus paper. The drawn bird showed decay and emitted a foul odor while the undrawn bird did not.

A health officers comment on this experiment was; "Were the dealers compelled to sell only drawn poultry there would be greater danger to the community from the sale of unwholesome meat than now exists through the sale of undrawn poultry"

The following is a summary from a butter storage test by Prof. McKay and C. E. Gray.

1 Butter containing a low percentage of salt kept better than with a high percentage.

2. Butter in full cans and tubs at -10°F and +10°F scored about the same. at +32°F there was a slight difference in favor of the cans.

3. Butter in full cans kept better than only partly filled, deterioration doubtless was due to air.

4. Butter held at +10F kept best, both when in storage and after removal from storage.

5. Butter made from cream received at the creamery sweet and in good condition kept well while stored at -10F and +10F; also after removal it gave satisfactory results.

6. Butter made from cream received at sour and in unfair condition kept well in storage at +10F and +10F but deteriorated rapidly after removal giving

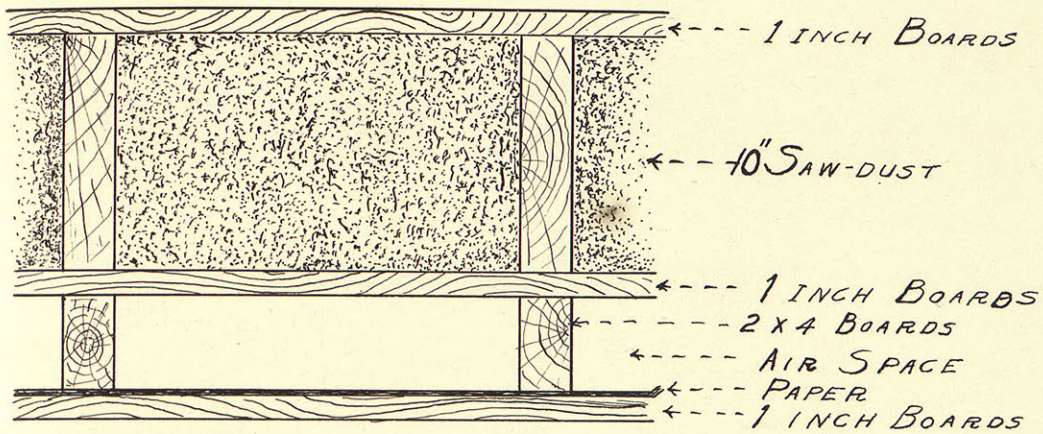
unsatisfactory results.

Experiment has proven that cheese should go directly from the hoop to cold storage. The quality of cheese improves faster in cold storage than outside. Most authorities agree that it is advantageous to parafine cheese, this can be done directly when the cheese leaves the hoop. In all cases parafine prevents loss of weight and when the cheese is stored at a low temperature the loss in weight, of parafined cheese, is reduced to a minimum.

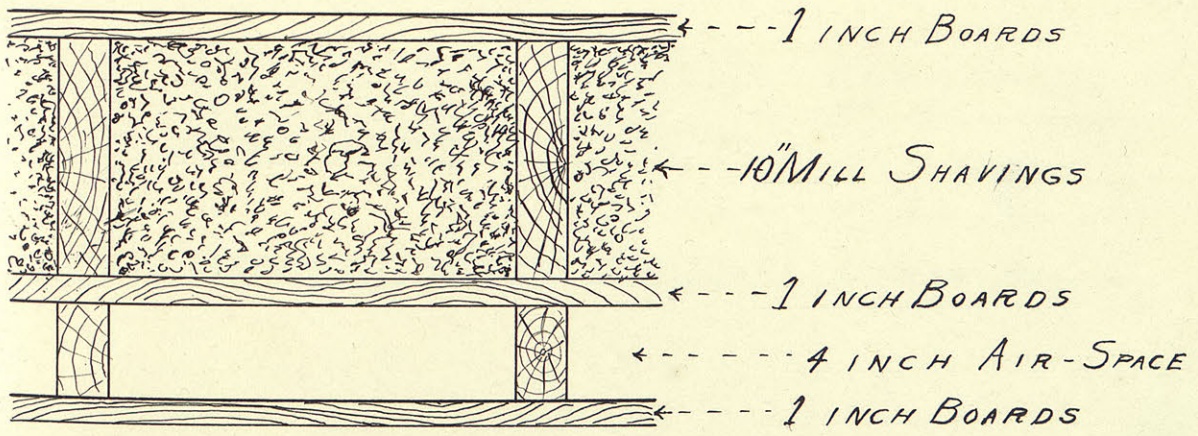
Cheese of indifferent quality when it enters storage may come out at the end of six months of very fine quality. This however does not hold with butter.

Cold storage is practical for the farmer and fruit grower. Any farmer can harvest his own ice and with this ice a storage room can be cooled; the size of the room will vary with the need.

