and piled and burned where heavy, to reduce fire hazard. Defective trees should be felled where their removal will not break up the even canopy needed for ribes suppression, and the resulting slash piled and burned.

Stands similar to the foregoing but with highly defective mixed timber should be cut in a series of two or three partial cuttings, keeping the first cut light. After the final cutting the resulting slash and defective material should be disposed of by broadcast burning in one or two operations.

Low vigor stands of high ribes potential should be harvested in one or more cuttings depending on the defectiveness of the mixed timber. If the mixed timber is highly defective, one cutting may be necessary; if the mixed timber is sound, more cuttings can be made. Following removal of all merchantable material the area should be broadcast burned in one or two operations as previously mentioned and then planted to white pine after the area is determined to be free of ribes.

Overmature Stands

In overmature stands, usually over 200 years of age, the objective of cutting is to harvest merchantable values, rid the area of defective material, suppress ribes, and put the land back into production. Merchantable material may be removed in one or more cuttings. Logging slash and defective trees should be disposed of in one or two prescribed burns as previously described. White pine can be planted after the area is eradicated of any ribes which may germinate.

These briefly are the recommended cutting practices for stands of the white pine type. The recommendations for each particular kind of stand were determined by integrating protection from insects, disease, and fire with the silvical requirements of the species involved and finally deciding on a practice which appears to be economically sound. Some of the methods proposed need to be tested, especially partial cuttings and burning practices. The demands of protection are forcing us to adopt some practices which may complicate the growing of maximum amounts of Western white pine. However, this only proves how definitely protection is a part of white pine silviculture.

ZERO REFRIGERATION FOR THE FARM HOME

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INTRODUCTION

Home refrigeration has constituted one of the most important contributions toward raising the modern standard of living. It provides for better food preservation and a consequent improved and more healthful diet. The cost of home refrigeration is now considered not as an expense, but an economy, not only because of reduced food wastage, but also because of reduced hazard to health from food spoilage. But the temperature of 35 to 40 degrees commonly maintained in household electric refrigerators is suitable only for short time food storage such as a couple of weeks or a month.

For the preservation of foods for several months or as long as a year a much lower temperature is required to halt bacterial growth, and to reduce the activity of enzymes. The latter constitute what might be termed "ripening" agents which affect quality but do not in themselves cause decay.

While bacterial growth is largely halted at 15 to 20 degrees Fahrenheit, the activity of enzymes is not greatly retarded until the temperature is 10 to 15 degrees lower. The ideal long term storage temperature would be 15 to 30 degrees below zero except that such low temperatures are expensive to maintain.

Experience has shown that a satisfactory storage temperature for preserving meat, fruit, and vegetables in the home ranges from 5 degrees above to 5 degrees below zero. This temperature range is commonly referred to as zero refrigeration.

The freezing of meat, fruit, and vegetables preserves them for future use without the necessity for canning and this fact has contributed greatly to i popular acceptance. The economy buying perishable produce at a lo market price for use throughout tl year has been the reason for the rap and continued growth of this type business.

During the period 1930 to 1936, cen tral locker plants came into very ger eral use for zero storage, the cliente including both city dwellers and rur dwellers as well. However, for th rural dweller living 10 to 15 miles fro the central locker plant, the need f special trips to the locker made th cost of such storage almost prohibitiv Therefore, for such rural dwellers small, individual zero locker, locate on the farm would not only be mor accessible and could be used to bette advantage but it also would be mor economical to use. However, at th time, namely as late as 1936, there wer no small zero refrigeration plants o the farm.

In 1935-36, Washington State Colleg undertook the study of zero refrigera tion for rural users and thereby be came the pioneer investigator in thi field throughout the United States. Th State of Washington already had th honor of being the pioneer in centra locker development at Chehalis, an thus it was fitting that the individua zero locker should be pioneered in th same State.

The problem of zero refrigeration fo the home has not called for any larg amount of basic research in the fiel of refrigeration. Rather it has involve an extended study of home requirements as well as the solving of the following problems of engineering design 1. Desirable physical size of storag space for average family use. 2. Relativ merits of chest type and side door zero boxes. 3. Best location in the home for use and convenience. 4. Type and amount of insulation and its installation. 5. Type and size of refrigerating equipment. 6. Type of temperature controls best suited for home use. 7. Uniform temperature distribution in storage space.

