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SMALL CANNING FACILITIES

• • • • • AN OPERATION MANUAL FOR COOPERATIVE PROGRAM USE

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington D C 20523

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INTRODUCTION TO THE THIRD EDITION

The International Cooperation Administration (predecessor to the Agency for International Development) originally published this manual in 1956, as an aid in the establishment and operation of community and small-scale canning facilities overseas. It remains unique in its presentation and coverage, and it has been in continous use by government and private sectors abroad and in the U.S. since then.

In re-issuing this manual in slightly revised form, A.I.D. is responding to the requests of the U.S.A.I.D. Missions in the developing countries. The manual also is used in the U.S. for training purposes, especially with foreign participants. Cost figures in this edition are based on 1955 (See page 15) and, obviously, are not valid. Users may wish to approximate 1972 prices by figuring percentage increases.

Acknowledgement is made to Mr. James M. Reed, Special Assistant to the Director, National Canners Association, for his advice and help.

Omer J. Kelley, Director
Office of Agriculture
Technical Assistance Bureau

March 1972

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In most cases, man can greatly improve his health and reduce his anxiety about his food supply by canning foods for consumption throughout the year. This introductory chapter explains the many desirable results of canning and the factors which are necessary to make the establishment of a canning plant a practical venture. Two general classes of canning plants are discussed. In the first, the plant is run for the benefit of the community residents in general, and in the second, the plant is run as a commercial enterprise. The most important problems, including type and size of the plants and equipment, availability of containers, and the training of supervisors, are also discussed.

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CHAPTER ONE. INTRODUCTION

In much of the world, man's most basic problem is finding sufficient quantities of nutritious food to sustain the population. Frequently, there is plenty of food available during some seasons; yet a shortage exists at other times. There are few portions of the world in which all of man's food requirements can be met throughout the year by the available supply of freshly grown foods. This statement is true in farming regions as well as in cities and in areas where low temperature or dry seasons prevent farming during portions of the year. Even in sections where the supply of fresh food is more or less adequate throughout the year, there is apt to be a certain amount of monotony in the meals and a scarcity of some necessary vitamins when the daily fare must be drawn from the limited variety of fresh foods.

At some seasons, in almost every part of the world it is possible to grow more food than can be eaten in fresh form. At times, when the yield of crops is greater than usual, much fresh food spoils. The supply of most meats is more or less seasonal and canning certain portions will substantially prolong the period of consumption. Furthermore, some areas have great quantities of seafoods available during part of the year.

Obviously the preservation of food in one way or another may be an answer to a year-round food supply. The preservation method must keep the food from spoiling and at the same time the food must be in such a form that its nutritive values are not lost. It is important that the canned food approaches fresh food in attractiveness and in palatability as nearly as possible. Of course, the cost of the process must also be considered.

Of the many different methods of preserving foods, canning is the most extensively used because of: freedom from spoilage, retention of nutritional value, palatability, attractiveness, and cost. Other methods may be superior to canning for particular products or for one or more of these five considerations. For example, drying will frequently preserve certain foods for longer periods of time than they can be preserved by canning. For many foods, freezing yields a product which is more like the original food than the canned product. Both salting and drying are much cheaper than canning. Still, for most foods, canning offers the best compromise of the five methods considered for preserving foods.

Most fruits, vegetables, and meats, including poultry and fish, can be suitably canned. Many juices can also be canned. The quality of the canned products which may be expected from the various foods is indicated in Table XLIII in the appendix of this manual. Actually a significant difference in the quality of canned products may be noticed in different kinds of a given food.

The life of canned goods varies greatly for different foods and for different storage temperatures. However, in general, it is reasonable to assume that most canned goods can be stored for two years.

Before any serious consideration is given to the establishment of a canning plant it is necessary to determine that there will be an adequate supply of the product. An adequate supply means enough to keep the plant operating at an efficient level after the usual demand for fresh food has been supplied. It is wise to prepare a chart similar to Figure 7 in order to determine the season in which the canning plant is likely to be used. Naturally, the longer the canning season, the more chance for the plant to be a useful project. After the availability of raw materials has been determined, it is necessary to study the market for the canned food. There must be enough families with a desire to can food for their own use to justify the cost of the plant if it is to be operated as a cooperative plant. As used in this manual, the term cooperative plant refers to plants which are run almost as a public utility. They are built by the individuals who plan to use the facilities or, more often, by the government. Such plants do not seek to make a profit.

Cooperative plants may be organized and financed by local groups of people or they may be financed wholly or in part from public funds. Such matters are naturally determined by local policies, but it may be of interest to point out the procedure followed in the United States. Usually the local canning plants are built by the county governments as part of the high school educational program. The supervision of the plants is often carried out by the high school agriculuture instructor and by the high school home economics instructor. These plants are built for the primary purpose of youth and adult education in preserving food. However, these plants serve as canning centers for the community in which they are located. The plant is usually part of the high school and is used for canning instruction of the high school students.

The cost of using the facilities includes the cost of the cans and the operating costs of the canning plant. It may or may not include a charge to pay the salary of the supervisor. It usually does not include the cost of the building or the equipment. The charges in plants of this type do not include a profit for the plant operators; they represent only the costs. It is a common practice to charge a flat fee regardless of the type food being processed. Costs vary with the size of containers. In some plants, the patrons are charged a slight extra amount for the use of special equipment such as pea shellers.

A considerable part of this manual is devoted to a discussion of the canning plant as a commercial enterprise. Nevertheless the manual is intended as a guide for the establishment of a cooperative plant. The inclusion of the material on commercial operations is believed to be the best way to explain the overall economics of the canning operation. It should be remembered that the cost of operating the two types of plants is actually closely related. The primary difference is in the fact that the cooperative plants do not have to stock a large inventory of finished goods, and they do not have to have a large labor supply and reserve capital for operation during emergency periods. The cooperatively operated plants

do not have to provide a storage space for the finished canned goods, and, hence, there is some saving in the initial cost of the plant. In the cooperative plant, the patrons perform most of their own labor, and they grow or purchase their own food. Consequently, the apparent cost of the canned goods in the cooperative plant is much less than in the commercial plant. Actually, however, the individual patrons make up most of the difference. In most cases, the use of an individual's time allows him to have a supply of canned goods at a price he can afford.

In spite of the subordinate role given to commercial plants in this discussion, they may be the most desirable type of canning facility in some areas. If the economy of an area is sufficiently well established for the citizens to purchase canned goods, a commercial plant should be considered. This is particularly true in areas which include sizeable nonagricultural populations. If a commercial plant appears desirable, an attempt should be made to interest private capital in building and operating one.

In some instances in the United States, groups of individuals will pool their resources and establish a canning plant for their own use and the use of the public. In general, such plants are run to make a profit. Even the persons who establish the plant pay the standard amount for the use of the facilities. Periodically the profits of such a plant are split among the persons who own the plant. Such an arrangement may make possible the establishment of a canning plant in cases where the local government is unable to undertake the project. The persons who help establish the plant have the facilities available for their own use and at the same time the plant serves as a public benefit, providing excessive charges are not made. The profits derived from such ventures are not especially large but they should more than repay the organizers' costs if the demand for the use of the plant is substantial and the plant is well managed.

Some cooperatively run plants permit persons to use the canning plant even though they do not have the money to pay for the facilities. In such cases, a portion of the canned goods is given to the canning plant instead of money. The canning plant then sells the goods just as a commercial plant would. It is possible that an arrangement of this type would be practical in many places where the families using the canning plant do not have adequate funds.

A. Plants Discussed

This manual includes a discussion of three different types of plants. The actual size of these plants is more or less arbitrary. The important difference in the plants is in the equipment which is used.

The smallest plant, plant A, includes only the most elementary utensils. It is unlikely that a plant of this type could be a practical commercial plant under any conditions. However, it may be practical to establish such a plant for cooperative use. If so, every effort should be made to improvise as much of the equipment as possible from locally available supplies.

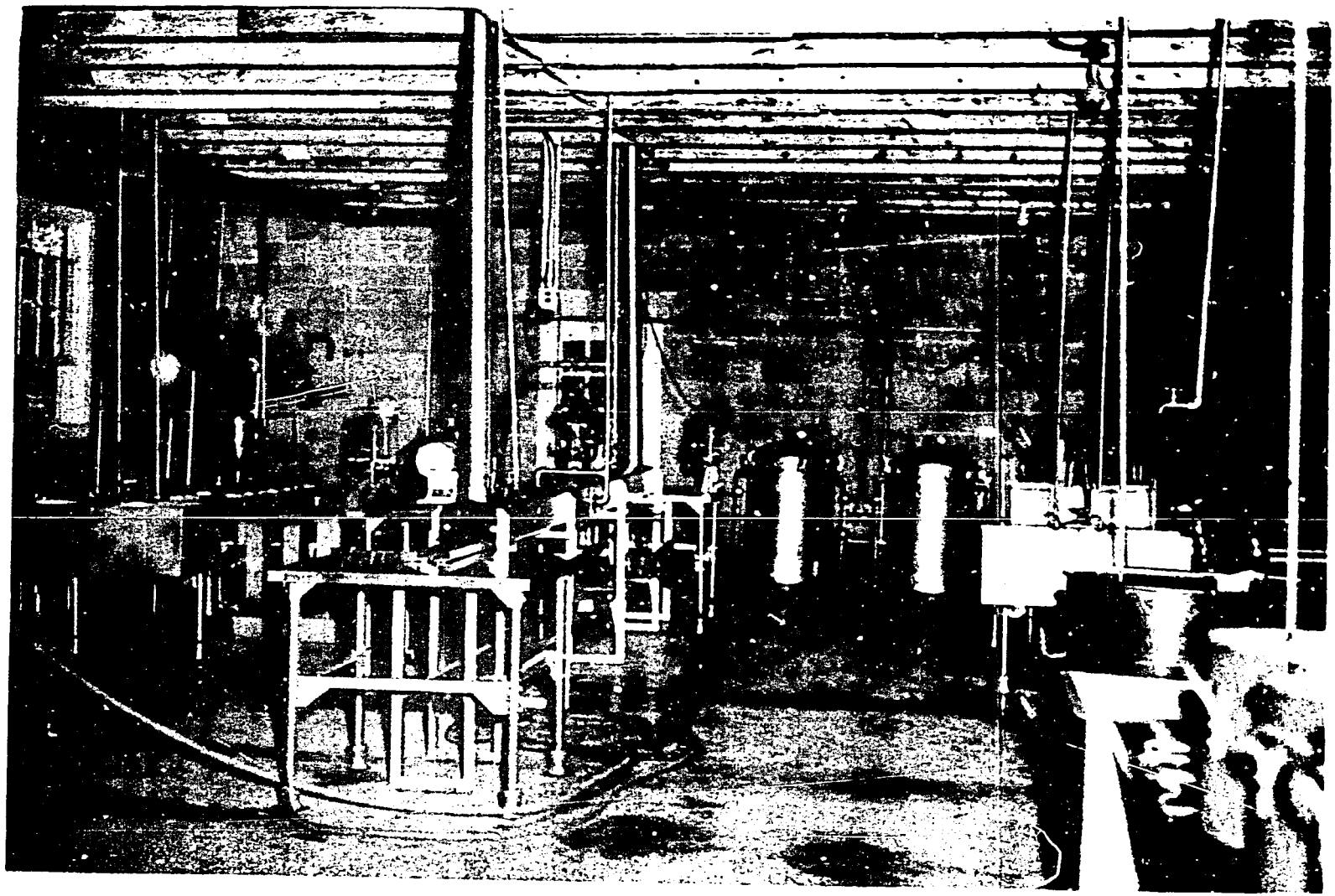

Figure 1. Arrangement of a Typical Small Canning Plant, Comparable to Plant C.
(Courtesy of the University of Georgia)

Plant B, the intermediate size plant, utilizes commercial equipment but does not have a boiler. Heat is generated locally.

Plant C, which has centralized steam-generating equipment, is the most desirable type even if the actual annual production will be much less than that outlined for this plant. (Figure 1.)

B. Plant Planning

The outline of these plants should be sufficient to allow persons who are not familiar with canning plants, but who have experience with other types of industrial facilities, to decide on the type of facilities which will best serve the needs of the community. The desired capacity of the plant should be estimated. Then calculations similar to the examples given in Chapter Two of this manual should be used to determine which of these plant types best serves the needs of the particular area.

If a plant of different capacity from those described in this manual is to be built, great care will be necessary to see that all the functions (e.g., preparing, cooking, sealing, etc.) have the same capacity. In most cases the company from which the equipment is to be purchased will be in a position to advise in balancing the various functions. Fortunately, it is not necessary to have all functions balanced perfectly.

C. Containers

If the canning plant is to be established in an area where canning is not already practiced, there may be a great deal of difficulty in obtaining suitable containers. To be satisfactory for canning, glass jars must have uniform top edges which make possible perfect seals. Such tops are not ordinarily found on reasonably priced jars except when they are made on precision equipment such as that used in mass production of very large quantities of jars.

Tin cans also must be produced in large quantities in order to be economical. Neither preformed cans nor jars can be shipped for great distances economically. However, cans can be purchased in collapsed form and shipped at a reasonable cost, but even these cans must be purchased in a minimum quantity of 100,000 of a single size per order. If smaller quantities are ordered, they will not be manufactured until additional orders for the same size can are received. Thus, it seems especially desirable for several of the small canning plants to combine their orders in an effort to improve this service.

D. Training of Supervisors

Before any plant can be put into operation it is necessary to have a well trained supervisor. This training is so important that it is necessary to send the man to a plant or school where he can receive first

hand experience. It is even more desirable to have a supervisor who is trained in food technology. One possibility which deserves careful consideration is for several plants to cooperate by having their future supervisors trained together. This training could take place while the canning plant is being planned. It may prove practical to have a special course also for the benefit of the training group. If so, the course may be operated in the country or area to be served.

CHAPTER TWO. PLANT REQUIREMENTS

I. GENERAL CANNING PLANT PRACTICES

The primary goal in canning foodstuffs is to preserve it in edible condition and thereby prevent spoilage. Since production is seasonal, this provides a way of conserving the oversupply in fresh form at the season of maturity for consumption in the balance of the year. However, it is also necessary that the canned product be attractive, palatable, and nutritious. Occasionally in commercial canning plants, and all too often in home canning operations, one or more of these goals is not attained. Food is wasted unnecessarily, and illness or death may result if spoiled food is eaten. It is therefore of the utmost importance that each of these goals be kept in mind.

A. Food Spoilage

Spoilage of food may take place through the action of living microorganisms (molds, yeasts, or bacteria), by chemical reaction, or through loss of attractiveness, palatability, or nutritive qualities by age or improper storage. Microorganisms are present everywhere--in the soil, on foods, and even in the air. Failure to destroy or at least prevent development of these organisms in canned foods leads to spoilage.

Molds have a characteristic fuzzy appearance and are often seen on bread, cheese, jellies, cured meats, and many fruits, nuts, and vegetables. Molds are not a serious problem if proper canning procedures are followed since they must have air to develop and are easily destroyed by heat. Lightly molded food such as hams, cheese, or bread may be used if the mold is scraped away. However, food on which the mold growth is heavy should be destroyed.

Yeasts grow in sweet, acid foods such as tomatoes and fruit products. They cause fermentation which results in the formation of alcohol and the evolution of carbon dioxide gas. Food spoiled by yeasts has an alcoholic or sour taste. Carbon dioxide pressure in the cans may cause them to swell, or it may cause the contents to spurt out when the can is opened. In some cases jars may be burst by the gas pressure. Yeasts are easily killed by heating in a boiling water bath.

The principal and most dangerous cause of microbial spoilage is bacterial contamination. Certain types of bacteria may exist in heat-resistant forms called "spores," which can survive temperatures even higher than that of boiling water. Spores do not form in acid foods, e.g., tomatoes and most fruits; these foods can be processed in boiling water without danger. Nonacid foods, including all types of meat, fish and most vegetables, must be processed by steam under pressure in order to attain the necessary temperatures. In prevention of bacterial spoilage, it is vital that the seal be perfectly air tight, that the processing temperature be sufficiently high, and that the processing time be adequate to insure destruction of all of the spores.

Possibly the most dangerous bacterium is Clostridium botulinum, which produces a toxin that causes a type of food poisoning called botulism. This organism is present in soil and is found on food grown in nonacid soil. When eaten on fresh vegetables it is harmless. However, in the absence of oxygen it produces a tasteless toxin, botulinin, which is one of the most poisonous substances known. Even to taste food that contains botulinin may be fatal. Spoiled food is usually putrid and dark or cloudy in appearance, but in some cases there may be no pronounced sign of spoilage. If canned vegetables or meats appear abnormal in any way, it is advisable to boil them for at least ten minutes before tasting or eating. This will destroy any botulinum toxin which might be present. The organism that causes botulism does not develop in an acid medium. It is important that food which shows signs of spoilage be discarded without tasting.

Other types of canned food spoilage are caused by non-putrefactive gaseous and flat sour bacteria. In some types of bacterial spoilage a gas is evolved which may cause the ends of cans to bulge. Flat sour is indicated by an unpleasant odor, a cloudy appearance, and a sour taste. In the case of flat sour, no gas is formed. Although these types of spoilage are not dangerous, botulism is a danger in any spoiled food. therefore, food that shows any signs of bacterial spoilage should never be used or tasted.

Food may be discolored by chemical reaction, either by reaction with the metal of the container, by oxidation, or by enzyme action. The discolored portions can sometimes be discarded and the remainder of the food safely consumed provided there is no bad odor or other evidence of bacterial spoilage. Chemical effects, as well as many types of fermentation and bacterial spoilage, can be prevented or retarded by storing in a cool place.

In order to prevent food spoilage, it is of the utmost importance that strict rules of sanitation be followed and that the canning plant and equipment be kept scrupulously clean. The floors should be scrubbed or, preferably, steamed daily. Floors made of concrete or tile are much easier to keep clean than are those of wood. Even the walls and ceiling should be cleaned at regular intervals. Particular attention should be paid to surfaces that will come in contact with food. Cutting tables, preparation tables, storage bins, and similar places should be scrubbed thoroughly at frequent intervals. In addition to the daily clean-up, floors should be swept frequently during the day.

All pots, kettles, knives, ladles, and other utensils should be cleaned immediately after use, and all other equipment should be washed at the end of the day's operations. Thorough cleaning with boiling water is the best way to avoid contamination. If possible, the equipment should be rinsed with chlorinated water several times during the day.

All employees should be required to follow strict rules of personal sanitation. Clean toilet and washroom facilities should be provided. Employees should wash thoroughly before starting work and often during the

day. No employee with any sort of cut or sore on his hands should be allowed to handle food unless he wears rubber or plastic gloves, and none should be allowed in the canning plant if he has a cold or other illness.

The canning plant and premises must be arranged with the problems of sanitation in mind. It is necessary to make arrangements for a clean water supply and for disposal of garbage and sewage. City water that is purified by a modern filtration process and chlorinated is safe. Surface water should not be used without purification. Well water may be safe, but it should be analyzed by a competent bacteriologist at frequent intervals to insure against contamination.

If well water is used, special attention must be paid to the arrangement of sewage disposal facilities. A city sewer system is the ideal solution to this problem. If a sewer is not available, a well-designed septic tank is satisfactory if care is taken to see that it drains away from the well. Kitchen wastes should not drain directly into the septic tank since grease will render it ineffective. It is desirable to provide separate disposal systems for the kitchen and the restroom facilities.

Garbage should be disposed of daily. It is a good practice to keep inedible garbage separate from edible garbage since the latter can be sold for use as livestock feed. Garbage should be hauled away every day or else burned in an incinerator.

B. Canning Operations or Procedures

In processing food, strict quality control as well as careful attention to sanitation is necessary to insure an attractive and palatable product. A flow chart showing the various operations involved in canning fruits, vegetables, meats, and juices is shown in Figure 2. A simplified pictorial flow chart of the operations involved in canning fruits and vegetables appears in Figure 3.

1. Harvesting

Care should be taken to see that produce is not damaged in harvesting and delivery to the canning plant. Ordinarily, fruits and vegetables to be used for canning are harvested in the same condition as those to be consumed fresh. Since changes take place rapidly in harvested produce, it is important that it be delivered to the canning plant and processed promptly. Best results are obtained if the produce is canned within 24 hours after harvesting.