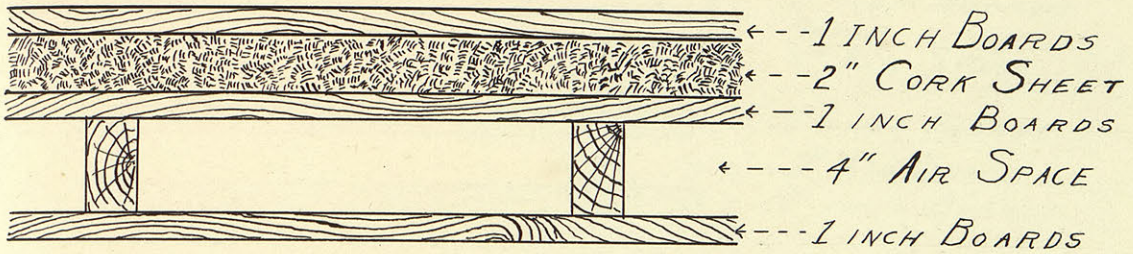
-1-


1 INCH BOARDS
10" SAW-DUST
1 INCH BOARDS
2 X 4 BOARDS
AIR SPACE
PAPER
1 INCH BOARDS

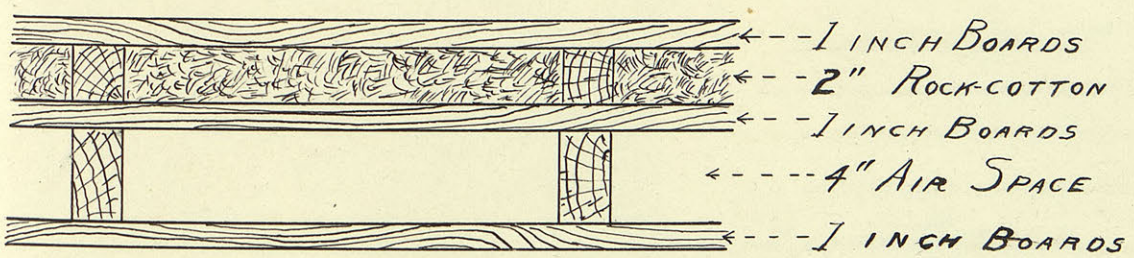
-2-


1 INCH BOARDS
10" MILL SHAVINGS
1 INCH BOARDS
4 INCH AIR-SPACE
1 INCH BOARDS

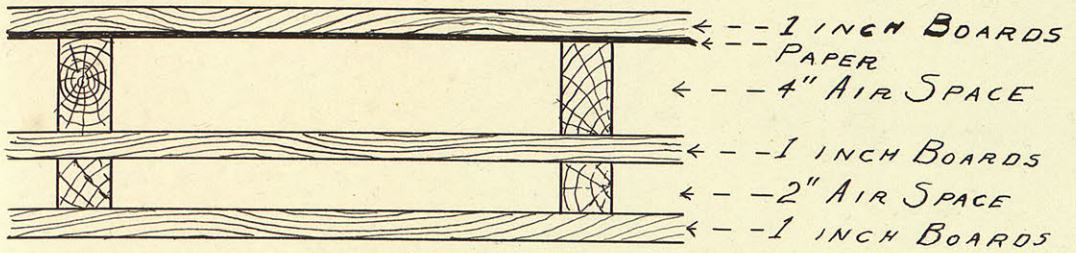
-3-


1 INCH BOARDS
2" CORK SHEET
1 INCH BOARDS
4" AIR SPACE
1 INCH BOARDS

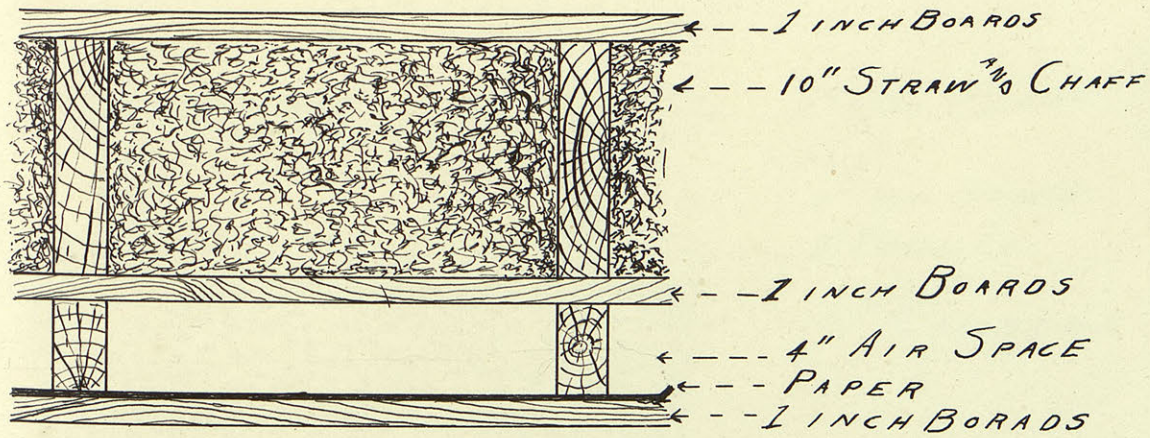
-4-


1 INCH BOARDS
2" ROCK-COTTON
1 INCH BOARDS
4" AIR SPACE
1 INCH BOARDS

-5-

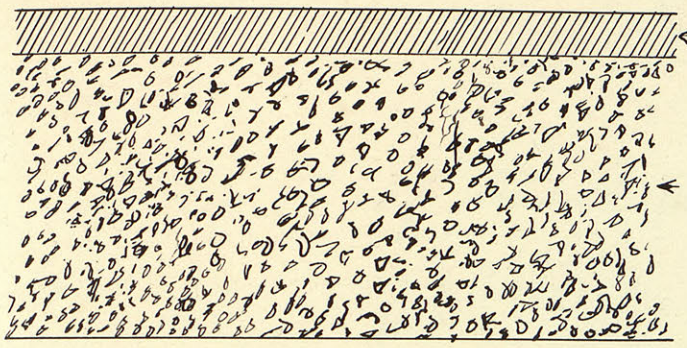

1 INCH BOARDS
PAPER
4" AIR SPACE
1 INCH BOARDS
2" AIR SPACE
1 INCH BOARDS

-6-

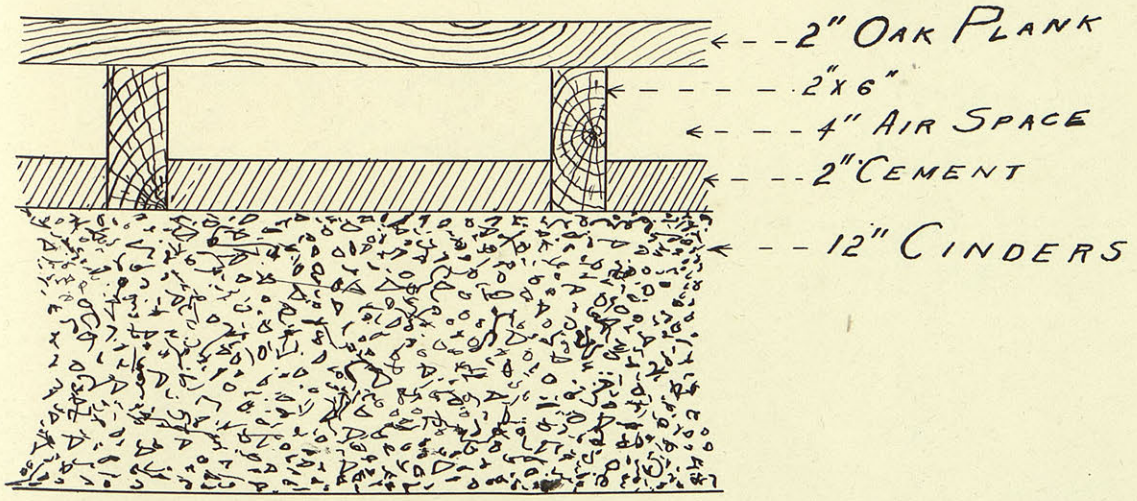

1 INCH BOARDS
10" STRAW AND CHAFF
1 INCH BOARDS
4" AIR SPACE
PAPER
1 INCH BORADS

FLOORS

-1-


2" CEMENT FLOOR
12" CINDERS OR CRUSHED ROCK

-2-


2" OAK PLANK
2"X6"
4" AIR SPACE
2" CEMENT
12" CINDERS

On the preceding pages the drawings show six different methods of wall construction and two of floor construction

The cost of these walls per square foot is as follows

#1

3 2/3 ft. lumber @ 3¢	.11
nails	.01
1 sq. ft paper	.005
3/4 cu. ft sawdust @ 3¢	.02