From an extended study over several years of many experimental plants installed under the supervision of the College it has been fairly well established that for an average farm home, the storage should consist of two compartments. A large walk-in room of 300 to 500 cubic feet should be provided to operate at 35° F. A smaller compartment not less than 50 to 60 cu. ft. capacity is usually located in, or opening into, the walk-in room and should be provided with controls to hold a zero temperature.

Nearly every user at first underestimates the size required, but after a year's experience would usually specify still larger storage space.

The refrigerating unit, or condensing unit, as it is termed, best suited for home use is the air cooled type rather than the water cooled type. It is customary to use one condensing unit to refrigerate both the 35° room and the zero compartment. The size required ranges from ⅓ H.P. to ¾ H.P. depending upon the size of the refrigerated space and upon the amount of insulation used.

Almost any of the commercial types of insulation for refrigerative use are suitable for zero storage plants. Where space is not at a premium, planer shavings are satisfactory and are in successful use in many plants. The thicker the insulation the less power will be required to maintain the desired temperature, and in case of power outage or equipment failure, the longer it takes before temperatures will rise high enough to injure the stored food.

With almost every kind of insulation used, (the principal exception being cork board laid up in asphalt) an effective vapor barrier of some description must be provided on the warm side of the insulation. And for the same reason no vapor barrier can be used on the cold side. The purpose of such an arrangement, of course, is to prevent the accumulation of moisture in the insulation with consequent greatly increased heat leakage, and in most cases, to eliminate serious damage to the wall. The vapor barrier is of primary importance in the continued successful operation of a zero plant and therefore merits more than passing comment.

Figure 1 illustrates an insulated wall but with no vapor barrier on the warm side of the insulation. Assume, for example, that the temperature gradient through the insulation is established somewhat according to the line AB where the outside temperature is 70° and the inside is 0°. Assume that the outside temperature drops to 50° during the night. Then the gradient will drop to line AC. Obviously, the temperature of the air in the insulated wall will be lowered with a resulting decrease in volume and, if both walls were air tight, there will be a tendency to create a vacuum. If there is an open hole at O there will be a resulting inflow of fresh air to equalize the pressure. This air will move inward through the insulation and at some point will be cooled to a dew point temperature; at this point moisture will begin to condense out of this fresh air. Later when the outside temperature rises and the air in the wall expands some of it will be expelled through the hole O but will leave most of the condensed moisture in the wall. During the next temperature cycle more moisture will be condensed in the wall and each time some of it will be carried further toward the inside wall where it will remain.

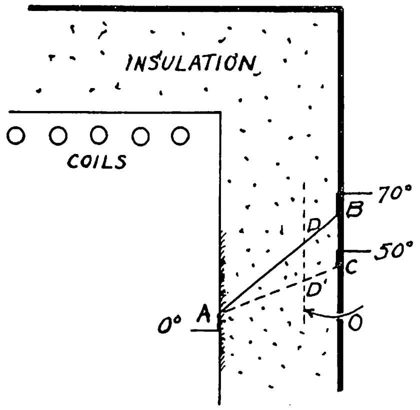

Figure I

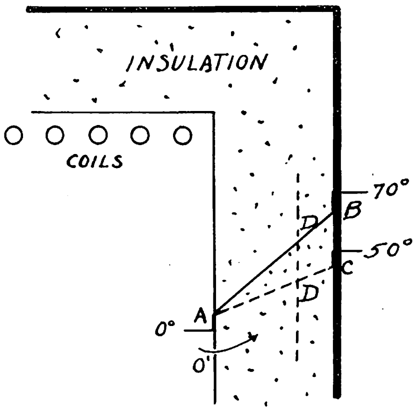

Figure II

Figure II shows a similar wall but with a vapor barrier on the warm side and a hole "O" through the cold side. Then during a temperature cycle the air drawn into the insulated wall v be from the refrigerated compartm where it will have passed over the co ing coils and had some of the moist frozen out of it. Then as this air trav deeper into the insulation it becon warmer and for that reason somewl thirsty and will take up moisture stead of depositing it. As the cycle cc tinues this moisture-laden air will expelled and will carry some of its mo ture into the refrigerated compartme where it will be deposited on the cc as frost.

This illustrates that the **lack** of properly located vapor barrier w cause moisture to accumulate in the i sulation and if a correctly located ba rier **is provided** it will cause the insul tion to become dryer. The inferen then is that the outer wall should as nearly air tight as possible and th the inner wall should, if necessary, deliberately punctured to permit t desired breathing described.