2. Washing

Washing, whether done by hand or mechanically, removes dirt and a large percentage of surface microorganisms. Thorough washing is important since the removal of microorganisms reduces the amount of heating required

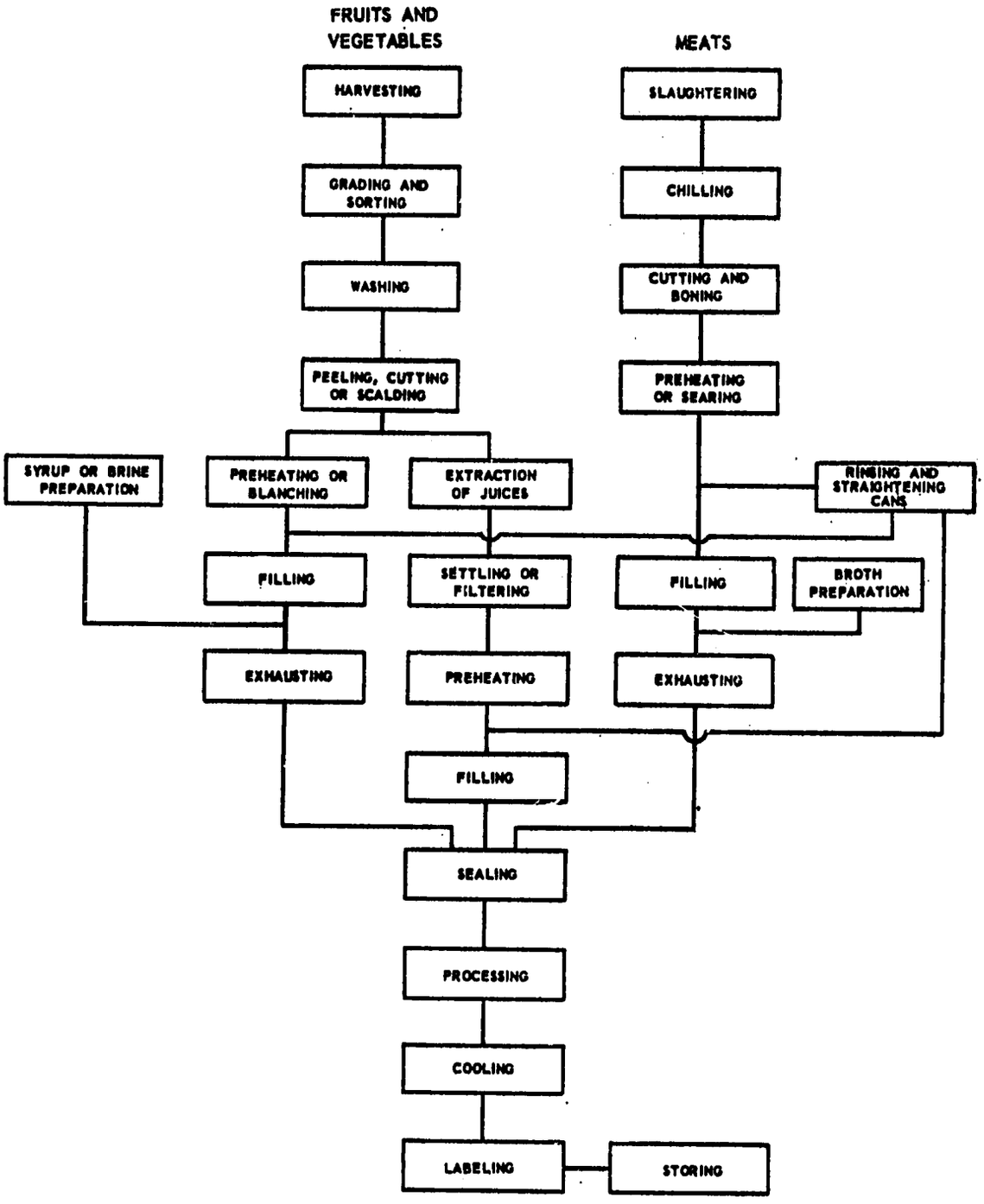

Figure 2. Flow Diagram for Canning Fruits, Vegetables, Juices, and Meats

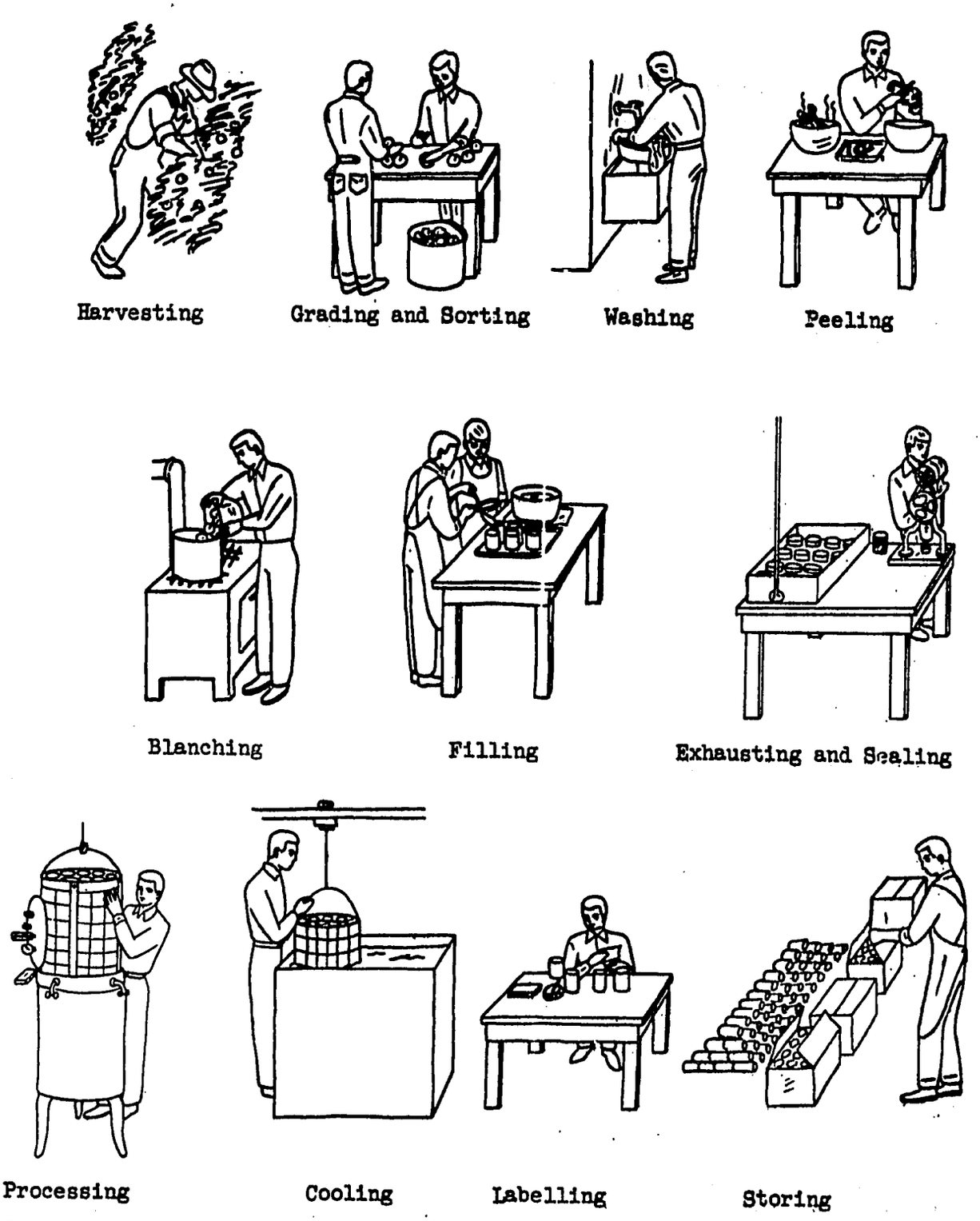

Figure 3. Simplified Pictorial Flow Diagram for Canning Fruits and Vegetables

to sterilize the canned food and therefore lessens the chance of some organisms surviving and spoiling the product. However, severe washing sometimes bruises the product or removes valuable juices. Washing can be carried out satisfactorily in pans of water, but, where good water is plentiful, many products can be washed more conveniently in running water, especially under sprays.

3. Grading and Sorting

Quality and uniformity in the finished product are maintained by grading and sorting the produce. Produce that is too green, overripe, or spoiled or shows serious insect damage should be discarded. Large, choice fruits or vegetables should be sorted from small ones and canned separately. Small fruit, if it is sound and fully ripe, can be used to make jelly, jam, or juice. Small vegetables can be used in making hash, stews, soups, and the like. In some cases, it may be desirable to can two or more different grades of produce. Of course, these comments as to size do not apply to material that is to be cut into pieces.

4. Preparation

Methods of preparation of produce for canning must be chosen according to the type of produce and style of canning desired. Food is ordinarily prepared for canning in the same style as fresh food is prepared for the table. Peeling is done by scalding, steaming, or with lye. Shelling of peas and beans by hand is a slow and tedious operation, and in large operations it is always done mechanically. The same is true of cutting corn off the cob. However, in small operations, and where labor costs are low, it may be more economical to do these operations by hand.

It is often desirable to can large fruits and vegetables whole or in pieces as large as can be conveniently packed into the can. From an aesthetic standpoint, it is necessary to make pieces uniform in size and shape and to preserve the natural appearance of the fresh food insofar as is possible.

Most vegetables are blanched before being packed in the cans. Blanching--exposing vegetables to boiling water or live steam--wilts the product, cleans it of dirt and organisms, rids it of earthy flavors, fixes some of the colors, and expels the respiratory gases from the food. In some cases, particularly in the canning of meat, food is actually cooked before it is put into the cans. Generally, however, care is taken in the peeling and blanching steps to avoid cooking the food since such cooking may harm the flavor, appearance, or texture of the food.

Some acid foods are not blanched but are cold-packed. However, it is difficult to get full cans without blanching. Care must be taken to preserve the color of cold-packed foods. Salt, sugar, or ascorbic acid may be used in the canning medium to prevent discoloration, and cans lined with an acid-resistant enamel are used.

5. Filling

When filling cans, the food is generally placed in the cans, and the liquid medium, brine or syrup, is poured over it. Vegetables may be packed with a salt tablet and covered with water. When packing, it is important to arrange the food in such a way as to leave a minimum of void space. This is one of the reasons for wilting the product by blanching. Such an arrangement insures full weight and, in the case of foods canned in glass, an attractive appearance. Attention to this point is particularly necessary in canning large fruits such as peaches.

6. Exhausting

Exhausting consists of heating the filled cans in boiling water or steam until a specified temperature at the center of the can is reached. This insures that a large portion of the respiratory gases is expelled and that the headspace is filled with steam rather than with air. Containers sealed hot will have a partial vacuum when cooled. It is particularly important to eliminate oxygen from the can since food exposed to oxygen discolors and loses flavor. Excessive gas sealed in the can will create high pressures in the can during processing and may cause it to explode.

Foods that are precooked need not be exhausted provided they are still hot while the containers are filled and sealed. Foods packaged in glass jars are generally either filled hot or are covered with boiling brine or sirup and do not require exhausting.

7. Sealing

Cans are sealed as soon as the center can temperature reaches the specified value for the food being canned. A perfect seal is vitally important since an imperfect one will permit spoilage. Tin cans are sealed by means of a sealing machine, which may be hand-operated or motor-driven. Sealers must be kept in good repair and inspected regularly to prevent improper functioning.

Glass jars with self-sealing lids are sealed by placing the top on the jars and screwing the ring down firmly, but not too tightly, on top of it. Screwing the ring down too tightly may break the sealing compound on the lid or prevent the jars from exhausting properly during processing. Although the self-sealing type of lid is the simplest and the most practical, several other types of lids are available and widely used.

8. Processing

Processing consists of exposing the sealed cans or jars to boiling water or to steam under pressure. Acid foods may be safely processed in boiling water since most heat-resistant spores are not able to grow in an acid medium. However, low-acid foods, which include most vegetables and

all meat, fish, and poultry, must be processed at temperatures higher than that of boiling water in order to kill the bacterial spores. Steam under pressure of ten or more pounds per square inch is used. The cans are processed in pressure cookers or retorts, which are vessels especially designed to withstand the pressures involved. These vessels vary in size from small pressure cookers that hold a few cans to large retorts capable of processing several thousand cans at a time.

From the standpoint of safety, it is vitally important that processing times and temperatures are sufficient to sterilize the product. However, from the standpoint of quality control, it is almost equally important that the food is not overcooked since overcooking is likely to spoil the flavor, appearance, and nutritional value of the food. For this reason, the pressures, temperatures, and times should be accurately measured and carefully controlled.

9. Cooling

Rapid cooling after processing is very important to prevent overcooking. Tin cans are ordinarily cooled by submerging them in cold, running water. Such drastic methods are unsatisfactory for glass jars since glass breaks easily under thermal shock. For this reason, overcooking is a greater problem in glass than in tin. Glass jars can be cooled slowly in air or somewhat more rapidly by a fine spray of water over the tops. Glass jars are best cooled by gradually replacing the steam pressure with pressure of cold water. This operation requires a special set of hand-operated valves on the retort.

10. Labeling

Labeling serves to identify the product by grade and ingredients used and the manufacturer, as well as to protect the cans from rust. In small canning plants, labeling is best done by hand since even small labeling machines are expensive and have a very large capacity. Labels should be attractively designed to appeal to the customer. Although most labels are printed on paper, it is possible in some areas to buy cans with the labels printed directly on the metal.

11. Storing

Storage areas must be provided for the finished cans. A cool, dry place is highly preferable since both microbial and chemical spoilage are greatly accelerated in warm, moist atmospheres. For storing glass jars, a dark place is recommended because light is likely to cause discoloration of the product.

II. ECONOMICS OF CANNING OPERATIONS

The various canning operations or procedures discussed in the previous section can be carried out in small equipment similar to that used in a home kitchen or in much larger equipment similar to that used in an industrial plant. For comparison purposes, the economics of canning operations in three plants of different sizes, designated hereafter as plant A, plant B, and plant C, will be discussed. Plant A, the smallest plant, utilizes elementary utensils and steam pressure cookers; plant B, the intermediate size plant, utilizes direct-fired steam retorts; plant C, the largest plant, utilizes indirect-fired steam retorts and atmospheric cookers.

In comparing these three plants, the following assumptions are made:

1. Each plant can operate either as a commercial plant or as a cooperative plant. As the economics of these two types of plants are different, both are discussed.

2. Equipment costs are based on 1955 prices for equipment in the United States, packaged for export shipment. Overseas freight charges are estimated to be 12 per cent of equipment cost.

3. Labor rates are the same as those found in typical, small-size canning plants in the United States.

4. Individual workers work eight hours per day, five days per week.

5. The two smaller plants would be unable to afford steam-generating equipment and labor-saving devices. In actual use, some of this equipment may be desirable in even small capacity plants.

It should be noted that with the assumed labor costs and other factors canned goods would be excessively expensive in plant A operated commercially. Under some conditions, however, this plant can prove to be a practical commercial plant, by utilizing "home" labor.

The three types of plants are discussed primarily to illustrate the use of the various equipment available for processing. The capacity of either plant B or plant C can be increased or decreased considerably. However, when plant B is expanded greatly, a steam boiler should be installed to replace the direct-fired equipment because of the increased heat load and the difficulty of effective maintenance without steam. Plant A can be decreased in size, but it would probably prove preferable to use plant B or plant C equipment rather than greatly increase plant A's capacity.

A. Economics of Canning in Plant A

It is estimated that plant A, utilizing elementary utensils, three pressure cookers (25 quart liquid capacity), and three atmospheric cookers

(35 quart liquid capacity), can produce approximately 480 No. 2 cans per day. If the plant operates six months per year (126 work days) the annual production will be 50,480 No. 2 cans.

For estimating the capacity of plant A, Table I was used. The times appearing on this table are the average times required for the various operations involved in canning a number of fruits and vegetables. Although the actual times vary from product to product, the average times were used for estimating plant capacity.

TABLE I

ESTIMATED UNIT TIMES FOR PROCESSING 20 NO. 2 CANS IN PLANT A

Operation	Description	Time (Man Minutes)
1	Grading and preparing product	105
2	Straightening and rinsing cans	6
3	Pre-heating the product	10
4	Filling the cans	13
5	Sealing (3 cans per minute)	7
6	Coding	8
7	Processing	55
8	Cooling and wiping cans	10
9	Labeling	9
	Total	223

Assuming that plant A operated cooperatively has the same capacity as plant A operated commercially, the economics of canning in each of these types of plants are presented below.

1. Canning Plant A Operated Commercially

a. Capital Requirements. In addition to the capital required to purchase the land, the building, and the equipment, it is necessary that the prospective owner have additional capital to buy raw materials, for payment of wages, etc. This additional capital is known as "working capital." The working capital should be sufficient to operate the plant until it begins to realize a profit. In effect, it is money set aside to insure that the canning operation will be a success.

The capital requirements for plant A operated commercially are summarized in Table II.

TABLE II

CAPITAL REQUIREMENTS FOR PLANT A OPERATED COMMERCIALLY

	Example	Actual
Fixed Assets:		
Land (estimated)	$ 600.00	
Building ($5.00 per square foot)	4,720.00	
Equipment (see Table IV)	1,772.41	
Working Capital:		
Raw materials (one month)	302.40	
Cans, cartons, labels (for annual production)	2,271.60	
Labor (one-sixth of annual cost)*	2,083.20	
Other expenses for two months**	338.18	
Inventory of finished goods***	9,540.72	
Subtotal	21,628.51	
Plus 10% for contingencies	2,162.85	
Total Capital Requirements	$23,791.36	

*See Table VI.

**Table VII less indirect labor.

***One-half of annual production multiplied by unit cost (see Table VIII).

b. Fixed Assets

(1) Land. Relatively inexpensive land which is not near the highly populated areas can be used as the site for a canning plant. It is estimated that the land required for plant A can be purchased for $600.

(2) Building. A one-story fire-proof structure having a minimum height of 12 feet is desirable. This type of structure can be built in the United States for approximately $5 per square foot of floor space. A schematic diagram of a suggest floor plan for plant A is given in Figure 4. This plant has 944 square feet of floor space. At $5 per square foot, this building will cost $4,720.

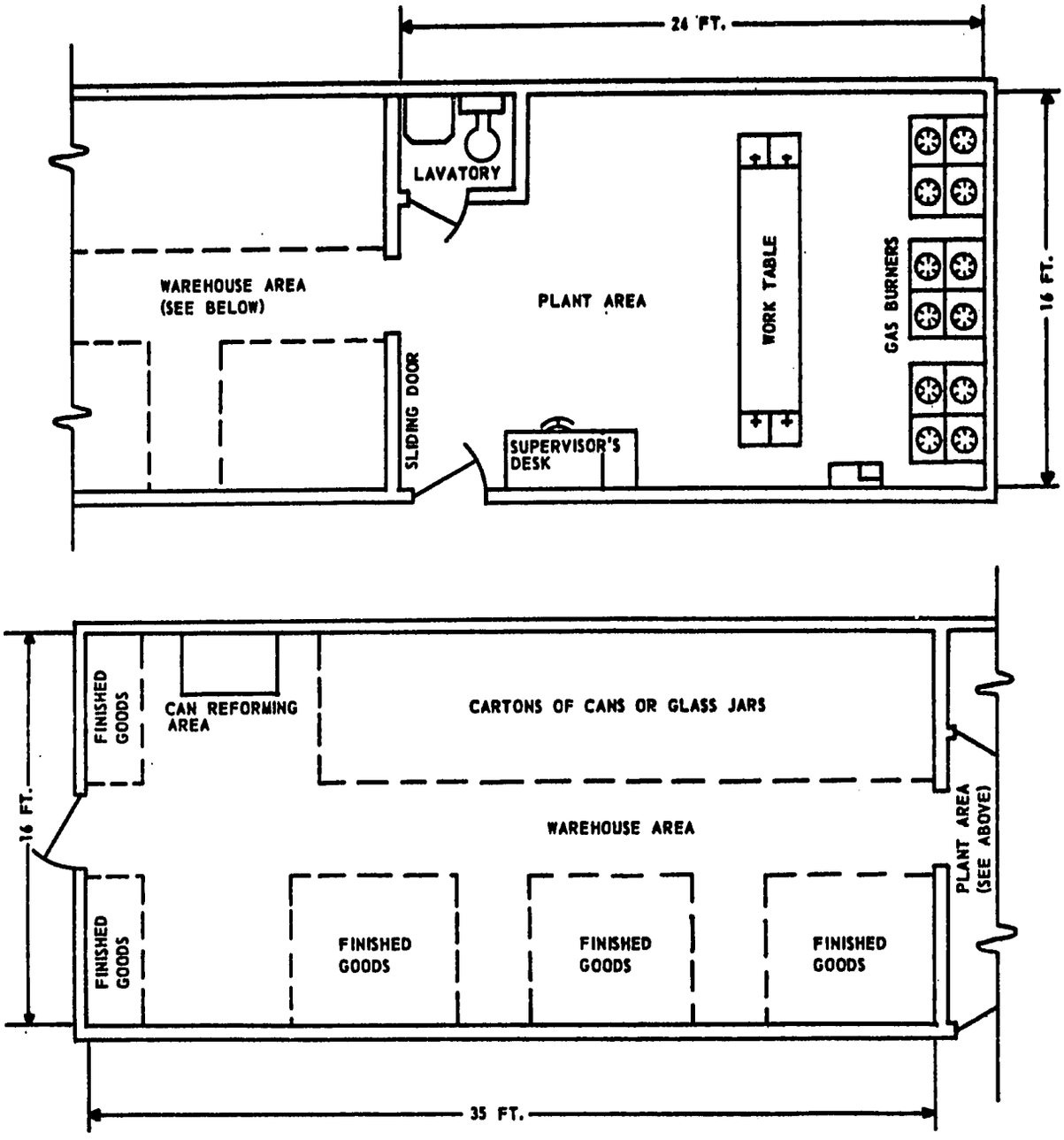

Figure 4. Layout for Plant A

(3) Production equipment. The equipment for a small canning plant using elementary utensils costs $1,607.82. This cost includes that of the equipment packaged in the United States for export shipment plus an estimated 12 per cent for overseas freight. Many items of equipment can undoubtedly be purchased locally at a saving to the prospective plant owner.

(4) Office equipment and fixtures. The office equipment and fixtures required in plant A cost $164.64. Used equipment, when available, can be substituted at a substantial saving, and much of the equipment can probably be purchased locally.

(5) Depreciation on fixed assets. Table III is self-explanatory.

c. Equipment Requirements. The equipment necessary to operate plant A is itemized in Table IV. The cost of each item of the equipment in the table is for the equipment packaged in the United States for overseas shipment. These costs do not include the cost of transportation to the plant site. At the end of the table 12 per cent of the total cost has been added as an estimate of the freight cost. A description of specialized equipment is given later in this manual in the section entitled "Equipment Descriptions."

d. Labor Requirements. When canning plant A is operated commercially nine persons are required to operate the plant and one to serve as plant manager. A summary of the total direct labor cost per hour and the indirect labor cost per hour is given in Table V, and a summary of the labor cost per year is given in Table VI. For calculating the annual labor cost, it is assumed that the direct labor is retained only for a six months canning season. The plant manager is employed for the full year.

e. Overhead Expenses. Table VII is self-explanatory.

f. Unit Cost Analysis. In plant A operated commercially at full capacity, the cost for manufacturing, selling, and distributing No. 2 cans amounts to $0.378 per can. A breakdown of this cost is given in Table VIII.

2. Canning Plant A Operated Cooperatively

a. Capital Requirements. When plant A is organized to be operated cooperatively the capital requirements can be reduced considerably due to elimination of the finished goods inventory and a decrease in the cost of raw materials and labor. The capital requirements for this plant are summarized in Table IX. The raw materials listed in this table refer to sugar, salt, pepper, and other seasoning.