Labor	.07
	.215 per sq. ft.

#2.

3 2/3 ft. lumber @ 3¢	.11
nails	.01
1 sq. ft. paper	.005
3/4 cu. ft. mill shavings @ 20¢	.15
Labor	.10
	.375

#3

3 2/3 ft. lumber @ 3¢	.11
nails	.01
1 sq. ft cork sheet	.10
Labor	.11
	.33

#4
3 2/3 ft. lumber @ 3¢ .11
nails .01
1 sq. ft rock cotton .10
Labor .11
.33

#5
4 ft. lumber @ 3¢ .12
nails .03
Labor .10
1 sq. ft paper .005
.235

#6
3 2/3 ft. lumber @ 3¢ .77
nails .07
3/4 cu. ft straw .005
1 sq. ft paper .005
.13

Floors
#1 Cinders or concrete with cement 14¢ sq. ft.

#2
Concrete & cement .14
2 sq. ft. lumber @ 3¢ 6
.20¢

The cheapest wall is #6 but it would not be the cheapest in the longrun as straw and chaff will not last long in a wall.

The highest priced wall is #2 constructed with mill shavings as the insulating material.

The wall with cork sheet and the one with rockcotton cost the same and either one is an excellent insulating material.

Many other combinations of these various insulating materials could be devised and the house would be easy to construct.

Ice and Refrigeration and Copes's Practical Cold Storage have been used as references.