This example is given for the pu pose of illustrating the importance care in insulation for zero refrigeratio It also will illustrate the possible sour of unsatisfactory performance whi

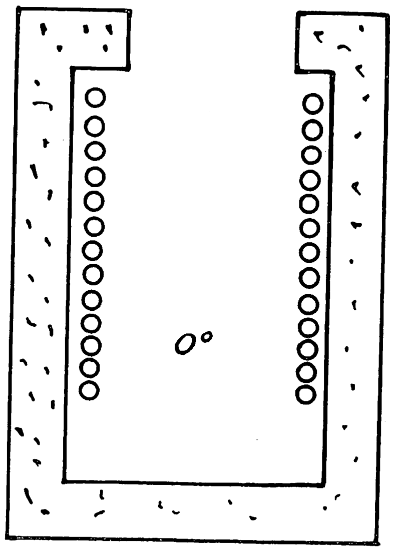

Figure III

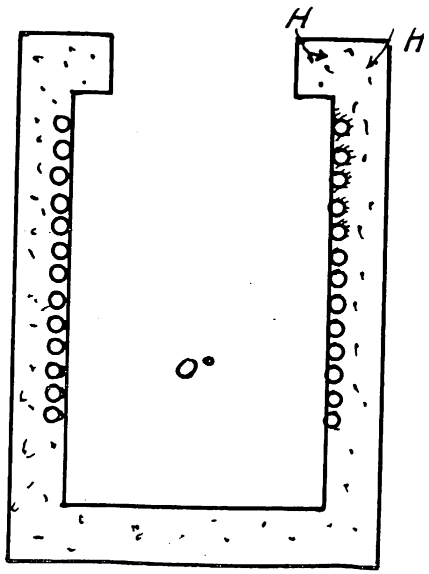

Figure IV

may be experienced with certain commercial types of zero boxes. Figure III shows a chest type zero box with insulation, vapor barrier, and punctured inner wall. Refrigeration coils are conveniently suspended inside the inner wall.

In Figure IV is illustrated the practice of using a metal inner can with the coils soldered to the surface next the insulation. This admittedly removes the coils from the inside of the can and improves its storage capacity and appearance. The inner can is, usually, intentionally made water and air tight. Likewise the outside case may be of metal and also air tight. However, there

is bound to be some joint between the inner and the outer cans which is not air tight and through which breathing will take place during temperature cycling. The result will be a slow accumulation of ice around the coils in the insulation resulting in greater heat loss and increased power consumption to maintain the desired temperature. Thus this so-called improved type of construction is based upon some incorrect engineering principles.