TABLE III

DEPRECIATION ON THE FIXED ASSETS OF PLANT A OPERATED COMMERCIALLY

	Example Cost	Estimated Service Life	Example Depreciation per Year	Actual Cost	Actual Depreciation per Year
Land (estimated)	$ 600.00	--	---		
Building ($5.00 per square foot)	4,720.00	30 years	$158.00		
Plant equipment (see Table IV)	1,607.82	10 years	160.78		
Office fixtures (see Table IV)	164.64	16 years	10.29		
Total	$7,092.46		$329.07		

TABLE IV

EQUIPMENT REQUIREMENTS FOR PLANT A

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
		PLANT EQUIPMENT				
1	3	Pressure cooker, 25-quart liquid capacity	$ 33.30	$ 99.90		
2**	12	Gas burner, 25,000 BTU per hour	7.20	86.40		
3	2	Hand sealer, equipped for No. 2 cans	42.00	84.00		
4	2	Sealer change parts for No. 2-1/2 cans	10.20	20.40		
5*	3	Atmospheric cooker complete with rack and lid, 35-quart liquid capacity	3.79	11.37		
6	3	Stock pot, aluminum, 5-gallon capacity	14.50	43.50		
7	3	Cover for stock pot	4.00	12.00		
8*	3	Exhaust thermometer	2.75	8.25		
9*	6 pairs	Gloves, cotton	0.75	4.50		
10*	3 pairs	Gloves, rubber	2.40	7.20		
11*	1	Table, galvanized, 33" x 117"	174.00	174.00		
12*	2	Sink rack	9.60	19.20		
13*	2	Two-compartment sink	42.00	84.00		
14	1	Flange reformer for No. 2 cans	11.50	11.50		
15	1	Flange reformer for No. 2-1/2 cans	11.50	11.50		
16*	3	Dish pan, aluminum, 14-quart capacity	7.00	21.00		
17*	3	Dish pan, aluminum, 21-quart capacity	11.15	33.45		
18*	3	Bucket	2.20	6.60		
19*	2	Dipper, 1-pint capacity	1.00	2.00		
20*	2	Dipper, 2-quart capacity	3.90	7.80		

(Continued)

TABLE IV (Continued)

EQUIPMENT REQUIREMENTS FOR PLANT A

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
21*	2	Boning knife (meat), 5"	1.62	3.24		
22*	6	Paring knife, 3-1/4"	1.20	7.20		
23*	3	Spoon, stainless steel	1.55	4.65		
24*	3	Funnel	1.00	3.00		
25*	1	Meat and bone saw, 24"	2.65	2.65		
26*	2	Extra blade for meat and bone saw	0.30	0.60		
27*	2	Pot brush	0.70	1.40		
28	3	Hot-lift tongs	0.75	2.25		
29*	1	Garbage can with cover, 20-gallon capacity	3.60	3.60		
30*	2	Cutting board, 12" x 18" x 2"	8.75	17.50		
31	1	Can reformer	235.00	235.00		
32	1	Can flanger	175.00	175.00		
33	1	Ventilating fan, 9,500 cubic feet per minute	156.50	156.50		
34*	1	Table for sealer	10.00	10.00		
35	1	Gauge tester	9.00	9.00		
36	1	Juice extractor, hand operated	21.00	21.00		
37	1	Meat and vegetable chopper	9.25	9.25		
38*	3	Vegetable brush	0.50	1.50		
39	1	Can opener	1.20	1.20		
40*	3	Wire basket or colander	2.00	6.00		
41*	1	Carborundum stone	2.40	2.40		
42*	1	Clock	4.00	4.00		
43*	1	File	0.50	0.50		
44*	2	Broom	1.00	2.00		
45*	2	Mop	1.25	2.50		
46*	1	First-aid kit	5.00	5.00		
		Subtotal, Plant Equipment		1,435.51		

OFFICE FIXTURES

47*	1	Supervisor's desk	90.00	90.00
48*	1	File cabinet	32.00	32.00
49*	1	Chair	25.00	25.00
		Subtotal, Office Fixtures		147.00
Total cost of plant equipment and office fixtures packaged for overseas shipment				1,582.51
Plus 12 per cent for overseas freight (estimated)				189.90
Total cost of equipment to purchaser				$1,772.41

*Item probably can be purchased locally or fabricated in the canning plant.

**If gas is not available, oil burners could be used or a coal or wood stove could be substituted.

TABLE V

LABOR REQUIREMENTS FOR PLANT A
OPERATED COMMERCIALLY

	Number	Example Hourly Rate	Example Hourly Cost	Actual Hourly Rate	Actual Hourly Cost
Direct Labor					
Food preparation personnel	6	$0.75	$4.40		
Pressure cooker operator	3	1.00	3.00		
Total	9		7.40		
Indirect Labor					
Plant supervisor	1	$2.50	$2.50		

TABLE VI

LABOR COST PER YEAR FOR PLANT A
OPERATED COMMERCIALLY

	Work Hours per Year per Individual	Example Plant Cost per Hour	Example Plant Cost per Year	Actual Plant Cost per Hour	Actual Plant Cost per Year
Direct labor*	1008	$7.40	$ 7,459.20		
Indirect labor**	2016	2.50	5,040.00		
	Total		$12,499.20		

*Labor paid for six months.

**Supervisor paid for twelve months.

TABLE VII

ANNUAL OVERHEAD EXPENSES FOR PLANT A
OPERATED COMMERCIALLY

	Example	Actual
Depreciation (see Table III)	$ 329.07	
Indirect labor (see Table VI)	5,040.00	
Fuel ($0.71 per million BTU)	300.00	
Utilities (estimated)	150.00	
Indirect factory materials (estimated)	200.00	
Insurance, property taxes, and miscellaneous (estimated)	1,000.00	
Office supplied (estimated)	50.00	
Total	$7,069.07	

TABLE VIII

UNIT COST OF NO. 2 CANS IN PLANT A
OPERATED COMMERCIALLY*

	Cost per Can	
	Example	Actual
Materials		
Raw materials	$0.030	
Cans, labels, and cartons	0.045	
Direct labor	0.148	
Overhead (including office expenses)	0.140	
Total factory cost	0.363	
Selling, distribution and administrative cost	0.015	
Total	$0.378	

*Based on annual production of 50,480 cans

TABLE IX

CAPITAL REQUIREMENTS FOR PLANT A
OPERATED COOPERATIVELY

	Example	Actual
Fixed Assets		
Land (estimated)	$ 600.00	
Building ($5.00 per square foot)	3,690.00	
Equipment (see Table IV)	1,772.41	
Working Capital		
Raw materials (one month)	42.00	
Cans, cartons, labels (for annual production)	2,271.60	
Labor (one-sixth of annual cost)*	840.00	
Other expenses for two months**	299.01	
Subtotal	9,515.02	
Plus 10% for contingencies	951.50	
Total Capital Requirements	$10,466.52	

*See Table VI (indirect labor).

**Table XI less indirect labor.

b. Fixed Assets. When plant A is operated cooperatively the same land, production equipment, and office equipment are required as when it is operated commercially. However, the building floor space can be decreased from 944 square feet to 738 square feet and the cost correspondingly reduced from $4,720 to $3,690. Less floor space is required because of the elimination of the storage area for finished goods.

The depreciation on the fixed assets of Plant A operated cooperatively is broken down in Table X.

c. Equipment Requirements. The equipment required to operate plant A cooperatively is the same as that required to operate plant A commercially. The equipment is itemized in Table IV.

d. Labor Requirements. In a cooperative plant only enough labor is retained to supervise the overall operation. Patrons prepare their own products and follow them throughout the canning operations. The plant manager should expect to give individual instruction and assistance to the patrons. Labor requirements for plant A operated cooperatively is summarized

TABLE X

DEPRECIATION ON THE FIXED ASSETS OF PLANT A OPERATED COOPERATIVELY

	Example Cost	Estimated Service Life	Example Depreciation per Year	Actual Cost	Actual Depreciation per Year
Land (estimated)	$ 600.00	--	---		
Building ($5.00 per square foot)	3,690.00	30 years	$123.00		
Plant equipment (see Table IV)	1,607.82	10 years	160.78		
Office fixtures (see Table IV)	164.64	16 years	10.29		
Total	$6,062.46		$294.07		

in Table V under Indirect Labor, and Annual Labor Cost is listed in Table VI under Indirect Labor. If the patrons do not cooperate in keeping the plant clean at all times, it may be necessary to employ a janitor.

e. Overhead Expenses. Table XI is self-explanatory.

TABLE XI

ANNUAL OVERHEAD EXPENSES FOR PLANT A OPERATED COOPERATIVELY

	Example	Actual
Depreciation (see Table X)	$ 294.07	
Indirect labor (see Table VI)	5,040.00	
Fuel ($0.71 per million BTU)	300.00	
Utilities (estimated)	150.00	
Insurance, property taxes, and miscellaneous (estimated)	1,000.00	
Office supplies (estimated)	15.00	
Total	$6,799.07	

f. Unit Cost Analysis. A summary of the unit cost of No. 2 cans in plant A operated cooperatively is given in Table XII. The cost can be cut approximately $0.01 by eliminating labels and cartons, which are useful but not essential.

If the canning plant operates as a nonprofit business, the patrons should be charged $0.185 per can. If the sponsoring agency subsidizes the operation, the cost to the patrons can be reduced.

B. Economics of Canning in Plant B

It is estimated that plant B using four, direct fired, No. 2 retorts can produce approximately 1,400 No. 2 cans per day on an eight-hour basis. If the plant operates six months per year (126 days), the annual production will be 176,400 No. 2 cans.

The capacity of plant B was determined from the unit times for the various canning operations given in Table XIII. The unit times appearing in this table are the averages for a large number of fruits and vegetables. The capacity of the plant could be more or less than that estimated depending on the actual unit times for the individual products being canned.

TABLE XII

UNIT COST OF NO. 2 CANS IN PLANT A OPERATED COOPERATIVELY*

	Cost per Can	
	Example	Actual
Materials		
Raw materials	$0.005	
Cans, labels, and cartons	0.045	
Overhead (including office expenses)	0.135	
Total Factory Cost	$0.185	

*Based on annual production of 50,480 cans.

TABLE XIII

ESTIMATED UNIT TIMES FOR PROCESSING 70 NO. 2 CANS IN PLANT B

Operation	Description	Time (Man Minutes)
1	Grading and preparing product	368
2	Straightening and rinsing cans	23
3	Preheating the product	37
4	Filling the cans	45
5	Exhausting cans and adjusting head space	10
6	Sealing (5 cans per minute)	14
7	Coding	27
8	Processing	55
9	Cooling and wiping cans	14
10	Labeling	30
	Total	623

1. Canning Plant B Operated Commercially

a. Capital Requirements. The capital requirements for plant B are summarized in Table XIV. The comments for plant A regarding working capital also apply to this plant.

TABLE XIV

CAPITAL REQUIREMENTS FOR PLANT B OPERATED COMMERCIALLY

	Example	Actual
Fixed Assets		
Land (estimated)	$ 1,200.00	
Building ($5.00 per square foot)	18,810.00	
Equipment (see Table XVI)	5,656.15	
Working Capital		
Raw materials (one month)	882.00	
Cans, cartons, labels for annual production	7,980.00	
Labor (one-sixth of annual cost)*	4,735.33	
Other expenses for two months**	679.67	
Inventory of finished goods**	24,078.60	
Subtotal	64,021.75	
Plus 10% for contingencies	6,402.18	
Total Capital Requirements	$70.423.93	

*See XVIII.

**Table XIX less indirect labor.

***One-half of annual production multiplied by unit cost (see Table XX).

b. Fixed Assets.

(1) Land. It is estimated that the cost of the land for plant B using direct-fired retorts will be $1,200. Since high-cost land is not required this price may be cut considerably in some locations. Space should be available for future expansion.

(2) Building. It is estimated that a building 45 feet wide by 75 feet long will be sufficient for the plant and warehouse areas of plant B operated commercially. A plant layout for this building is shown in Figure 5. At $5 per square foot of floor space, the building including office space will cost $18,810.

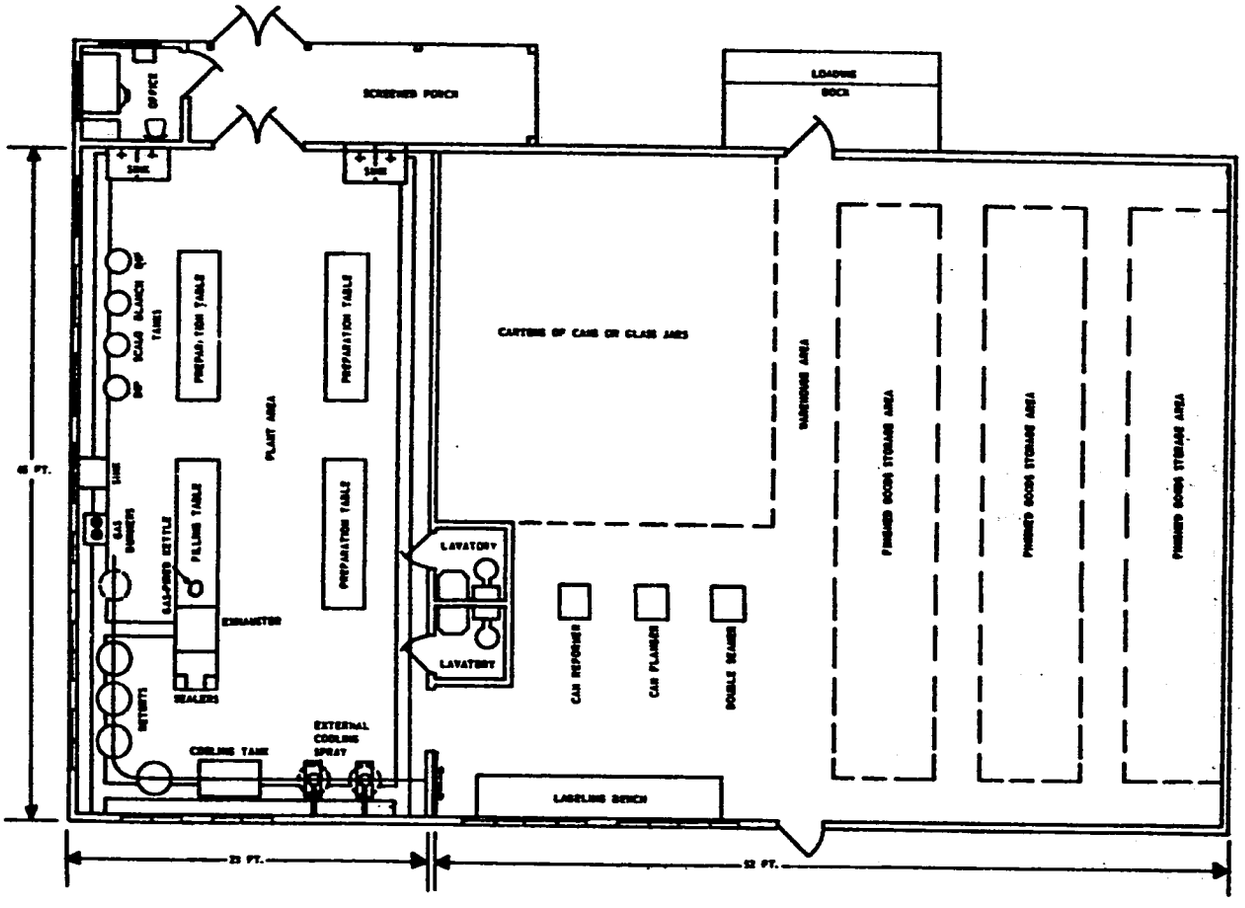

Figure 5. Layout for Plant B

(3) Production equipment. The cost of the equipment for plant B is $5,267.50. This cost is that of the equipment packaged in the United States for overseas shipment plus an estimated 12 per cent for overseas freight. Undoubtedly some of the equipment can be purchased locally thus saving on the actual cost of equipment.

(4) Office equipment and fixtures. New office equipment and fixtures for plant B will cost $388.64. If second hand equipment and fixtures are purchased, this cost can be cut substantially.

(5) Depreciation of fixed assets. Table XV is self-explanatory.

c. Equipment requirements. The equipment necessary for operating plant B is listed in Table XVI. The comments regarding equipment requirements for plant A also apply to this table.

d. Labor Requirements. Twenty-four workers are required to process canned goods in plant B when it is operated commercially. It is assumed that these workers will be employed only during the canning season. In addition, three indirect workers are necessary. In order to utilize the plant most effectively it will be necessary for part of the workers to begin their work shift considerably before the retort operators begin work. The hourly cost of the direct and indirect labor is given in Table XVII; the annual labor cost is summarized in Table XVIII.

e. Overhead Expenses. Table XIX is self-explanatory.

f. Unit Cost Analysis. The cost for manufacturing, selling, and distributing one No. 2 can in plant B operated commercially at full capacity is $0.275. A breakdown of this cost is given in Table XX.

2. Canning Plant B Operated Cooperatively

a. Capital Requirements. The capital requirements for plant B operated cooperatively are given in Table XXI. The comments regarding capital requirements for plant A operated cooperatively apply also to this plant.

b. Fixed Assets. Plant B operated cooperatively requires the same land, production equipment, and office equipment as when it is operated commercially. However, the cost of the building can be reduced from $18,810 to $15,840 because of the elimination of most of the finished goods storage area.

An analysis of the annual depreciation on the fixed assets of plant B operated cooperatively is given in Table XXII.

TABLE XV

DEPRECIATION ON THE FIXED ASSETS OF PLANT B OPERATED COMMERCIALLY

	Example Cost	Estimated Service Life	Example Depreciation per Year	Actual Cost	Actual Depreciation per Year
Land (estimated)	$ 1,200.00	--	--		
Building ($5.00 per square foot)	18,810.00	30 years	$ 627.00		
Plant equipment (see Table XVI)	5,267.50	10 years	526.75		
Office fixtures and equipment	388.64	16 years	24.29		
Total	$25,666.14		$ 1,178.04		

TABLE XVI

EQUIPMENT REQUIREMENTS FOR PLANT B

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
		PLANT EQUIPMENT				
1	4	No. 2 retort	$ 119.70	$ 478.80		
2	4	Extra insert crate for retort	10.80	43.20		
3**	4	Gas burner for retort, 89,000 BTU/hr	27.60	110.40		
4*	2	All-purpose dolly	23.50	47.00		
5	1	Power sealer, equipped for No. 2 cans	126.00	126.00		
6	1	Sealer change parts for No. 2-1/2 cans	10.20	10.20		
7	1	Power sealer, equipped for No. 10 cans	240.50	240.50		
8*	1	Exhauster, batch type, 3' x 4' x 15"	25.00	25.00		
9**	1	Gas burner for exhauster, 125,000 BTU per hour	32.00	32.00		
10**	1	Kettle, gas-fired, aluminum, 10-gallon capacity	317.00	317.00		
11*	3	Exhaust thermometer	2.75	8.25		
12*	2	Water hose, 25 feet	6.30	12.60		
13*	2	Nozzle for water hose	1.00	2.00		
14*	2 pair	Gloves, rubber, gauntlet	3.00	6.00		
15*	2 pair	Gloves, rubber	2.40	4.80		
16*	12 pair	Gloves, cotton	0.75	9.00		
17*	4	Table, galvanized, 33" x 117"	174.00	696.00		
18*	3	Two-compartment sink with legs	71.40	214.20		
19*	1	Cooling tank, 4' x 3' x 2'	35.00	35.00		
20	1	Can reformer				
21	1	Can flanger	1,200.00	1,200.00		
22	1	double seamer				

23	1	Flange reformer for No. 2 cans	11.50	11.50
24	1	Flange reformer for No. 2-1/2 cans	11.50	11.50
25	1	Flange reformer for No. 10 cans	11.50	11.50
26	2	Stock pot, aluminum, 10-gallon capacity	23.25	46.50
27	2	Cover for 10-gallon stock pot	4.75	9.50
28	2	Stock pot, aluminum, 5-gallon capacity	14.50	29.00
29	2	Cover for 5-gallon stock pot	4.00	8.00
30*	4	Dish pan, aluminum, 21-quart capacity	11.15	44.60
31*	3	Bucket	2.20	6.60
32*	3	Dipper, 1-pint capacity	1.00	3.00
33*	2	Dipper, 2-quart capacity	3.90	7.80
34*	3	Boning knife (meat), 5"	1.62	4.86
35*	12	Paring knife, 3-1/4"	1.20	14.40
36*	12	Fruit and vegetable knives	0.36	4.32
37*	3	Spoon, stainless steel	1.55	4.65
38*	3	Spoon, wooden handle	0.65	1.95
39*	1	Meat and bone saw, 24"	2.65	2.65
40*	3	Extra blade for meat and bone saw	0.30	0.90
41*	1	All-purpose scales	18.00	18.00
42*	6	Pot brush	0.70	4.20
43	5	Hot-lift tongs	0.75	3.75
44*	1	Garbage can with cover, heavy duty, 26-gallon capacity	11.75	11.75
45*	1	Garbage can with cover, 20-gallon capacity	3.60	3.60
46*	2	Cutting board, 12" x 18" x 2"	8.75	17.55
47*	3	Funnel	1.00	3.00
48	1	1/2-ton hand hoist	93.00	93.00
49	32 feet	Overhead track, standard	0.55/ft	17.60
50	1	Overhead track curve, standard	14.65	14.65
51	42	Bracket for standard overhead track	0.55	23.10
52	1	Trolley for standard overhead track	6.20	6.20
53	2	External cooling spray for No. 10 cans and glass jars	15.00	30.00

(Continued)

TABLE XVI (Continued)

EQUIPMENT REQUIREMENTS FOR PLANT B

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
54*	2 dozen	Jar dividers for retort	11.70	23.40		
55**	2	25,000 BTU burner for stove	7.20	14.40		
56*	2	107,000 BTU burner for blanch tank and scald tank	30.00	60.00		
57*	2	Scald tank and blanch tank, 18" diameter x 20" deep	20.00	40.00		
58*	2	Cold dip tank, 18" diameter x 20" deep	20.00	40.00		
59*	1	Sealer table, 30" x 33" x 34"	10.00	10.00		
60	6	Blanching basket, wire mesh	6.90	41.40		
61	1	Gauge tester	9.00	9.00		
62	1	Ventilating fan, 21,000 cubic feet per minute	239.00	239.00		
63*	6	Vegetable brush	0.50	3.00		
64	1	Juicer, motorized	70.80	70.80		
65	2	Meat and vegetable chopper	9.25	18.50		
66*	2	Can opener	1.20	2.40		
67	1	Carborundum stone	2.40	2.40		
68*	1	File	0.50	0.50		
69*	1	Clock	4.00	4.00		
70**	1	Labeling bench, 3' x 16'	25.00	25.00		
71	1	First-aid kit	5.00	5.00		
72*	3	Broom	1.00	3.00		
73	3	Mop	1.25	3.75		
		Subtotal, Plant equipment		4,703.13		

OFFICE EQUIPMENT AND FIXTURES

74*	1	Desk	90.00	90.00	
75*	1	File cabinet	32.00	32.00	
76*	1	Typewriter with table	175.00	175.00	
77*	2	Chair	25.00	50.00	
		Subtotal, Office equipment and fixtures		347.00	
		Total cost of plant equipment and office equipment and fixtures packaged for overseas shipment		5,050.13	
		Plus 12% for overseas freight (estimated)		606.02	
		Total cost of equipment and fixtures to purchaser		$5,656.15	

*Items probably can be purchased locally or fabricated in the canning plant.

**If gas is not available, oil burners could be used or a coal or wood stove could be substituted.

TABLE XVII

LABOR REQUIREMENTS FOR PLANT B
OPERATED COMMERCIALLY

	Number	Example Hourly Rate	Example Hourly Cost	Actual Hourly Rate	Actual Hourly Cost
Direct Labor					
Food preparation personnel	16	$0.75	$12.00		
Can straighteners, pre-heaters, etc.	4	0.75	3.00		
Sealer	1	1.00	1.00		
Coder	2	0.75	1.50		
Processor	1	1.25	1.25		
Total	24		$18.75		
Indirect Labor					
Plant supervisor	1	2.50	2.50		
Clerk	1	1.50	1.50		
Janitor	1	0.75	0.75		
Total	3		$ 4.75		

TABLE XVIII

LABOR COST PER YEAR FOR PLANT B
OPERATED COMMERCIALLY

	Work Hours per Year per Individual	Example Plant Cost per Hour	Example Plant Cost per Year	Actual Plant Cost per Hour	Actual Plant Cost per Year
Direct labor*	1008	$18.75	$18,836		
Indirect labor**	2016	4.75	9,576		
Total			$28,412		

*Labor paid for six months.

**Labor paid for twelve months.

TABLE XIX

ANNUAL OVERHEAD EXPENSES FOR PLANT B
OPERATED COMMERCIALLY

	Example	Actual
Depreciation (see Table XV)	$ 1,178.04	
Indirect labor (see Table XVII)	9,576.00	
Fuel ($0.68 per million BTU)	700.00	
Utilities (estimated)	300.00	
Indirect factory materials (estimated)	400.00	
Insurance, property taxes, and miscellaneous (estimated)	1,400.00	
Office supplies (estimated)	100.00	
Total	$13,654.04	

TABLE XX

UNIT COST FOR NO. 2 CANS IN PLANT B
OPERATED COMMERCIALLY*

	Cost per Can	
	Example	Actual
Materials		
Raw Materials	$0.030	
Cans, labels, and cartons	0.045	
Direct labor	0.107	
Overhead (including office expense)	0.077	
Total factory cost	0.259	
Selling, distribution and administrative cost	0.015	
Total	$0.274	

*Based on annual production of 176,400 cans

TABLE XXI

CAPITAL REQUIREMENTS FOR PLANT B
OPERATED COOPERATIVELY

	Example	Actual
Fixed Assets		
Land (estimated)	$ 1,200.00	
Building ($5.00 per square foot)	15,840.00	
Equipment (see Table XVI)	5,656.15	
Working Capital		
Raw materials (one month)	147.00	
Cans, cartons, labels (for annual production)	7,980.00	
Labor (one-sixth of annual cost)*	1,596.00	
Other expenses for two months**	663.17	
Subtotal	33,082.32	
Plus 10% for contingencies	3,308.23	
Total Capital Requirements	$36,390.55	

*See Table XVIII (indirect labor).

**Table XXIII less indirect labor.

c. Equipment Requirements. The same equipment used in plant B operated commercially can be used in plant B operated cooperatively. Equipment is itemized in Table XVI.

d. Labor Requirements. In a cooperative plant only enough labor is retained to supervise the overall operation. Patrons prepare their own products and follow them throughout the canning operations. The plant manager should expect to give individual instruction and assistance to the patrons. Labor requirements for plant B operated cooperatively are summarized in Table XVII under Indirect Labor, and Annual Labor Cost is listed in Table XVIII under Indirect Labor. If the patrons do not cooperate in keeping the plant clean at all times it may be necessary to employ a janitor.

e. Overhead Expenses. Table XXIII is self-explanatory.

f. Unit Cost Analysis. A summary of the unit cost of No. 2 cans in plant B operated cooperatively is given in Table XXIV. The cost can be cut approximately $0.01 by eliminating labels and cartons, which are useful but not essential.

TABLE XXII

DEPRECIATION ON THE FIXED ASSETS OF PLANT B OPERATED COOPERATIVELY

	Example Cost	Estimated Service Life	Example Depreciation per Year	Actual Cost	Actual Depreciation per Year
Land (estimated)	$ 1,200.00	--	---		
Building ($5.00 per square foot)	15,840.00	30 years	$ 528.00		
Plant equipment (see Table XVI)	5,267.50	10 years	526.75		
Office fixtures (see Table XVI)	388.64	16 years	24.29		
Total	$22,696.14		$1,079.04		

TABLE XXIII

ANNUAL OVERHEAD EXPENSES FOR PLANT B
OPERATED COOPERATIVELY

	Example	Actual
Depreciation (see Table XXII)	$ 1,079.04	
Indirect labor (see Table XVIII)	9,576.00	
Fuel ($0.68 per million BTU)	700.00	
Utilities (estimated)	300.00	
Indirect factory materials (estimated)	400.00	
Insurance, property taxes, and miscellaneous (estimated)	1,400.00	
Office supplies (estimated)	25.00	
Total	$13,480.04	

TABLE XXIV

UNIT COST OF NO. 2 CANS IN PLANT B OPERATED COOPERATIVELY*

	Cost per Can	
	Example	Actual
Materials		
Raw materials	$0.005	
Cans, labels, and cartons	0.045	
Overhead (including office expenses)	0.076	
Total Factory Cost	$0.126	

*Based on annual production of 176,400 cans.

If the canning plant operates as a nonprofit business, the patrons should be charged $0.126 per can. If the sponsoring agency subsidizes the operation, the cost to the patron can be reduced.

C. Economics of Canning in Plant C

It is estimated that plant C using three No. 3 retorts and two No. 2 atmospheric cookers can produce approximately 2,760 No. 2 cans per day.

If the plant operates six months per year (126 days) the annual production will be 347,760 No. 2 cans.

As a means of estimating the plant capacity, the unit times for the various canning operations shown in Tables XXV and XXVI were used. Labor saving equipment such as shellers, corn cutters, etc. were used in preparing the product. No information is available on the actual time for preparing the product; the grading and preparation time was arbitrarily assumed to be one-third that of a plant using no labor-saving equipment.

TABLE XXV

ESTIMATED UNIT TIMES FOR PROCESSING 185 NO. 2 cans
IN A NO. 3 RETORT IN PLANT C

Operation	Description	Time (Man Minutes)
1*	Grading and preparing product (975 minutes if labor-saving equipment is not used	325
2	Straightening and rinsing cans	60
3	Preheating the product	53
4	Filling the cans	120
5	Exhausting cans and adjusting head space	22
6	Sealing (5 cans per minute)	37
7	Coding	72
8	Processing	55
9	Cooling and wiping cans	37
10	Labeling	80
	Total	861

*Labor-saving equipment such as shellers, corn cutters, etc. used in preparing the product.

1. Canning Plant C Operated Commercially

a. Capital Requirements. The capital requirements for plant C are summarized in Table XXVII. The comments for plant A regarding working capital also apply to this plant.

TABLE XXVI

ESTIMATED UNIT TIMES FOR PROCESSING 70 NO. 2 CANS IN A NO. 2 ATMOSPHERIC COOKER IN PLANT C

Operation	Description	Time (Man Minutes)
1*	Grading and preparing product	123
2	Straightening and rinsing cans	23
3	Preheating the product	37
4	Filling the cans	45
5	Exhausting cans and adjusting head space	9
6	Sealing (5 cans per minute)	14
7	Coding	27
8	Processing	55
9	Cooling and wiping cans	14
10	Labeling	30
	Total	377

*Labor-saving equipment such as shellers, corn cutters, etc. used in preparing the product.

b. Fixed Assets.

(1) Land. It is estimated that the land on which to construct plant C can be purchased for approximately $2,000. Space should be available for future plant expansion.

(2) Building. It is estimated that a building containing approximately 6,486 square feet of floor area will be sufficient for plant C when operated commercially. A suggested plant layout for this building is shown in Figure 6. At a construction cost of $5 per square foot of floor space, the building will cost $32,430.

(3) Production equipment. The cost in the United States of the production equipment packaged for overseas shipment is $13,477.60. This figure includes an estimated 12 per cent allowance for overseas freight charges. By purchasing many of the smaller items locally a substantial saving in the cost of production equipment can be realized.

(4) Office equipment and fixtures. It is estimated that the office equipment and fixtures for plant C will cost $788.48. This

TABLE XXVII

CAPITAL REQUIREMENTS FOR PLANT C OPERATED COMMERCIALLY

	Example	Actual
Fixed Assets		
Land (estimated)	$ 2,000.00	
Building ($5.00 per square foot)	32,430.00	
Equipment (see Table XXIX)	14,236.09	
Working Capital		
Raw materials (one month)	1,738.80	
Cans, cartons, labels (for annual production)	15,649.20	
Labor (one-sixth annual cost)*	6,468.00	
Other expenses for two months**	1,040.29	
Inventory of finished goods***	38,253.60	
Subtotal	111,816.18	
Plus 10% for contingencies	11,181.62	
Total Capital Requirements	$122,997.80	

*See Table XXXI.

**Table XXXII less indirect labor.

***One-half of annual production multiplied by unit cost.

cost is that of new equipment packaged in the United States for overseas shipment plus an estimated 12 per cent allowance for overseas freight charges.

(5) Depreciation of fixed assets. Table XXVIII is self-explanatory.

c. Equipment Requirements. Table XXIX lists the equipment and fixtures necessary to operate plant C. The comments regarding equipment requirements for plant A also apply to this table.

d. Labor Requirements. Thirty-two direct workers and four indirect workers are needed to operate plant C commercially. The hourly labor cost is given in Table XXX and the annual cost is given in Table XXXI. The comments regarding labor requirements in plant B also apply to this plant.

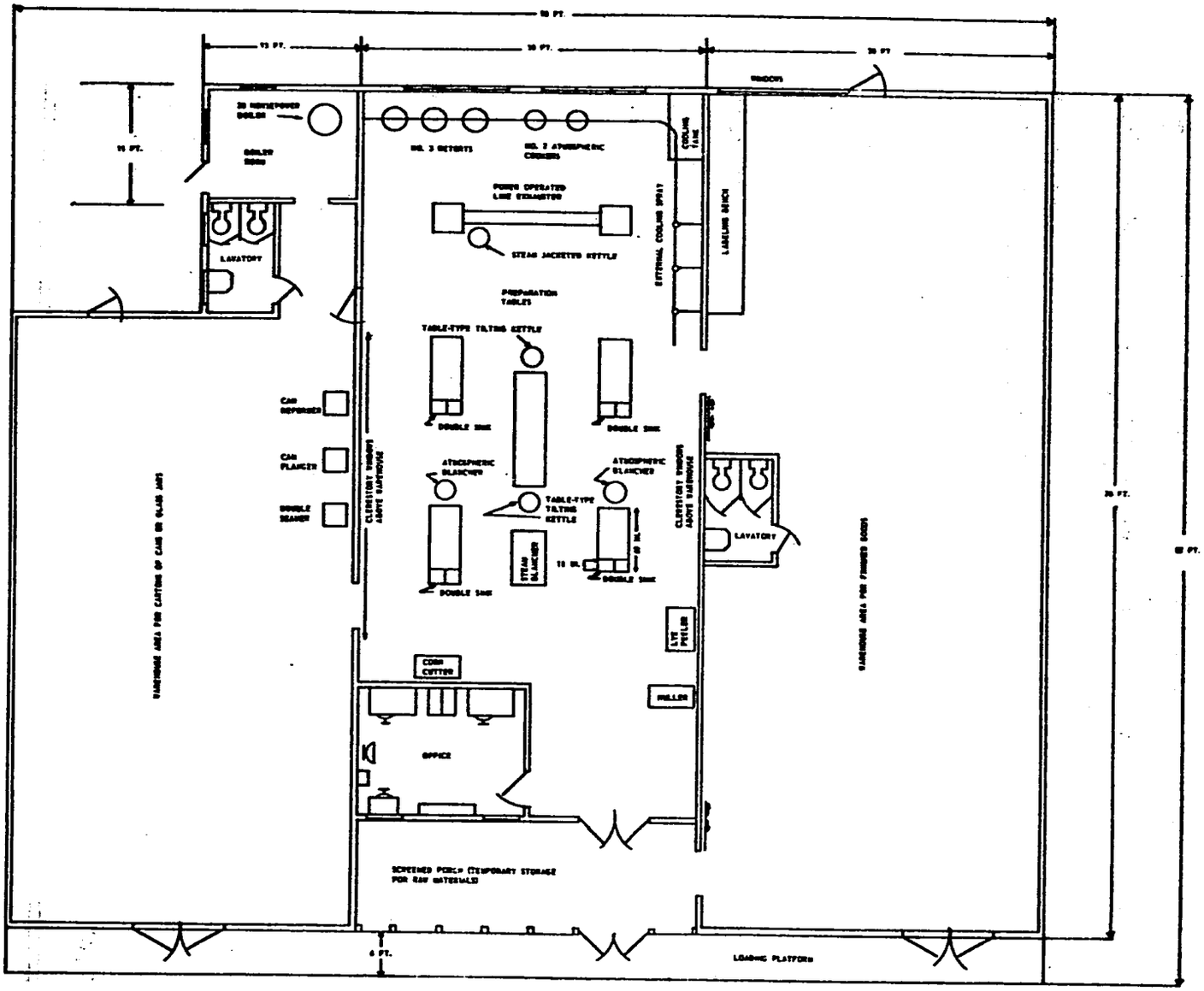

Figure 6. Layout for Plant C

TABLE XXVIII

DEPRECIATION OF THE FIXED ASSETS OF PLANT C OPERATED COMMERCIALLY

	Example Cost	Estimated Service Life	Example Depreciation per Year	Actual Cost	Actual Depreciation per Year
Land (estimated)	$ 2,000.00	--	--		
Building ($5.00 per square foot)	32,430.00	30 years	$1,147.67		
Plant equipment (see Table XXIX)	13,447.60	10 years	1,344.76		
Office fixtures and equipment (see Table XXIX)	788.48	16 years	49.28		
Total	$48,666.08		$2,541.71		

TABLE XXIX

EQUIPMENT REQUIREMENTS FOR PLANT C

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
		PLANT EQUIPMENT				
1	1	Boiler, 20 H.P., complete for firing with a suitable fuel. Installation includes: 15 foot smokestack complete with guy wires; automatic burner; and automatic water control	$2,521.80	$2,521.80		
2	--	Pipe, joints, and fittings for the installation	200.00	200.00		
3	3	No. 3 retort (with cooling spray if glass or No. 10 cans are to be processed)	195.00	585.00		
4	3	Extra insert crate for retort	15.00	45.00		
5	3	Pressure control valve (one per retort)	24.60	73.80		
6	3	Steam pipe line strainer (one per retort)	3.00	9.00		
7	1	Steam trap, high pressure	10.50	10.50		
8*	3	All-purpose dolly	23.50	67.50		
9	1	Can opener	10.25	10.25		
10	2	Power sealer, for No. 2 cans	126.00	252.00		
11	1	Power sealer for No. 10 cans (if large cans are processed)	240.50	240.50		
12	1	Sealer changer parts for No. 2-1/2 cans	10.20	10.20		
13	1	Sealer change part for No. 1 cans	10.20	10.20		
14	1	Exhauster, continuous, power operated	402.00	402.00		

15	2	No. 2 atmospheric cooker	51.00	102.00
16	2	Insert crate for atmospheric cooker	10.80	21.60
17	1	Steam blancher	153.00	153.00
18	46 feet	Overhead track, standard	0.55/ft.	25.30
19	1	Overhead track curve	14.65	14.65
20	56	Bracket for standard overhead track	0.55	30.80
21	1	Trolley for standard overhead track	6.20	6.20
22	1	1/2-ton hand hoist	93.00	93.00
23	1	Steam jacketed kettle, 30-gallon, aluminum or stainless steel	396.00	396.00
24	1	Steam regulating valve for 30-gallon steam kettle	30.00	30.00
25	2	Steam jacketed kettle, 10-gallon, stainless steel or aluminum	399.00	798.00
26	2	Kettle rack for table kettle	15.60	31.20
27	2	Steam regulating valve (10-gallon kettle)	24.60	49.20
28	2	Safety valve for 10-gallon kettle	9.00	18.00
29	3	Steam pipe line strainers (for kettles)	3.30	9.90
30	1	Steam trap (for kettle)	10.50	10.50
31	4	Table, galvanized, 33" x 69"	109.80	439.20
32	1	Table, galvanized, 33" x 117"	174.00	174.00
33*	4	Two-compartment sink	42.00	168.00
34*	1	Cooling tank, 3' x 6' x 3'	85.00	85.00
35*	4	Sink rack	9.60	38.40
36	1	Flange reformer for No. 2 cans	11.50	11.50
37	1	Flange reformer for No. 2-1/2 cans	11.50	11.50
38	1	Flange reformer for No. 10 cans	11.50	11.50
39	3	Stock pot, aluminum, 10-gallon capacity	23.25	69.75
40	3	Cover for 10-gallon stock pot	4.75	14.25
41	3	Stock pot, aluminum, 5-gallon capacity	14.50	43.50
42	3	Cover for 5-gallon stock pot	4.00	12.00
43*	8	Dish pan, aluminum, 21-quart capacity	11.15	89.20

(Continued)

TABLE XXIX (Continued)

EQUIPMENT REQUIREMENTS FOR PLANT C

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
44*	6	Bucket	2.00	12.00		
45*	6	Dipper, 1-pint capacity	1.00	6.00		
46*	6	Dipper, 2-quart capacity	3.90	23.40		
47*	6	Boning knife (meat), 5"	1.62	9.72		
48*	24	Paring knife	1.20	29.80		
49*	12	Fruit and vegetable knife	0.36	4.32		
50*	6	Long cook fork	2.00	12.00		
51*	12	Spoon, stainless steel	1.55	18.60		
52*	6	Spoon, wooden handle	2.00	12.00		
53*	1	Meat and bone saw, 24"	2.65	2.65		
54*	6	Extra blade for meat and bone saw	0.30	1.80		
55*	1	Portable platform scales, 1000-pound capacity	87.00	87.00		
56*	1	All-purpose scales	18.00	18.00		
57*	12	Pot brush	0.70	8.40		
58*	12	Work stool, metal, without back	5.60	67.20		
59	6	Hot-lift tongs	0.75	4.50		
60*	2	Garbage can with cover, heavy duty, 26-gallon capacity	11.75	23.50		
61*	1	Garbage can with cover, 20-gallon capacity	3.60	3.60		
62*	4	Cutting board, 12" x 18" x 2"	8.75	35.00		
63	6	Exhaust thermometer	2.75	16.50		
64*	1	Steam hose, 25'	24.75	24.75		
65*	2	Water hose, 25'	6.30	12.60		
66*	2	Nozzle for water hose	1.00	2.00		
67*	4 pairs	Gloves, rubber, gauntlet	3.00	12.00		
68*	4 pairs	Gloves, rubber	2.40	9.60		

69*	15 pairs	Gloves, cotton	0.75	11.25
70	1	Air compressor, 1/2 H.P.	248.40	248.40
71	1	Air-regulating valve	27.00	27.00
72	3	External cooling spray for No. 10 cans and glass jars	15.00	45.00
73*	2 dozen	Jar dividers for No. 3 retorts using glass jars	20.70	41.40
74*	2 dozen	Jar dividers for No. 2 cooker using glass jars	11.70	23.40
75	1 dozen	Metal tray bottoms (tote boxes with open bottoms)	7.15/doz.	7.15
76	1	Ventilating fan, 21,000 cubic feet per minute	239.00	239.00
77	1	Corn cutter	690.00	690.00
78	1	Scraping attachment corn cutter	36.00	36.00
79	1	Cutting head adjustment stand for corn cutter	81.00	81.00
80	1	Lye peeler-scalder	138.00	138.00
81	1	Extra rinse basket	21.60	21.60
82	1	Pea and bean huller	690.00	690.00
83	2	Extra sieve for pea and bean huller	51.00	102.00
84	2	Steam blancher and scalder	35.40	70.80
85	1	Corn silker	42.00	42.00
86	1	Food chopper, 1/2 H.P.	300.00	300.00
87	1	Juice puree attachment for food chopper	56.40	56.40
88	1	Can reformer		
89	1	Can flanger	1,200.00	1,200.00
90	1	Double seamer		
91	2	Gauge tester	9.00	18.00
92*	5	Funnel	1.00	5.00
93*	8	Vegetable brush	0.50	4.00
94*	2	File	0.50	1.00
95*	2	Clock	4.00	8.00
96*	2	Carborundum stone	2.40	4.80

(Continued)

TABLE XXIX (Continued)

EQUIPMENT REQUIREMENTS FOR PLANT C

Item Number	Quantity	Description	Example Price Unit	Example Price Total	Actual Price Unit	Actual Price Total
97*	1	First-aid kit	5.00	5.00		
98*	3	Broom	1.00	3.00		
99*	3	Mops	1.25	3.75		
100*	1	Labeling bench, 3' x 20'	32.00	32.00		
		Subtotal, plant equipment		12,006.79		
		OFFICE EQUIPMENT AND FIXTURES				
101*	2	Desks	90.00	180.00		
102*	2	File cabinet	32.00	64.00		
103*	4	Chair	25.00	100.00		
104*	1	Typewriter with table	175.00	175.00		
105*	1	Adding machine	125.00	125.00		
106*	2	Storage shelves	30.00	60.00		
		Subtotal, office equipment and fixtures		704.00		
Total cost of equipment and fixtures packaged for overseas shipment				12,710.79		
Plus 12% for overseas freight (estimated)				1,525.30		
		Total cost of equipment and fixtures for purchaser		$14,236.09		

*Items probably can be purchased locally or fabricated in the canning plant.

TABLE XXX

LABOR REQUIREMENTS FOR PLANT C
OPERATED COMMERCIALLY

	Number	Example Hourly Rate	Example Hourly Cost	Actual Hourly Rate	Actual Hourly Cost
Direct Labor					
Food preparation personnel	12	$0.75	$ 9.00		
Can straighteners and pre-heaters	3	0.75	2.25		
Can fillers	5	0.75	3.75		
Sealers	2	1.00	2.00		
Coders	3	0.75	2.25		
Processors	2	1.25	2.50		
Wipers and labelers	4	0.75	3.00		
Can former	1	1.25	1.25		
Total	32		$26.00		
Indirect Labor					
Plant supervisor	1	2.50	2.50		
Clerk	2	1.50	3.00		
Janitor	1	0.75	0.75		
Total	4		$ 6.25		

e. Overhead Expenses. Table XXXII is self-explanatory.

f. Unit Cost Analysis. In plant C operated at full capacity commercially the cost for manufacturing, selling, and distributing No. 2 cans amounts to $0.22 per can. A breakdown of this cost is given in Table XXXIII.

2. Canning Plant C Operated Cooperatively

a. Capital Requirements. The capital requirements for plant C operated cooperatively are given in Table XXXIV. The comments regarding capital requirements for plant A operated cooperatively also apply to this plant.

TABLE XXXI

LABOR COST PER YEAR FOR PLANT C
OPERATED COMMERCIALLY

	Work Hours per Year per Individual	Example Plant Cost per Hour	Example Plant Cost per Year	Actual Plant Cost per Hour	Actual Plant Cost per Year
Direct labor*	1008	$26.00	$26,208		
Indirect labor**	2016	6.25	12,600		
Total			$38,808		

*Labor paid for six months.