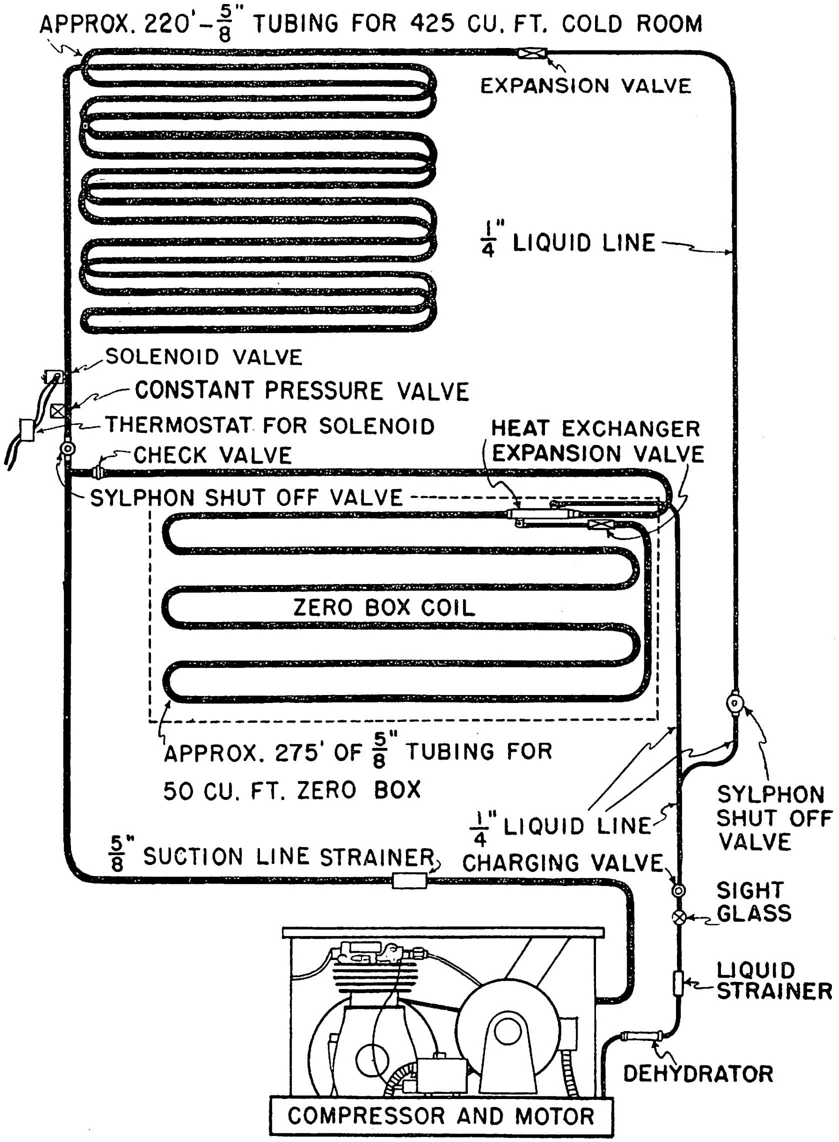

Figure V

Figure V illustrates the refrigeration circuit for a two temperature plant operated from one condensing unit. The condenser motor is controlled by a pressure switch set to maintain the zero temperature compartment which constitutes the base load. Then the temperature of the walk-in room is controlled by means of a thermostat and solenoid valve. This illustrates engineering practice.

Unfortunately some manufact are cheapening the construction of a plant by omitting the walk in evaporator coil. As shown in Figur they use a fan to circulate air the zero compartment. While it maintain the desired temperature, method involves two incorrect engi ing principles. First, zero refriger is expensive as compared to 35° frigeration and therefore this meth wasteful of power. It resembles pu ing water from a pond into a high only to let it return to be used at pressure just a few feet above the face. Second, the air circulated fro walk-in room into the zero comp ment will have part of the mois frozen out of it and deposited on

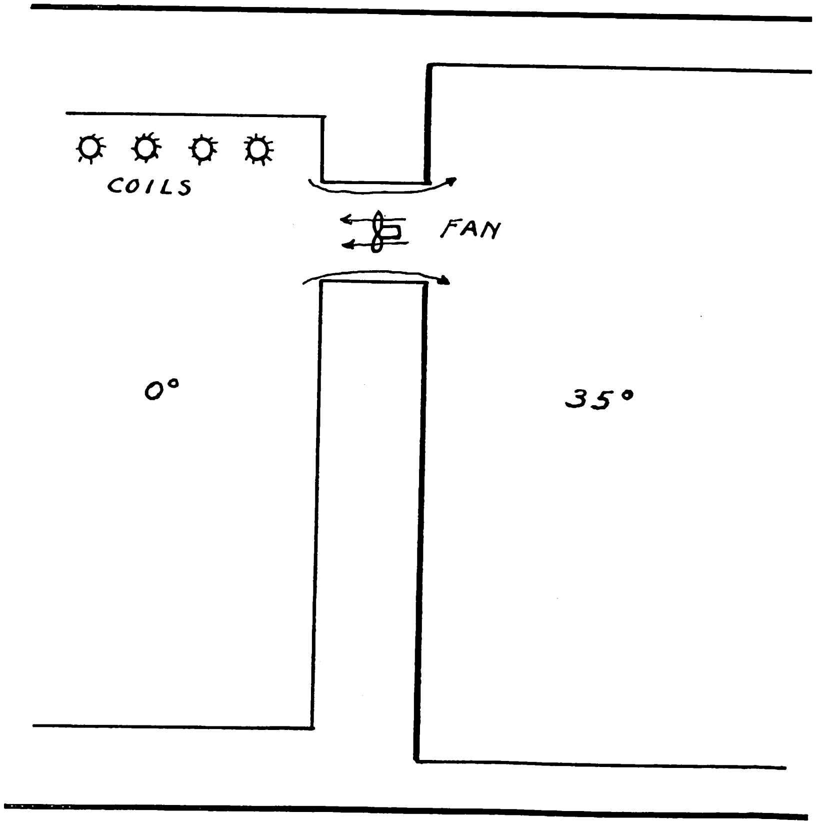

Figure VI

coils, requiring frequent defrosting as well as reducing the efficiency of the coils themselves. When this dried air is circulated over the produce in the walk-in room, excessive dehydration results.