**Labor paid for twelve months.

TABLE XXXII

ANNUAL OVERHEAD EXPENSES FOR PLANT C
OPERATED COMMERCIALLY

	Example	Actual
Depreciation (see Table XXVII)	$ 2,541.71	
Indirect labor (see Table XXX)	12,600.00	
Fuel ($0.65 per million BTU)	1,000.00	
Utilities (estimated)	450.00	
Indirect factory materials (estimated)	500.00	
Insurance, property taxes, and miscellaneous (estimated)	1,600.00	
Office supplies (estimated)	150.00	
Total	$18,841.71	

TABLE XXXIII

UNIT COST FOR NO. 2 CANS IN PLANT C
OPERATED COMMERCIALLY*

	Cost per can	
	Example	Actual
Materials		
Raw materials	$0.030	
Cans, labels, and cartons	0.045	
Direct labor	0.075	
Overhead (including office expense)	0.054	
Total factory cost	0.205	
Selling, distribution and administrative cost	0.015	
Total	$0.220	

*Based on annual capacity of 347,760 cans.

b. Fixed Assets. When plant C is operated cooperatively the same land, production equipment, and office equipment is required as when it is operated commercially. However, the building cost can be decreased from $32,430 to $21,429.97 becase of the elimination of most of the finished goods storage space.

A breakdown of the annual depreciation on the fixed assets of plant C operated cooperatively is given in Table XXXV.

c. Equipment Requirements. The same equipment is required to operate plant C cooperatively as is required to operate it commercially. An itemized list of equipment is given in Table XXIX.

d. Labor Requirements. In a cooperative plant only enough labor is retained to supervise the overall operation. Patrons prepare their own products and follow them throughout the canning operations. The plant manager should expect to give individual instruction and assistance to the patrons. Labor requirements for plant C operated cooperatively are summarized in Table XXX under Indirect Labor, and Annual Labor Cost is listed in Table XXXI under Indirect Labor. If the patrons do not cooperate in keeping the plant clean at all times it may be necessary to employ a janitor.

e. Overhead Expenses. Table XXXVI is self-explanatory.

TABLE XXXIV

CAPITAL REQUIREMENTS FOR PLANT C
OPERATED COOPERATIVELY

	Example	Actual
Fixed Assets		
Land (estimated)	$ 2,000.00	
Building ($5.00 per square foot)	21,429.97	
Equipment (see Table XXIX)	14,236.09	
Working Capital		
Raw materials (one month)	289.80	
Cans, cartons, labels (for annual production)	15,649.20	
Labor (one-sixth of annual cost)*	2,100.00	
Other expenses for two months**	968.06	
Subtotal	56,672.12	
Plus 10% for contingencies	5,667.21	
Total Capital Requirements	$62,339.33	

*See Table XXXI (indirect labor).

**Table XXXVI less indirect labor.

f. Unit Cost Analysis. A summary of the unit cost of No. 2 cans in plant C operated cooperatively is given in Table XXXVII. As in plants A and B, the cost can be decreased approximately $0.01 by eliminating labels and cartons, which are useful but not essential.

III. SELECTION OF PLANT SITE

A. General Considerations

A canning plant should not be located at a particular site merely because the land can be obtained cheaply. Rather, many factors should be considered and carefully evaluated before the ideal site is selected. Any local ordinances pertaining to the operation of industrial plants should be known. An adequate supply of raw materials of acceptable quality and an adequate and dependable supply of water should be available at the proposed canning plant. Sufficient labor must also be obtainable from the area surrounding the canning plant. Good transportation facilities and sewage and

TABLE XXXV

DEPRECIATION ON THE FIXED ASSETS OF PLANT C OPERATED COOPERATIVELY

	Example Cost	Estimated Service Life	Example Depreciation per Year	Actual Cost	Actual Depreciation per Year
Land (estimated)	$ 2,000.00	--	--		
Building ($5.00 per square foot)	21,429.97	30 years	$ 714.33		
Plant equipment (see Table XXIX)	13,447.60	10 years	1,344.76		
Office fixtures and equipment (see Table XXIX)	788.48	16 years	49.28		
Total	$37,666.05		$2,108.37		

TABLE XXXVI

ANNUAL OVERHEAD EXPENSES FOR PLANT C
OPERATED COOPERATIVELY

	Example	Actual
Depreciation (see Table XXXV)	$ 2,108.37	
Indirect labor (see Table XXXI)	12,600.00	
Fuel ($0.65 per million BTU)	1,000.00	
Utilities (estimated)	450.00	
Indirect factory materials (estimated)	500.00	
Insurance, property taxes, and miscellaneous (estimated)	1,600.00	
Office supplies (estimated)	50.00	
Total	$18,308.37	

TABLE XXXVII

UNIT COST OF NO. 2 CANS IN PLANT C
OPERATED COOPERATIVELY*

	Cost per Can	
	Example	Actual
Materials		
Raw materials	$0.005	
Cans, labels, and cartons	0.045	
Overhead (including office expenses)	0.053	
Total factory cost	$0.103	

*Based on annual capacity of 347,760 cans.

waste disposal facilities are essential. Also required is an adequate fuel and power supply. Finally, it is recommended that the site for the proposed canning plant have adequate land available for future expansion purposes.

B. Raw Materials

In selecting the site for a proposed canning plant an adequate and dependable supply of raw materials should be available in the immediate vicinity. The supply should be sufficient to keep the plant operating for at least half of the time. If the district under consideration is not capable of producing the volume of raw materials needed, expenditures for a building and equipment are not justified.

It should be determined whether the quality of the raw materials is suitable for canning purposes. Some fruits and vegetables, although acceptable for fresh market, are not suitable for canning.

The success of a canning plant depends as much on continuous operations as on the maximum capacity. This is necessary in order to decrease the cost of operating the plant per unit of produce canned. Figure 7 shows the approximate harvesting season for a number of fruits and vegetables grown in the United States in the state of California. A chart similar to this one could be used as a guide in selecting the raw products to be canned.

Especially when fruits and vegetables are canned, there is no question as to the advantages of being located near the raw materials. Advantages of being located adjacent to the source of raw products are as follows:

1. The fruits and vegetables can be harvested at the best time in order to assure a quality product.

2. There is a decrease in the injury from handling of the product and in the deterioration changes after gathering the product.

3. Transportation costs of the raw materials are reduced.

4. It is not necessary to use expensive containers to transport the product.

When the source of raw material is adjacent to the cannery, the producer very often makes frequent delivery of products. This results not only in better quality products but also in a much closer relationship between the canner and producer. Under such conditions, the canner is better able to explain his requirements for raw materials, and the producer is more likely to understand them.

In many instances, the canning plant contracts with the grower for his season's crop. Sometimes the canner even furnishes the seeds. In other instances, the canner buys raw materials from the grower on a batch basis.

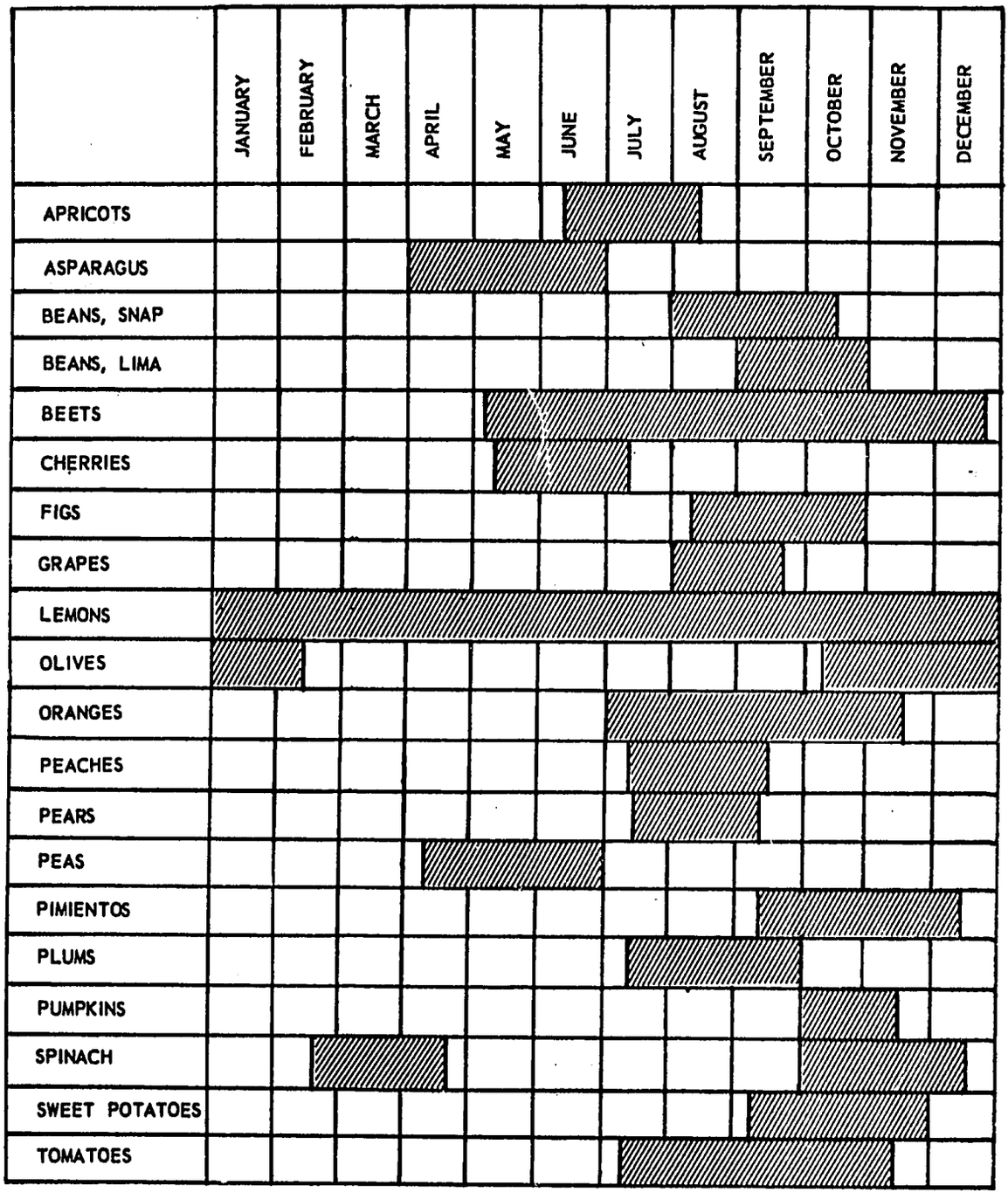

Figure 7. Harvesting Seasons in the State of California, U.S.A.
(Based on Catalog of Food Machinery and Chemical Corporation)

C. Water Supply

In selecting a site for a canning plant, the availability of water should be considered after the availability of raw products has been determined. This is true because large quantities of water are needed in the canning operations. The most important uses of water are listed below:

1. Cooling of processed cans,
2. Steam generation,
3. Preparation of brine, syrups, etc.,
4. Blanching,
5. Cleaning and preparation of raw materials, and
6. Cleaning of equipment, floors, walls, etc.

In general, fruit and vegetable canning plants will require more water than meat or fish canning plants. Approximately 1-1/2 to 2-1/2 gallons of water are required for each No. 2 can of peas packed in the United States today.

All water used around a canning plant should be of good drinking quality, free from any possibility of sewage contamination, and low in mineral salts, especially sulfates and iron salts. "Hard" water containing appreciable quantities of calcium and magnesium salts also should be avoided, not only because of any possible effects on the product but also because of the damage to the boiler tubes. If the water available at the canning site does not meet these requirements, it can possibly be made fit for use by the installation of a water softener. Experienced engineers should be consulted on this problem.

Water for a canning plant may be obtained from wells, lakes, rivers, or municipal water supplies. In many instances, well water requires no purification whatsoever. However, surface water drawn from lakes and rivers almost always requires purification. Municipal water supplies can be of any quality, depending on their source and the treatment used by the municipality. They are almost always free of bacterial impurities. In all cases, a competent bacteriologist should analyze the water supply to determine what purification is necessary.

D. Labor Supply

An important factor to consider in selecting a site for a proposed canning plant is the availability of an adequate supply of labor. Unlike many types of businesses, canning plant labor demands fluctuate with the season. To attract and to hold satisfactory labor can be exceedingly difficult. Small towns and rural communities where there are no large industries often provide a good source of seasonal labor. If sufficient labor cannot be obtained otherwise, it may be necessary to bring in outside help and to provide living accomodations. If suitable dwellings have to be erected by the canning plant, an additional item is added to the capital requirements of the new plant.

During the busy canning season a fixed work day is often impractical for commercial plants. The raw material may be brought to the plant at more or less irregular intervals and, since it is extremely perishible, it must be processed as soon as possible.

As a rule, key personnel such as plant superintendent and clerk are retained for a full twelve month work year. Cooperative canning plants in the United States are often managed by teachers who instruct high school classes in agriculture or home economics during the inactive canning seasons

E. Transportation Facilities

The proposed site for a canning plant should be located close to good transportation facilities. The types of transportation which will be needed, e.g., rail, water, and public highways, should be carefully considered. For many canned products, freight rates may be the determining factor as to whether an item can be packaged and marketed profitably.

Many small canning plants make the mistake of not considering transportation facilities for future expansion. As the canning plant grows the importance of transportation becomes greater. For this reason transportation facilities should be considered very carefully in selecting the site for a canning plant.

F. Sewage and Waste Disposal

The sewage and waste disposal facilities of a proposed canning site should be evaluated carefully. As a rule the canning plant should be located on flat land where there is ample provision for drainage facilities. The yards of the canning plant should be hard with sufficient slope for good drainage . In general, the sewage can be dumped in wells, ditches, or municipal sewage disposal systems. Wells or ditches can be used if the soil is porous and the amount of disposal is relatively small. If local municipal sewage disposal systems are available it should be determined whether these systems are adequate to handle the wastes of the proposed plant. An expert on sewage and waste disposal should be consulted on this important problem.

G. Fuel and Power Supplies

Fuel and power supplies should be available at a reasonable rate. If gas is used in the plant, the supply should be large enough to meet the present and future needs.

Electric power is very desirable in operating a successful canning plant. A careful check should be made to see that adequate power is available at all times. Capacity of the power lines for future expansion of the plant facilities should also be considered.

It is suggested that local representatives of the utility companies be contacted to determine whether the services are adequate.

H. Land Available for Expansion

In selecting a site for a canning plant, sufficient land should be available for future expansion. Although a small site of probably half an acre is sufficient for a start, availability of adjoining property to expand to seven or eight acres should be considered.

IV. PLANT CONSTRUCTION

A. General Considerations

After the site for the canning plant has been selected, the type building to be constructed should be considered. This is influenced somewhat by the variety of products to be canned. Ideally, a building should not be erected and then adapted for canning purposes. Rather the space should be arranged and the utilities installed to provide an optimum arrangement for efficient operations.

A single-story building is most practical for a small canning plant. The single floor facilitates the work of the superintendent because it is possible for him to have the entire canning plant under direct observation at all times. The use of a single floor also facilitates the handling of materials from one operation to the next.

The actual size of the building should be determined by the amount of produce to be canned and the type and amount of equipment to be used. Considerations should be given to future expansion of the plant. A rectangular building is most desirable because its floor space can be used to best advantage in arranging equipment. However, any space having the required number of square feet could be used.

Almost any type of construction can be used for a canning plant. However, fireproof buildings are strongly recommended. Because of the steam released during processing, canning plants are usually humid. Hence, the materials of construction should not be harmed by water. The walls and floors should be designed to facilitate easy washing.

While it is desirable to construct a new building especially designed for canning purposes, used buildings that can readily be converted are satisfactory. Suitable buildings for steam-operated canning plants include abandoned bottling works, bakeries, laundries, garages, creameries, and other buildings where steam facilities have already been installed. Buildings adjacent to steam facilities can also be used.

Several special features should be incorporated into the design of a canning plant. These features are pointed out in the following sections. However, it is recommended that a person experienced in the construction of buildings be consulted.

B. Floors

The floor in the processing area and boiler room of a canning plant should be constructed of concrete while the floors in the other areas can be constructed of wood. In the processing area the concrete floor should be laid in a single piece and not in sections, as it is customary for sidewalks and similar construction. Hand trucks with metal wheels would otherwise soon cause the floor to break and disintegrate at the points of union between the various sections. The floors should slope at about 1/4 to 1/8 of an inch per foot, but all parts of the floor should be within 20 feet of a drain so that it will not be necessary for waste to flow a great distance. The top inch of concrete may be treated with one of the waterproofing compounds which make it hard and resistant to acid attack. It also may be treated with sodium silicate to reduce the refractory characteristics. Some canning plants are finding that a concrete floor surface with a hardening compound and with iron filings included in the concrete gives a good surface. In any instance, good floors are a necessity for sanitary operations.

C. Walls and Ceilings

The walls can be made of almost any material which is not harmed by water. It is important that they be smooth and easily cleaned. They should be finished with portland cement plaster up to about six feet from the floor. This finish must be smooth, waterproof, and easily cleaned. The rest of the walls must be as smooth as construction will permit and painted.

A light colored ceiling is recommended. All ceilings should be high and no ceiling should be placed on overhead joists to form an attic as good ventilation is essential in order to maintain a reasonably cool and odor-free atmosphere. A minimum ceiling height of 10 feet is required to allow for clearances necessary where a track and hoist are used over retorts. Some operators feel that this height is not sufficient. Generally, ceiling heights of at least 12 feet are recommended.

D. Windows

Sufficient windows should be provided so that artificial lighting will not be necessary during the daylight hours. The windows should be arranged to take advantage of the prevailing winds in order to provide good cross ventilation. The windows in the food preparation areas may be either casement or double-hung types. The window area should not be less than 25 per cent of the total floor area in the plant. For good light distribution, it is desirable to have windows located on both sides of the

food preparation area. Screens must be provided on all windows that are to be opened. Window sills should be arranged to permit the incoming fresh air to enter as low as possible and yet to be above the table tops.

E. Doors

The number of doors provided should conform to any local codes regulating the number of doors required for a public building. Each external door should be hinged and mounted in such a way that screens may be attached to the door openings. Sliding doors can be used to save space.

F. Roof

The roof should be self-supporting; posts in the processing area are objectionable. Roof supports over retorts and overhead tracks should be designed to support the tracks and a concentrated load on the hoists of 500 pounds. The roof is usually supported by clear-span wood trusses. These may be of light-truss rafters spaced about two feet apart with the roof decking nailed directly on them or of heavier built-up trusses (wood or metal) with light beams between them to carry the roof decking. The latter type is more expensive and must have light beams between trusses to carry tracks. It has, however, few exposed members to collect dust and retard air circulation.

G. Lighting

Good lighting is essential especially in the grading operation. Natural daylight will provide most of the lighting normally used. A plant built in an east to west direction is much better than one oriented north and south. Plenty of long windows placed near the ceilings are desirable to provide maximum light in the center of the plant. In addition, sky lights should be provided in the roof.

Artificial lighting will be required at times during the day and for night operation. The artificial lighting should be arranged so that each operation will be properly lighted. The intensity of light required varies in the different parts of the canning plant. In the food grading area an illumination intensity of 100 foot-candles is recommended, 30 to 35 foot-candles is recommended in the preparation room, 20 foot-candles is recommended in the processing room, and 10 foot-candles is satisfactory in the storage and warehouse areas.

Lighting is an item that does not remain constant but is influenced by dirty floors, dirty lamps, dirty reflectors, and walls that need painting. Consequently, it is good policy to design the lighting requirements for 50 per cent more than is recommended.

H. Heating and Ventilating

If the canning plant is to be occupied during cold weather, it should be heated for the comfort of the plant personnel. Generally, a temperature

of 70° F. is adequate. Heaters should be located where they will blow against cold air entering the building through frequently used outside doors, etc.

Mechanical ventilation of the plant is necessary during the summer months. It is recommended that the air in the plant be changed at least once every minute. A fan should be located in the end of the building and adjacent to the retorts and tunnel exhaust. Because the canning plant floor is usually wet, the movement of the air across the floor tends to cool the air through rapid evaporation of moisture.

I. Floor Drains

Drains in the floor should be of the open or trough type. When the drains cross walk-ways they should be covered with a removable cover that is flush with the floor. Metal grating or treated wood may be used. Drain covers should be easily removed for cleaning. Deep drains are not recommended. Drains that are designed according to the cross section shown in Figure 8 and slope 1/4-inch per foot have proven very satisfactory in canning plants in the United States. However, in some plants the drain should be wider than shown in Figure 8 to facilitate cleaning.

J. Sewage Disposal

A septic tank should be installed where there are no available sewers, and an adequate tile drainage field provided. As mentioned earlier, an expert on sewage and waste disposal should be consulted when the canning plant is designed.

K. Auxiliary Space

1. Boiler Room

In some canning plants, the boiler room is situated with a 25-foot space between it and the canning plant. In other plants, the boiler is within the main building. When this is done a fire wall should be built to isolate the boiler room. The minimum-size boiler room is 8 feet by 10 feet for vertical boilers. The ceiling height of the boiler room is important. The space provided above the boiler should be approved by a local insurance company and fire safety inspector. All floors and frames in the boiler room should be fire resistant (covered with sheet metal or asbestos). Ceilings in the boiler room should be covered with 3/16-inch sheet asbestos. Masonry or cement walls are recommended for their fireproof qualities. If the boiler room is located in the same building as the canning plant, a fire door should be provided separating the two areas. As a safety precaution, the fire door should be in a remote area away from equipment.

If possible, the type of boiler to be used for the canning plant should be selected first and then the boiler room designed and constructed to properly house it.

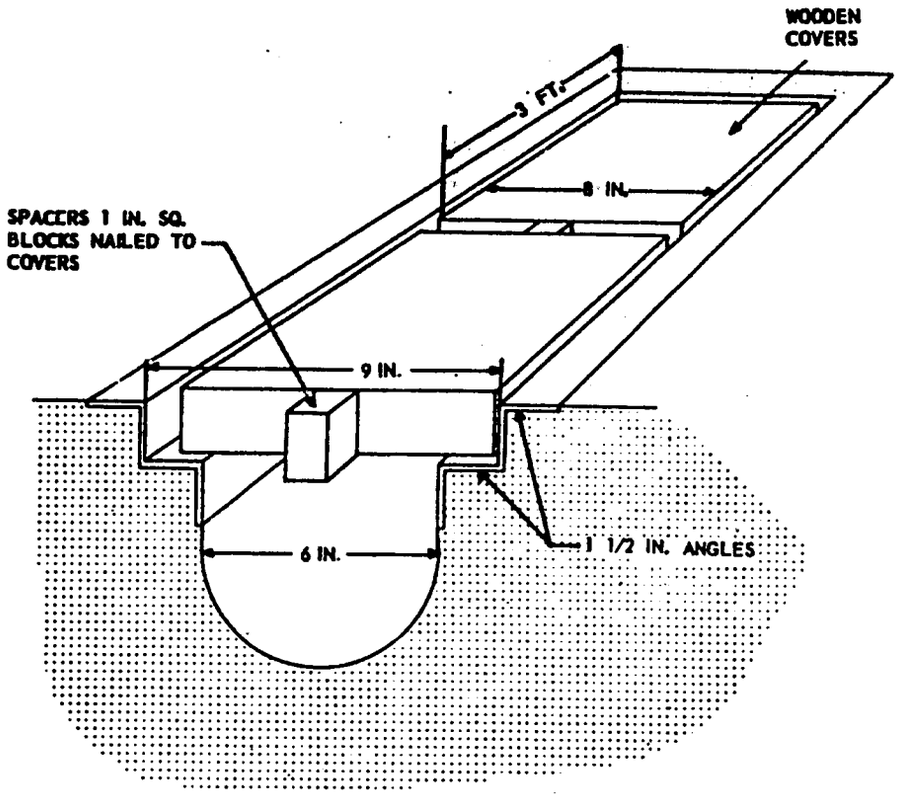

Figure 8. Cross-Section View of Floor Drain Used in Canning Plant. The Cover Shown is Made of Wood and Must be Treated to Prevent Rot.

2. Cold Storage Area

Some canning plants have found it profitable to operate freezing and cold storage areas. This is true because during the rush season the canning plant is often over-supplied with fruits and vegetables and raw materials sufficient for five or six days operation of the canning plant. Much of this material will spoil unless cold storage facilities are available. If the canning plant is to process meat, it is necessary that cold storage areas be available to properly age the product. In countries having cold winters it is possible to slaughter the animals in the winter months and thus it is not necessary to use cold storage facilities in small canning plants. However, if the animals are slaughtered in the summer months, cold storage facilities will be necessary.

Fish can be stored for a short time in cold storage areas. However, if the fish are stored for a longer period of time, freezing facilities are required. While the fish are frozen the quality of the product for canning purposes is not affected.

3. Warehouse

No set rule can be laid down for sizes of different areas for storing incoming products and finished goods because of the wide variation in space required for different types of operations. However, there are some so-called "rule-of-thumb" bases which can be applied to develop approximate storage requirements. For instance, there seems to be the thought among better operators that there should be receiving room space enough to store double the amount of raw products which might be expected for one day's production. Ceilings in this area should be high enough to permit over-the-road trucks to back in if necessary.

With respect to warehouse storage space, it is generally felt that enough space must be provided to store approximately 50 per cent of the anticipated annual capacity of the plant and also the annual supply of cans. Finished goods should not be stacked higher than six feet; unfilled cans can be stacked to the ceiling. The warehouse may be a separate unit, as it usually is in seasonal canning operations, or it may be part of the same building that houses the processing area. In any event, the foremost consideration regarding this location in relation to the plant is ease of movement of the finished product from the processing section to the storage area.

The warehouse area may be constructed of a wide variety of materials. Wood, brick, concrete, and metal sheeting on steel frames are commonly used. Wood-frame buildings offer the advantage of relatively low initial cost, but they require more in maintenance over a period of years than many other type buildings. They are fire hazards, and, unless the buildings are insulated, the cost of heating is high and the maintenance of uniform temperature is difficult. Brick and concrete construction has

many advantages. Such buildings have long useful life expectancy and low maintenance cost. They are easy to heat, and uniform temperatures are more readily maintained within them. The great disadvantage of brick and concrete construction is the high initial cost. Tile and steel frames are used frequently in modern warehouse construction. Like brick and concrete it has the advantages of low maintenance cost, long useful life, and ease in maintaining correct even temperatures. It too requires a higher initial investment than wooden or metal sheeting warehouses. Metal sheeting on steel frames requires a relatively low investment and may be erected quickly. Galvanized steel is commonly used; in recent years, many "quonset" hut buildings, utilizing this construction, have been erected as canning plant warehouses. Buildings of metal sheeting on steel frames have the disadvantages of comparatively short usable life and greater maintenance cost. Unless insulated, they are difficult to heat in cold climates, and their interior temperatures are subject to relatively rapid changes.

4. Sanitary Facilities

Lavatories for both men and women should be provided in the canning plant. The lavatories should contain a toilet and a sink. The plumbing must meet all sanitary regulations, and the toilets and sinks must be maintained in a sanitary condition. Plant personnel should be encouraged to wash their hands in the sinks in the lavatories and thus keep soap away from the raw materials in the food wash sinks.

L. Safety

In constructing the plant consideration should be given to the safety of the workers. The following points should be considered:

1. See that stairways and entries are well lighted.
2. Equip platforms and stairs on which people walk or work with hand rails that are securely fastened at a height for convenient use.
3. Locate electrical receptacles close to equipment.
4. Place fire extinguishers at convenient locations in the plant and check them regularly to see that they are properly charged.
5. Place a first-aid kit in a centralized location in the plant.

V. PLANT LAYOUT

A. General Considerations

When designing an efficient food processing plant, major consideration should be given to the location of equipment so that the raw products enter the plant and flow through the processing lines quickly and with a minimum of lost motion and delay due to high capacity in one part of the plant and low capacity in another part.

The receiving area should be conveniently located with reference to rail and road transport and the raw material preparation section of the plant.

The preparation area should be large enough so that the equipment can be arranged to best advantage and the quality and quantity of the output does not suffer.

In the precooking area, the atmospheric blancher should be located adjacent to the preparation area, over a floor drain, and convenient to a sink and table. A kettle should be located near the preparation table, but it should be in the line of movement toward the cooking area. A small table should be placed beside the kettle for use in filling, etc.

When a batch exhauster is used, tables similar to the preparation tables may be used for filling the cans. When a tunnel exhaust is used for exhausting cans, a small table should be located at the entry end of the exhaust for filling.

The tunnel exhaust should be placed near the end of the room, thus separating the cooking and the cooling areas from the rest of the plant as shown in Figure 6.

Sealers may be mounted on a stationary table placed at the discharge end of the exhaust or on a table mounted on casters which can be moved about the plant as needed.

In the processing area, the retorts should be placed near the end of the plant, over a drain, and underneath an overhead track which moves insert crates of cans from the sealers to the retorts and then to the cooling tank. The retorts are usually in line along a wall. Sufficient space must be left between the retorts and the wall to allow for pipes, etc. and for access to the rear of the retorts.

A tank for cooling tin cans should be located under the overhead track and usually against a wall. It should be convenient to a drain. External cooling sprays for cooling glass jars or large tin cans should be located near the retorts and under the overhead track. Floor drains must be located underneath the spray units.

The warehousing or storage area must be located away from the retorts and steam boiler because excessive heat will deteriorate the canned goods.

It is desirable to provide separate office space in a canning plant. In addition, there should be dressing rooms and lavatory facilities for men and women, properly separated from the canning area.

The boiler room should be in a separate building adjacent to the canning plant or separated from the processing area by fire walls.

In designing a canning plant for a particular product, undoubtedly several possible floor plans will need to be made showing in detail the placement of all equipment and the continuity of expected operations. Since the sequence of operations varies somewhat with different products, the floor plans should be checked to determine which one would best accomodate the particular foods to be canned.

B. Canning Plant Layouts

Figures 4, 5, and 6 give plant layouts for canning plants A, B, and C.

Plant A utilizes only elementary utensils similar to equipment commonly used for home canning.

Plant B is equipped with direct-fired retorts which hold 70 No. 2 cans. These retorts are used for both pressure and atmospheric cooking. Most operations in plant B are carried out by hand.

Plant C is equipped with a boiler and steam-heated retorts which hold 185 No. 2 cans and steam-heated atmospheric cookers which hold 70 No. 2 cans. In this plant, machinery is used to speed up many of the individual operations.

These plants were designed as all-purpose units. It may be desirable to limit the types of products to be canned in some plants. Also, the need for mechanized equipment will be determined by the cost of labor, the amount of a given product to be canned, etc. In general, steam-heated cooking units are preferable to direct-fired ones. The capacity of the three types of plants can be varied within wide limits.

VI. EQUIPMENT DESCRIPTIONS

A substantial part of the equipment used in canning plants is more-or-less specialized. All unusual or specialized equipment recommended for plants A, B, or C are described and illustrated in this section of this manual. The approximate prices of the equipment will be found with the dividual plant descriptions in Tables IV, XVI, and XXIX of this manual. In installing and operating this equipment, the recommendations of the manufacturer should be followed closely.

Can Reformer

When cans are purchased in collapsed form, it is necessary that equipment be available for reforming the cyllindrical shapes of the cans. This is done by a can reformer. The hand-operated can reformer (Figure 9) will reform approximately seven cans per minute; the power-operated can reformer (Figure 11) will reform approximately 10 to 14 cans per minute.

Can Flanger

After collapsed cans have been reformed, it is necessary that flanges be placed on the ends of the cans. This is done by equipment known as can flangers. The hand-operated equipment (Figure 10) will flange approximately seven cans per minute; the power-operated equipment (Figure 12) will flange approximately 10 to 14 cans per minute.

Double-Seamer

A double-seamer or can sealer is used to secure the ends on the cans. A hand-operated double-seamer (Figure 37) can secure ends on three or four cans per minute; a power-operated double-seamer (Figure 13) can secure the ends on approximately 10 cans per minute.

Flange Reformer

It is recommended that a can flange reformer (Figure 15) be available in a canning plant for each size can that is used. The flange reformer straightens flanges of cans that have been bent and would otherwise be unusable.

Scales

All-purpose scales are useful in canning plants for weighing various products such as those canned by weight. They have a capacity of sixty pounds. Portable platform scales (Figure 16) are used to weigh heavier objects. They have a capacity of 1,000 pounds.

Galvanized Table

Galvanized iron is a material often used for table tops (Figure 18); however, the zinc it contains affects some food. Care must be taken to keep cut surfaces of fruits and acid vegetables from coming in contact with it. Therefore, cutting boards (Figure 19) should be used whenever fruits and vegetables are cut on the tables. Stainless steel tops are more desirable from this standpoint; however, they are much more expensive.

Cutting Board

A cutting board (Figure 19) made of the best quality hardwood should be available when meats are processed in a canning plant and when galvanized tops are used on the preparation tables.

Two-Compartment Sink

At least one two-compartment sink having hot and cold water is recommended in all canning plants for washing the raw materials. The sinks can be placed on sink racks and mounted on the preparation tables (Figure 18),

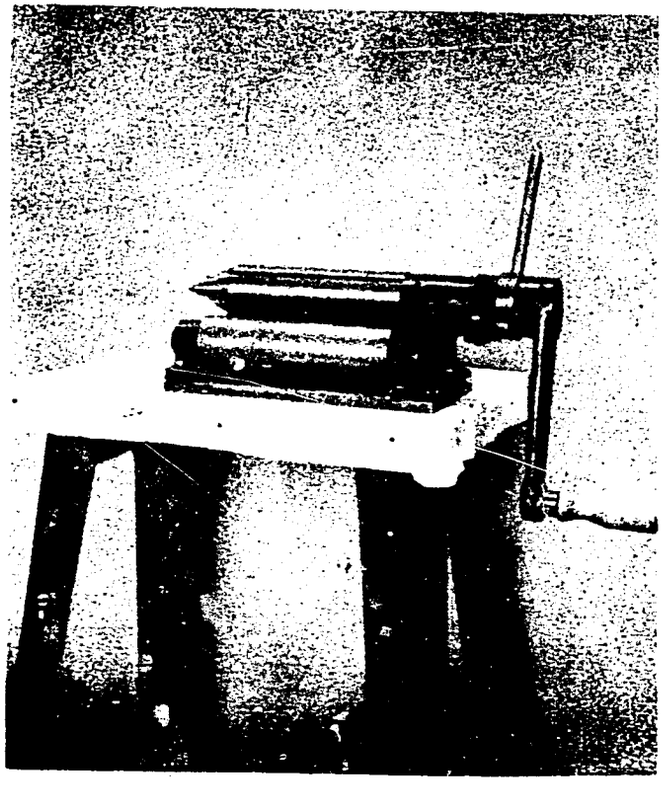

Figure 9. Manual Can Reformer
(Courtesy of Max Ams Company)

Figure 10. Manual Can Flanger
(Courtesy of Max Ams Company)

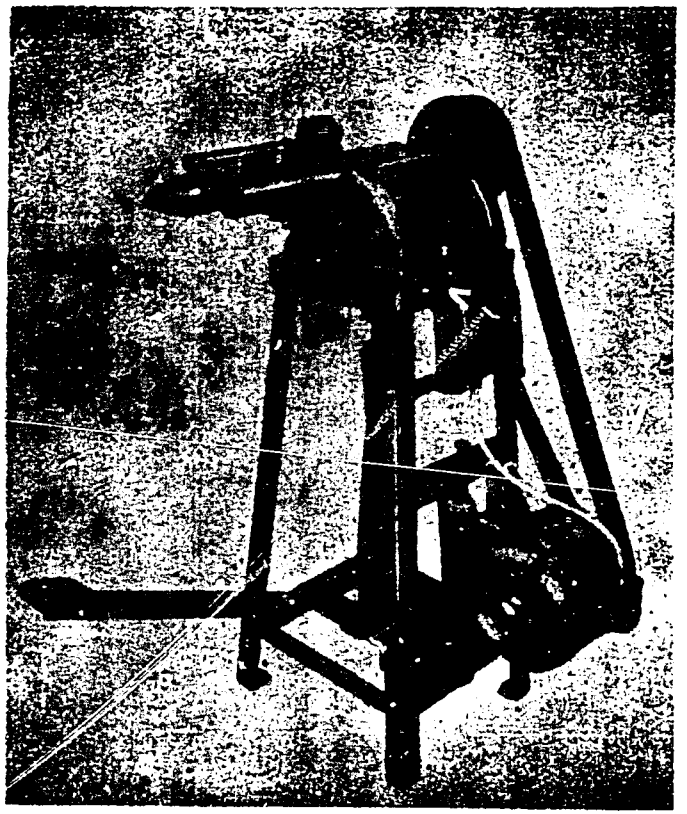

Figure 11. Power-Operated Can Reformer
(Courtesy of Continental Can Company)

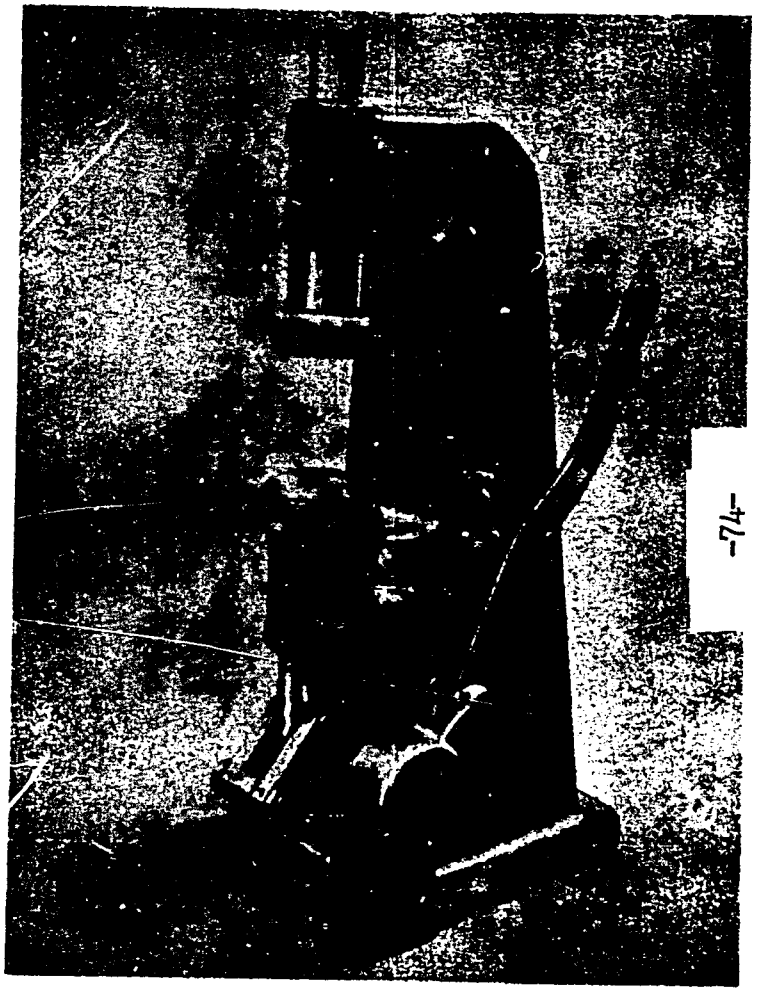

Figure 12. Power-Operated Can Flanger
(Courtesy of Continental Can Company)

Figure 13. Double Seamer
(Courtesy of Continental
Can Company)

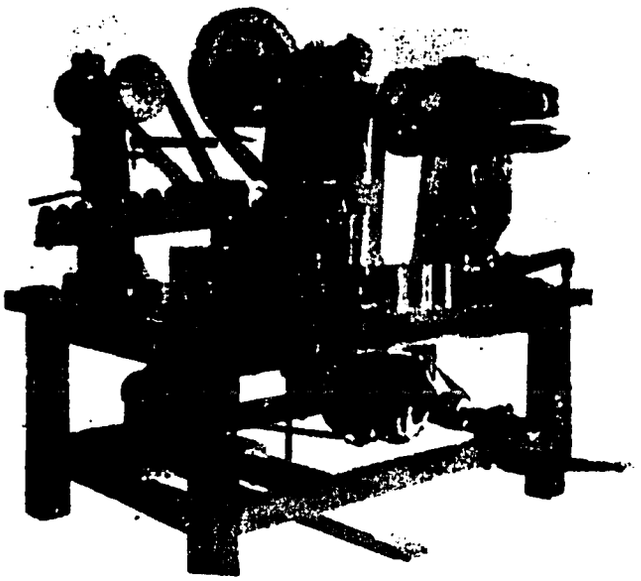

Figure 14. Power-Operated Can Reforming Line
(Courtesy of Continental Can Company)

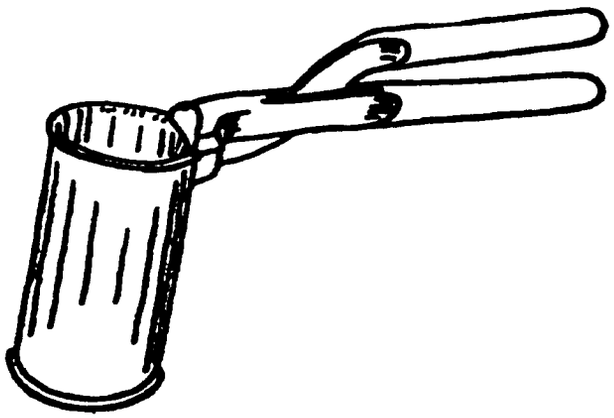

Figure 15. Flange Reformer
(Based on Dixie Canner Company
Catalog No. 50.

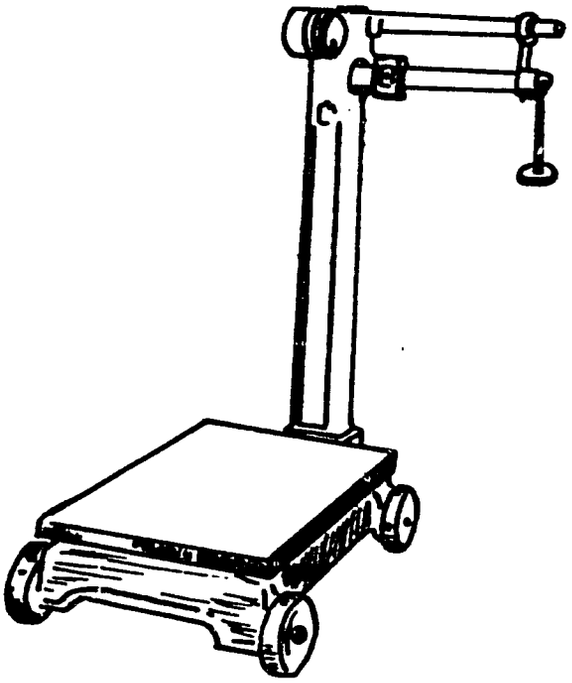

Figure 16. Portable Platform Scales
(Based on Dixie Canner Company Cata-
log No. 50

or they can be equipped with legs and placed in any convenient location in the plant.

Miscellaneous Utensils

A number of miscellaneous utensils are required in a canning plant. In Figure 17 are shown a collection of knives, forks, and spoons, a dipper, a pot brush, a carborundum stone, and a meat and bone saw.

Lye Peeler-Scalder

A lye peeler-scalder is useful for lye peeling peaches, pears, potatoes, and carrots, for scalding of tomatoes, and for water blanching and washing of products.

The lye peeler-scalder shown in Figure 20 has a swing basket in a heated lye compartment 18 inches by 24 inches. This compartment is equipped with a steam-heated coil and quick opening drain. Food in the lye compartment is transferred to the rinse compartment by lifting the swing basket. When the basket is lifted sufficiently, the food tumbles into the rinse section. The rinse compartment is 18 inches by 18 inches and is equipped with a rinse basket. The lye peeler-scalder has a capacity of 1/2 bushel.

Scald and Blanch Tank

Scald and blanch tanks can be fabricated in the canning plant, or they can be purchased locally. The dimensions of one of these tanks recommended for plant B is shown in Figure 21.

Cold-Dip Tank

A cold-dip tank can also be fabricated locally. It is similar to the blanch or scald tank except that it does not have a burner.

Pea and Bean Huller

The pea and bean huller shown in Figure 22 has a capacity of six to ten bushels of unhulled product per hour. It is operated by a 1/2-horsepower motor. Special features of this equipment are the hopper-type top for convenience in feeding the raw materials to the machine, a two-piece sieve through which the peas or beans fall when hulled, a variable speed drive for adjusting the speed of the machine to the type or variety of production or degree of maturity, and an adjustable conveyor belt which separates the peas or beans from broken pieces of pod. The metal sides lift off the machines completely and the top may be removed by simply loosening only four nuts. Thus, all parts are accessible for quick and easy cleaning.