Thus this type of reduction in first cost of the installation will result in greater power bills for operation, and in unsatisfactory operation of the plant as well as having an undesired and damaging effect on the stored food.

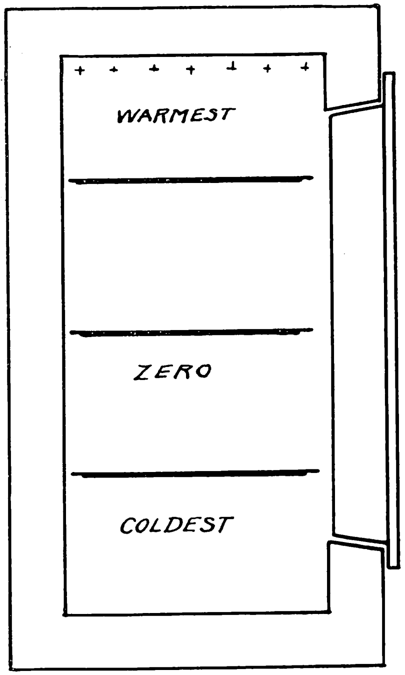

Figure VII

Figure VII illustrates a side door type zero box as compared to Figure III showing a chest type box. In Figure VII, again illustrating faulty engineering, the evaporator usually consists of plate coils used as shelves. Examination of temperature distribution in such a box will reveal that the space underneath the top shelf will be refrigerated to the desired temperature but that the space above the top shelf may be as much as 20 degrees warmer. In other words the material stored on the top shelf is not being stored at a satisfactory temperature and may therefore suffer damage in storage.

The obvious solution to this difficulty is to place additional refrigeration coils in the very top of the box to extract the heat which normally rises to this point.

In conclusion it may be stated that Washington State College has carefully studied not only the needs of zero refrigeration for the home but has also studied the performance of many plants in operation, including various commercial plants. The foregoing illustrations together with many others not herein included, outline some of the requirements for satisfactory refrigeration and some of the objectionable features to be avoided in poorly engineered commercial plants.

In the early years of zero home refrigeration the plants were all home made or custom built. Today many commercial firms are offering a wide choice of plants ready built for the trade. Some of these plants, unfortunately, possess serious shortcomings, and it was one of the purposes of this paper to point out these shortcomings and to show what engineering principles had been violated

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THE SOCIAL IMPLICATIONS OF FOREST MANAGEMENT RESEARCH

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Forest management research deals primarily with the biological and physical sciences. It may, therefore, seem a little out of place to discuss its social science aspects. The purpose of this paper is to show that forest management research bears a direct relationship to the everyday problems of mankind.

The Economics section of the Forest Experiment Stations surveys forest resources, and their uses, and also points out the social significance of these findings in special publications. To a considerable degree, forest management research takes its cues from the findings of such resource surveys. It is the job of management research to find better ways to protect, improve, harvest and regenerate forests. The needs and practices of our society determine the direction and conduct of work programs.

As an illustration of how management research is influenced by economic factors, consider Western white pine timber. White pine is the backbone of the timber industry of northern Idaho and adjacent parts of Washington and Montana. Although white pine is only one of five or six almost equally abundant tree species that grow in close association, the wood of white pine has certain technical qualities which make it particularly useful and valuable to man. As a result, much of the forest research in this region has been centered around white pine.

One of the first needs in white pine management was to determine harvest cutting methods and basic silvical info mation that would insure regenerati of the type after logging. Obviousl if forests are to continue supplying d sirable products, it is necessary to ke the land stocked with the right speci

The studies of requirements for r generation, although most directly co cerned with ecological factors such sunlight, moisture and plant compet tion, impinged upon human activiti in many ways. Various methods logging, such as skidding with horse tractors, or jammers can have strikin ly different effects upon the regener tion of various trees. Logging operato near the Coeur d'Alene mines se somewhat different kinds and class of materials than in localities whe match plank is the principal produ Large logging organizations regular employ different methods and equi ment than small operators, and hen exert measurably different effects up the future timber stand. Even the ha its, customs and training of individu workers have to be taken into accou in setting up experiments and inte preting the findings into practical re ommendations.

Silvicultural practices are heavily i fluenced by economic considerations well as by physical and biological fa tors affecting the growth of trees. Abo five years ago, Dr. Kenneth P. Dav at that time a member of the Expe ment Station, and now Dean of t Montana Forestry School, investigat and published a report on econom management of Western white pine fo ests. In this special study, Dr. Da