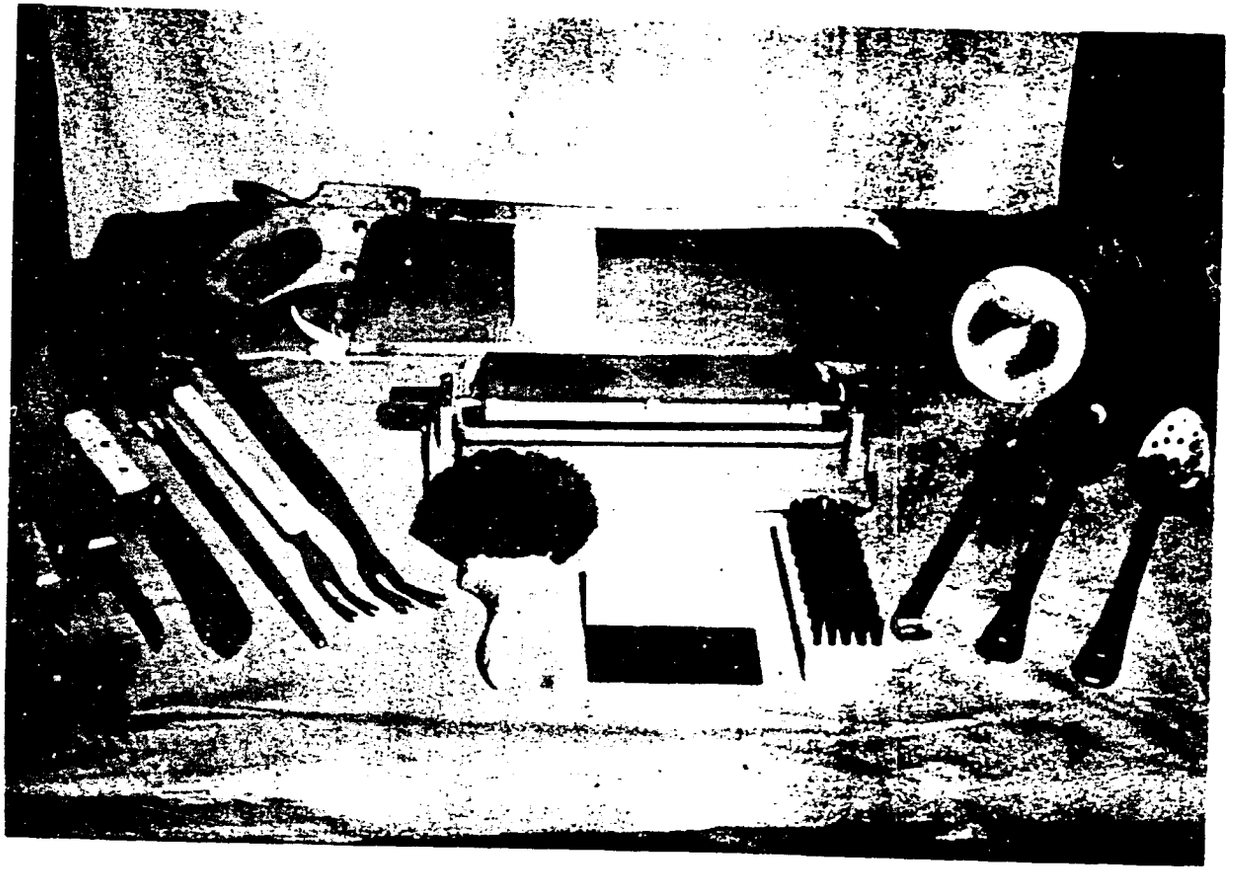

Figure 17. Miscellaneous Utensils
(Courtesy of Dixie Canner Company)

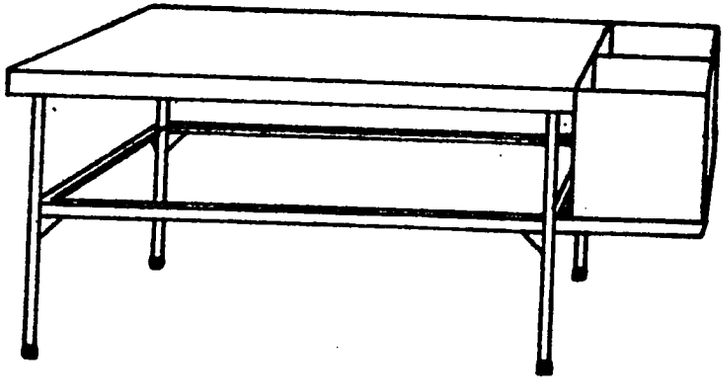

Figure 18. Table with Two-Compartment Sink
(Based on Dixie Canner Company Catalog No. 50)

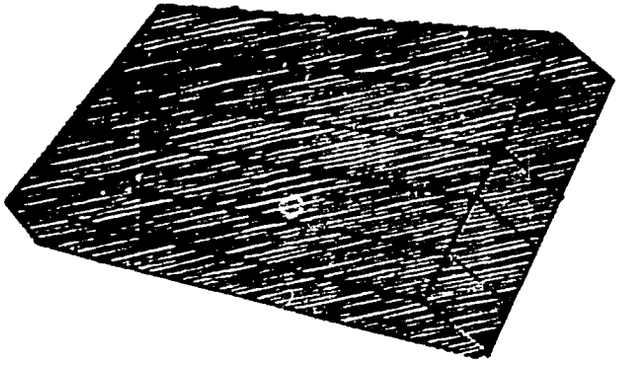

Figure 19. Cutting Board
(Based on Dixie Canner Company Catalog No. 50)

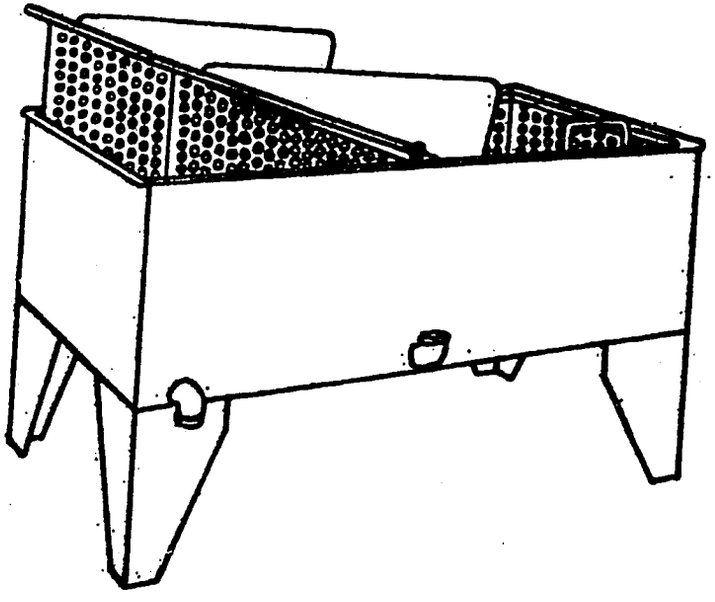

Figure 20. Lye Peeler-Scalder
(Based on Dixie Canner Company Catalog No. 50)

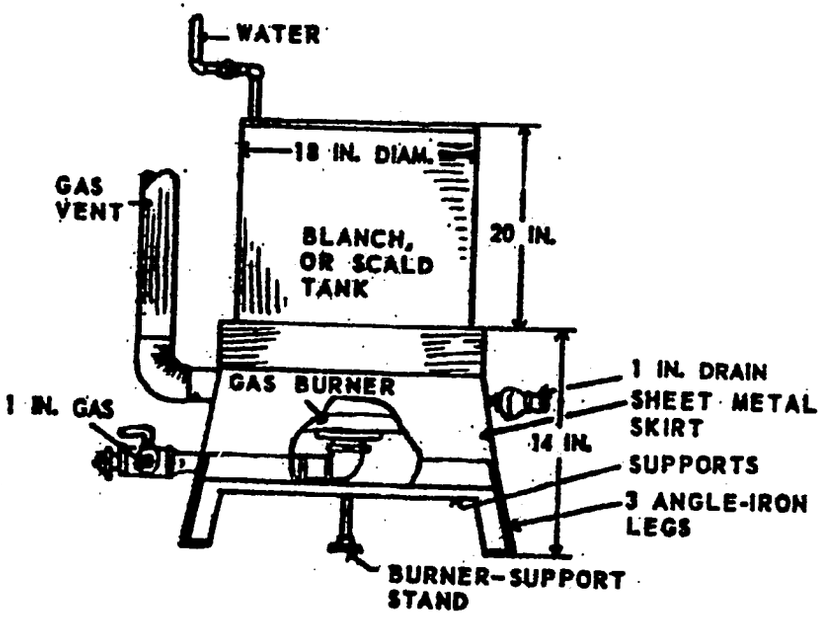

Figure 21. Scald and Blanch Tank
(Based on USDA Miscellaneous Publication No. 544)

Steam Blancher and Scalder

Blanching with steam improves the quality of the blanched product. A steam blancher (Figure 23) is easier to use than the conventional water bath method. The blanching and scalding baskets are 12 inches high and 10 inches wide.

Food Chopper

A hand-operated food chopper (Figure 24) is recommended for plants A and B. However, a power-operated one should be used in plant C. The power-operated food chopper has a capacity of eight to ten pounds per minute. It is driven by a 1/2-horsepower induction motor.

Juicer or Juicer-Puree Attachment

A hand-operated juicer (Figure 25) is recommended for plant A. It is equipped with a stainless steel screen and an aluminum pan and feeding funnel.

A power-operated juicer is recommended for plant B. This juicer is similar to the hand-operated one and is driven by a 1/2-horsepower motor. It has a capacity of three to five bushels of fruit per hour.

A juicer-puree attachment (Figure 26) for the food chopper is recommended for plant C.

Corn Cutter and Attachments

The corn cutter (Figure 28) is adjusted to operate at 20 ears per minute. The head is nonrotating, easy to adjust, and easily cleaned. Diagonal knives give a clean, uniform cut at all times.

The cutter is furnished complete with special grease guns and a 1/2-horsepower motor.

An attachment known as a corn-cutter scraping attachment (not shown in Figure 28) can be attached to the front of the cutter head for use in preparing cream-style corn. The ears of corn come through the cutter head where the tops of the grain are cut off, then through the scraper where the other parts of the grain are removed by scraping.

Another attachment, the cutting head adjustment stand (not shown in Figure 28), is desirable for changing, setting, or adjusting cutter head knives or scraper blades. An accurate adjustment is assured if the stand is used.

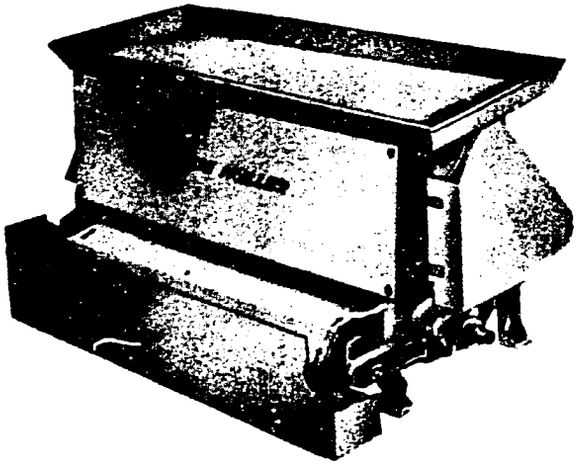

Figure 22. Pea and Bean Huller
(Courtesy of Dixie Canner Company)

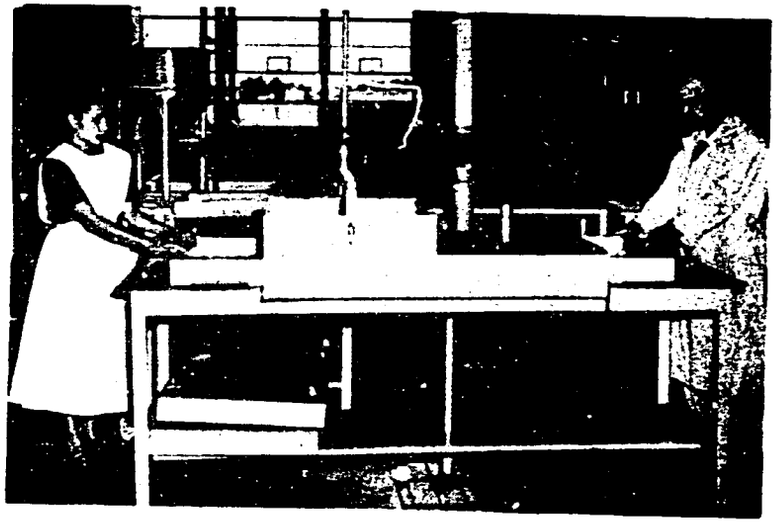

Figure 23. Steam Blancher and Scalder
(Courtesy of Louisiana Department of Education)

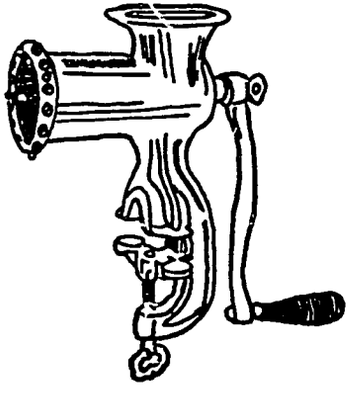

Figure 24. Food Chopper
(Based on Dixie Canner
Company Catalog No. 50)

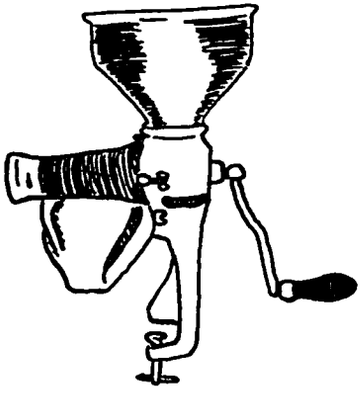

Figure 25. Juicer
(Based on Dixie Canner
Company Catalog No. 50)

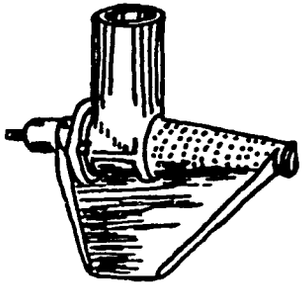

Figure 26. Juicer-
Puree Attachment
(Based on Dixie Canner
Company Catalog No. 50)

Corn Silker

The corn silker shown in Figure 27 is recommended for plant C. It will remove silks as fast as the operator can roll the ear over the revolving brushes. The corn silker is equipped with a 1/3-horsepower motor. Nylon is used for bristles in the brushes because nylon is easily cleaned and is long lasting.

Hot-Lift Tongs

Hot-lift tongs (Figure 29) are designed to grasp cans or jars firmly. They should be available in canning plants for handling hot containers.

All-Purpose Dolly

An all-purpose dolly (Figure 30) equipped with casters is useful for moving materials from place-to-place in a canning plant.

Stock Pot, Aluminum

Stock pots (Figure 31) are useful in a canning plant for handling, storing, and precooking foods of all types. They come in various sizes from 5-gallon capacity to 15-gallon capacity.

Gas-Fired Aluminum Kettle

A gas-fired aluminum kettle (Figure 32) is convenient for preheating the product and for preparation of syrups and brines.

Steam-Jacketed Kettle, Ten-Gallon, Tilting-Type

A steam-jacketed, tilting-type kettle (Figure 34) is useful for fast cooking of small batches. It is usually mounted on the preparation table by a kettle rack.

Exhauster, Batch-Type

A batch-type exhauster can either be fabricated locally or purchased ready-made. A suggested design for a gas-fired exhausted is shown in Figure 35.

Exhauster, Continuous, Power-Operated

The continuous, power-operated exhauster shown in Figure 36 is equipped with a filling and sealing table each of which is 33 inches by 33 inches. The cans are pulled through the exhauster by a conveyor driven by a 1/4-horsepower motor. The exhauster is of all steel construction and takes cans from a No. 1 size up to a No. 10 size. It has a 12-foot enclosed tunnel. It operates at three different speeds. At the slowest speed each can remains in the exhauster for 5-1/2 minutes; at the fastest speed, 2-1/2 minutes.

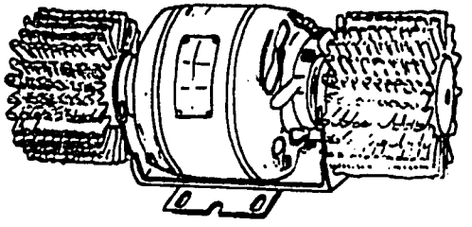

Figure 27. Corn Silker
(Based on Dixie Canner Company Catalog No. 50)

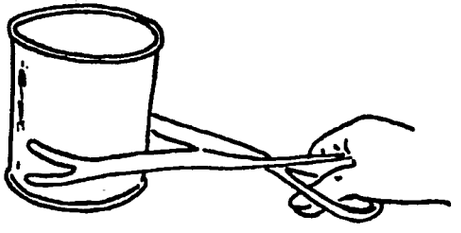

Figure 29. Hot-Lift Tongs
(Based on Dixie Canner Company Catalog No. 50)

Figure 28. Corn Cutter
(Courtesy of Louisiana Department of Education)

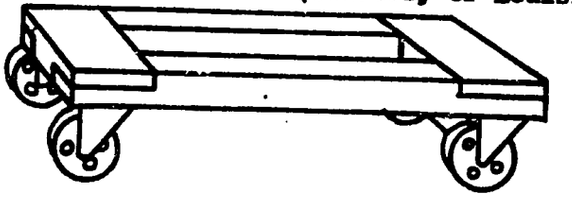

Figure 30. All-Purpose Dolly
(Based on Dixie Canner Company Catalog No. 50)

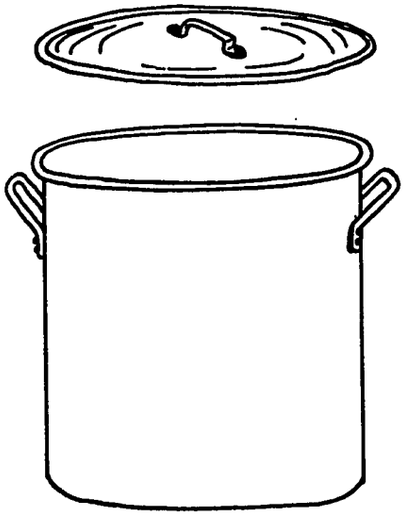

Figure 31. Stock Pot
(Based on Dixie Canner Company Catalog No. 50)

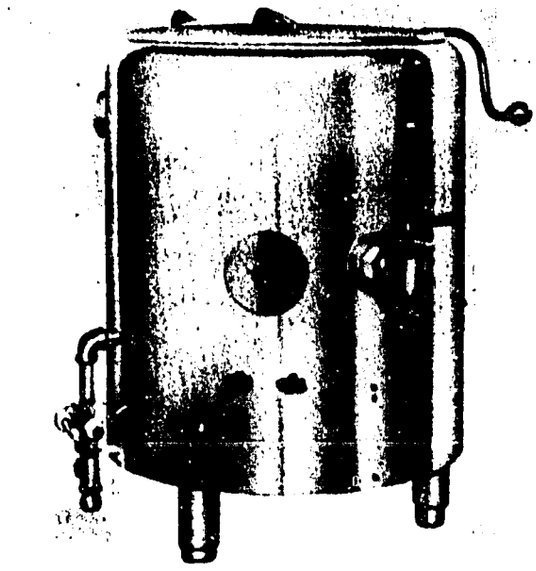

Figure 32. Gas-Fired Kettle
(Courtesy of Aluminum Cooking Utensil Company)

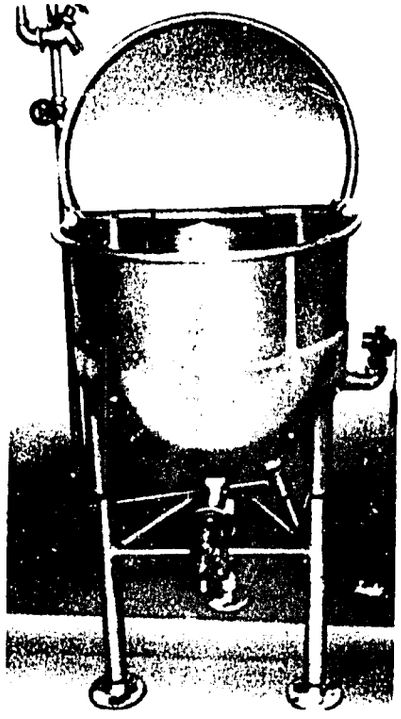

Figure 33. Steam-Jacketed Kettle
(Courtesy of United States Department of Agriculture)

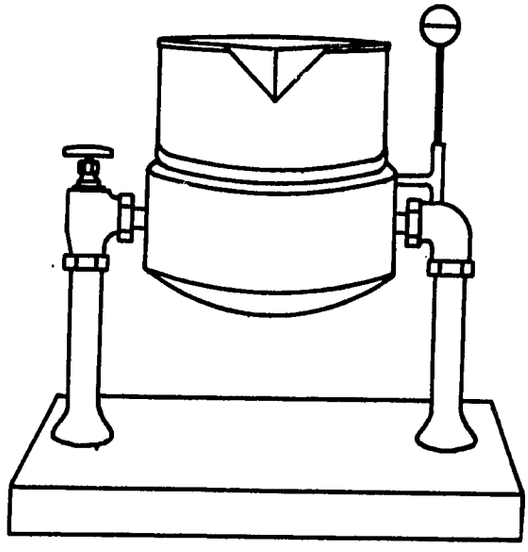

Figure 34. Steam-Jacketed Kettle, Tilting-Type
(Based on Dixie Canner Company Catalog No. 50)

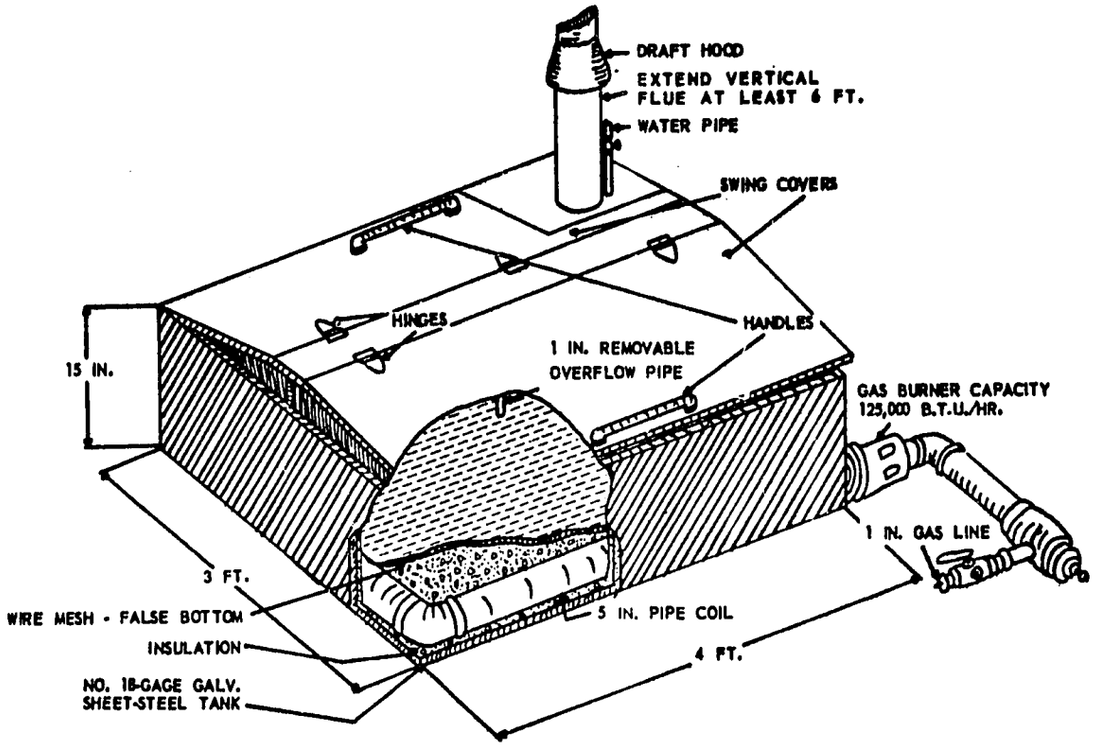

Figure 35. Gas-fired Batch Exhauster

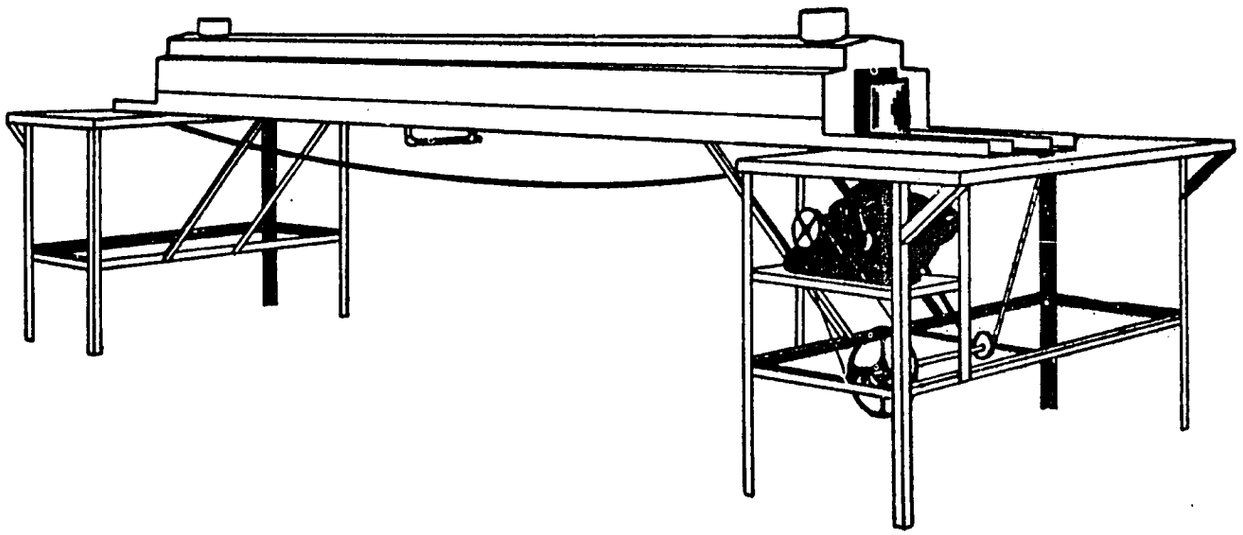

Figure 36. Power Operated, Steam-heated Continuous Exhauster
(Based on Dixie Canner Company Catalog No. 50)

Hand Sealer

A hand sealer (Figure 38) will close any standard size can up to and including No. 3. The hand sealer recommended for plant A is equipped to close No. 2 cans. Sealer change parts for No. 2-1/2 cans are also required. The hand sealer can close a maximum of three or four No. 2 cans per minute

Power Sealer

A power sealer (Figure 39) equipped for No. 2 cans has a capacity of five or six cans per minute; one equipped for No. 10 cans has a capacity of two or three cans per minute.

Atmospheric Cooker

Any big, clean vessel can be used for an atmospheric cooker if it is deep enough to let water boil well over the tops of jars or cans, has a good lid, and has a rack to keep the jars or cans from touching the bottom. The rack can be made of wire or wood.

Atmospheric cookers can be fabricated locally from scrap material, or a cooker specifically designed for this purpose (Figure 37) can be used.

A typical-size atmospheric cooker, the one selected for the plant A, has a capacity of 35 quarts of liquid or 30 No. 2 cans.

If steam is available, it can be used for atmospheric cooking instead of boiling water. Specially designed equipment (Figure 40) is required. In plant C steam is used in a No. 2 atmospheric cooker. The cooker can process 70 No. 2 cans, 37 No. 3 cans, or 10 No. 10 cans at one time.

Pressure Cooker

Pressure cookers (Figure 41) range in size from those having a capacity of 7 quarts of liquid to those having a capacity of 41-1/2 quarts of liquid. The pressure cooker selected for the canning plant A has a capacity of 25 quarts of liquid. It can process 18 pint jars, 7 quart jars, 20 No. 2 cans, or 10 No. 3 cans at one time.

Retorts

Three different types of retorts are available for canning plants. The capacities of these retorts vary from 70 No. 2 cans to 1424 No. 2 cans. A No. 2 retort (Figure 42) has a capacity of 70 No. 2 cans; a No. 3 retort (Figure 43) has a capacity of 185 No. 2 cans; industrial retorts vary in size and have a capacity from 534 No. 2 cans to 1424 No. 2 cans.

A No. 2 retort is recommended for canning plant B. This retort has a capacity of 70 No. 2 cans, 37 No. 3 cans, or 10 No. 10 cans. It has an

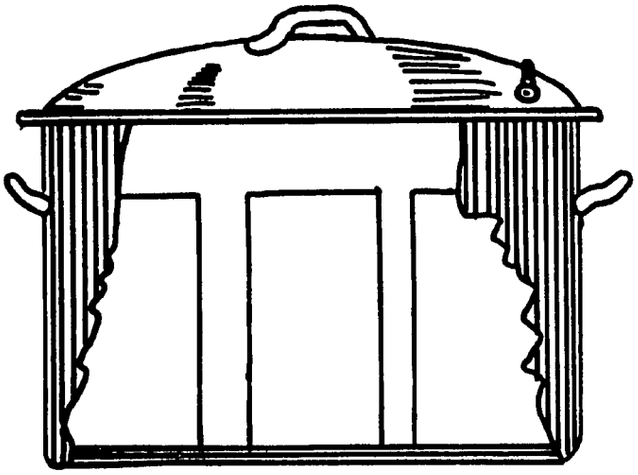

Figure 37. Atmospheric Cooker

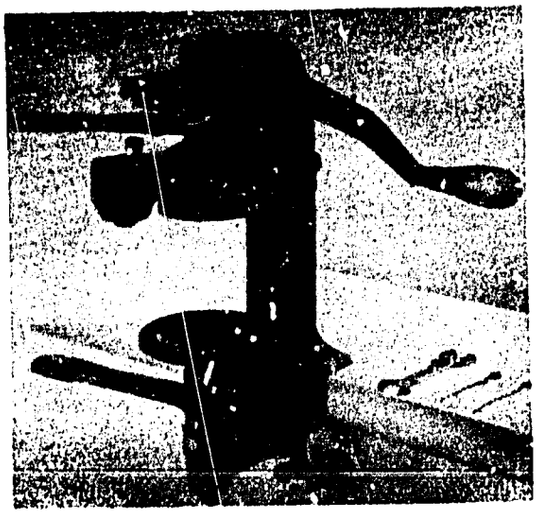

Figure 38. Hand Sealer
(Courtesy of United States Department of Agriculture)

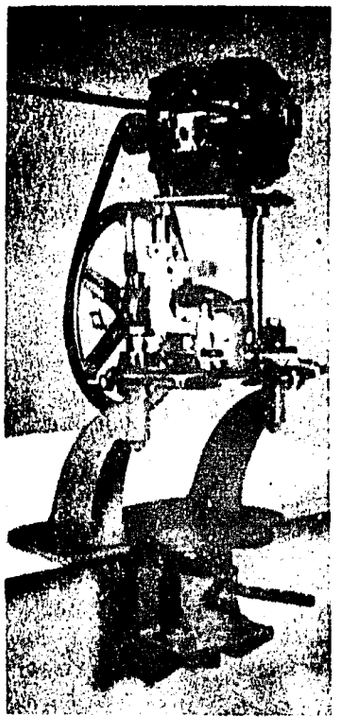

Figure 39. Power Sealer
(Courtesy of United States Department of Agriculture)

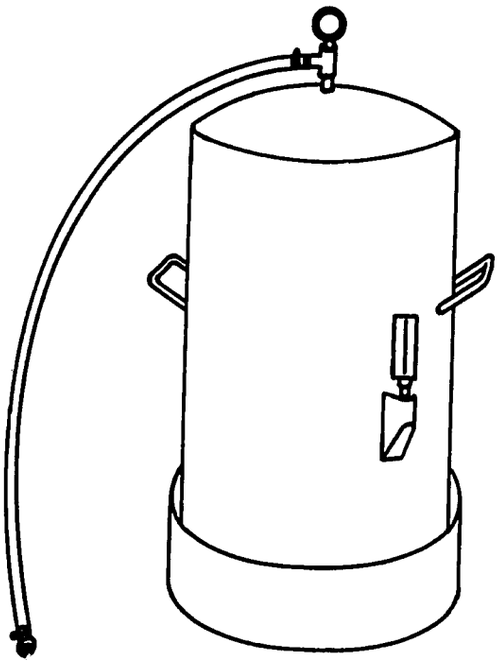

Figure 40. Steam-Heated No. 2 Atmospheric Cooker
(Based on Dixie Canner Company Catalog No. 50)

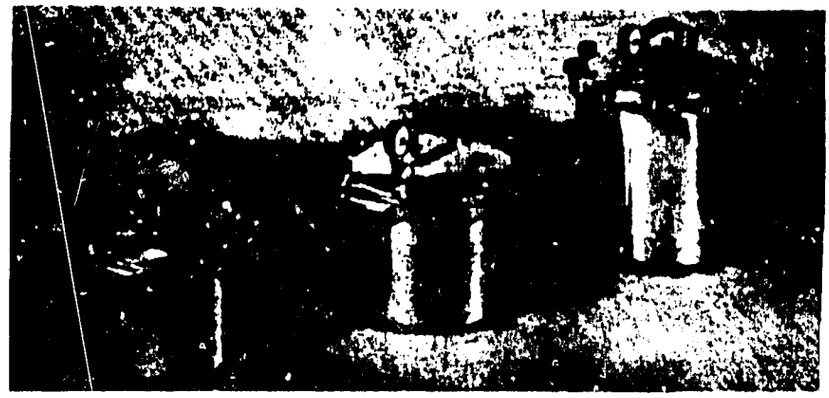

Figure 41. Pressure Cookers with Capacities of 5, 14, and 20 No. 2 Cans
(Courtesy of Dixie Canner Company)

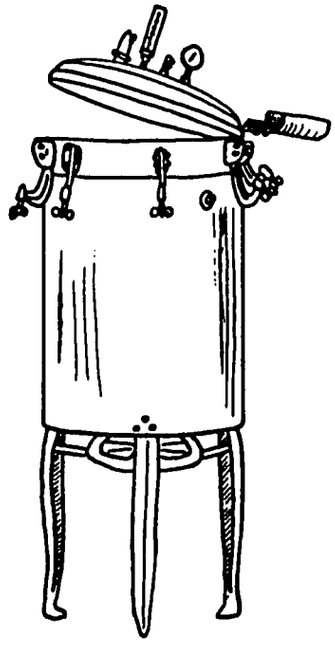

Figure 42. Gas-Fired No. 2 Retort
(Based on Dixie Canner Company Catalog No. 50)

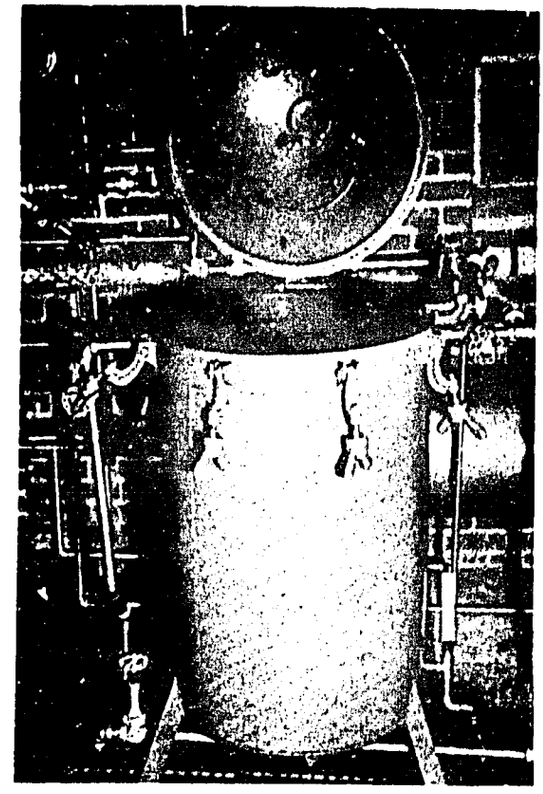

Figure 43. Steam-Heated No. 3 Retort
(Courtesy of Dixie Canner Company)

inside diameter of 18 inches and an inside depth of 23 inches. The retort comes equipped with a 3/4-inch pop safety valve, a 1/4-inch petcock, a 0 to 30-pounds-per-square-inch pressure gauge, a thermometer indicating temperatures between 120° and 250° F., and an insert crate.

Cooling Tank

Cooling tanks (Figure 44) can be fabricated locally. They are fabricated of wood, metal, concrete, or other water-resistant materials. A tank approximately 4 feet by 3 feet by 2 feet is satifactory for plant B. For plant C, the tank should be at least 6 feet by 3 feet by 3 feet. A larger size may be desirable.

External Cooling Spray

The external cooling spray (Figure 45) is used for cooling glass jars and large tin cans which have been partially cooled in the retort or atmospheric cookers. The two-step sprays for this purpose produce a solid cone of water which removes the heat without breaking the jars. The cooling spray itself has a swivel joint which permits mounting of the spray so that the valve is in easy reach of the operator, and the entire unit can be swung clean to permit lowering a basket into the cooling position.

Air Compressor

A heavy-duty type air compressor complete with all accessories for installation in plant C is shown in Figure 47.

Air-Regulating Valve Assembly

The air-regulating valve assembly (Figure 46), used to maintain constant air pressure when cooling under pressure, comes complete with a 1/2-inch air line strainer and pressure gauge. The valve itself is of all bronze construction. The valve has an oil resistant diaphragm.

Boiler Installation

The boiler installation (Figure 48) for plant C should include the following: 20-horsepower vertical boiler, smokestack complete with guy wires, automatic burner, and automatic water control. It is most practical to purchase this equipment as a complete unit.

Ventilating Fan

A ventilating fan (Figure 49) is a recommended item for all canning plants. Since much heat is generated locally in the plant it serves to remove this heat and thus provide more comfortable working conditions for the employees. The fan should have sufficient capacity to change the air in the plant every one to two minutes.

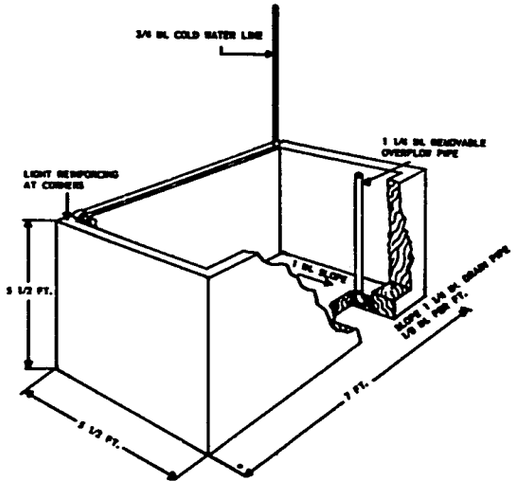

Figure 44. Cooling Tank

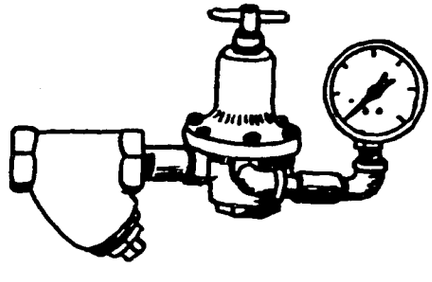

Figure 46. Air-Regulating Valve Assembly
(Based on Dixie Canner Company Catalog No. 50)

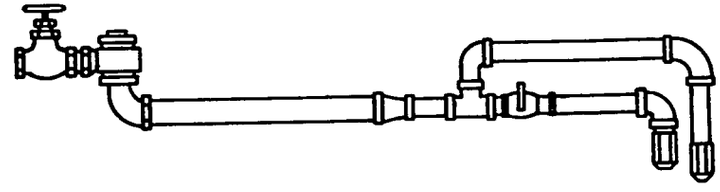

Figure 45. External Cooling Spray Assembly
(Based on Dixie Canner Company Catalog No. 50)

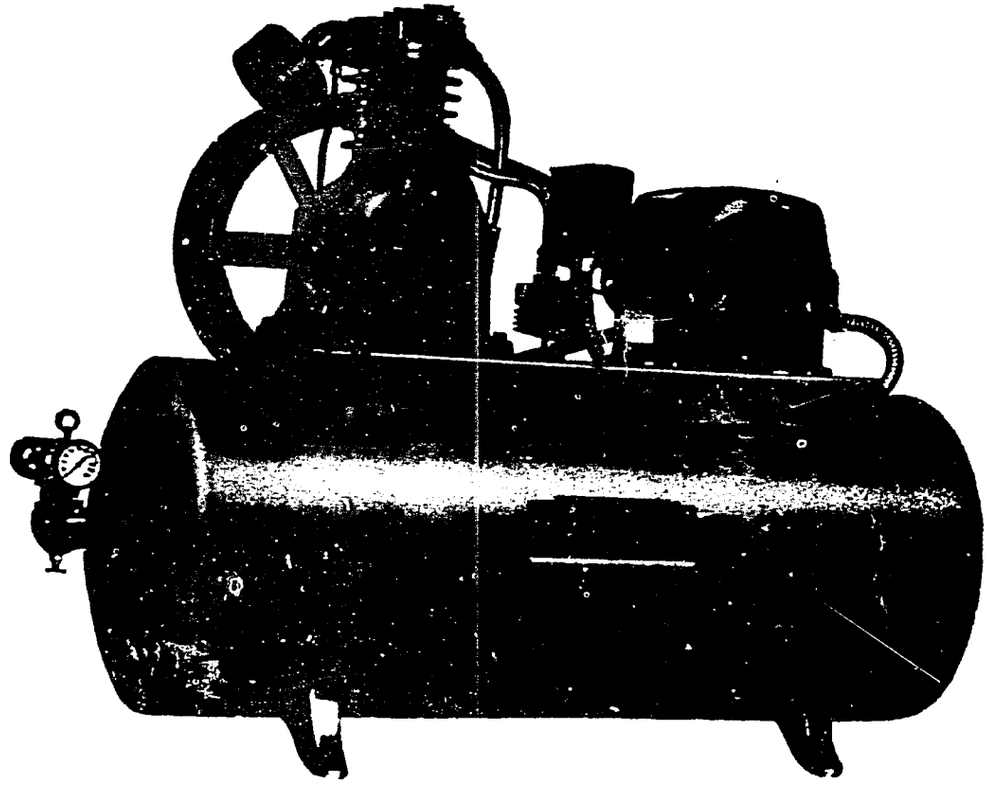

Figure 47. Air Compressor
(Courtesy of Dixie Canner Company)

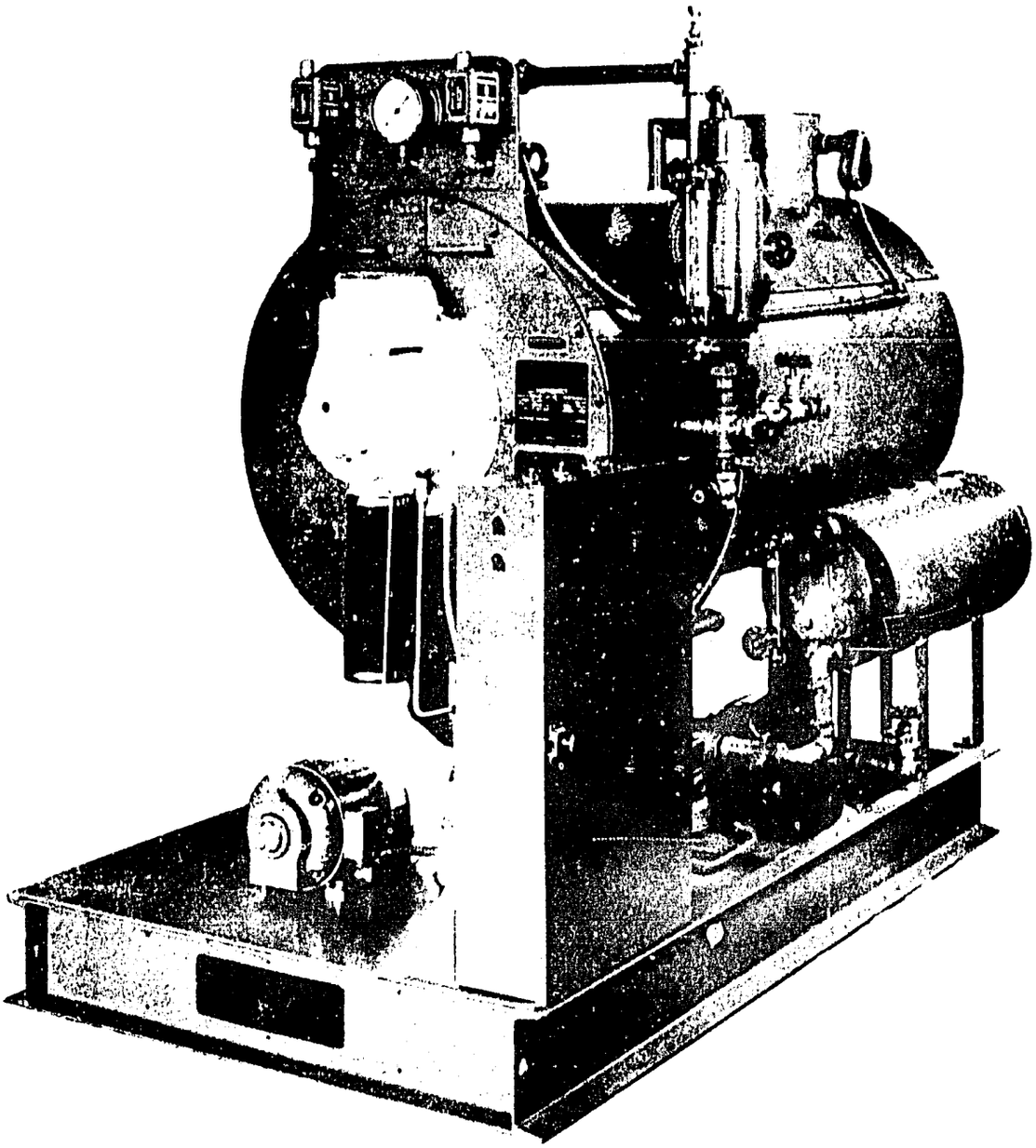

Figure 48. An Automatic Oil-Fired, 20 Horsepower Boiler. This Unit Includes Automatic Boiler-Water and Burner-Cutoff Control Systems. (Courtesy of Orr and Sembower Company)

Can Opener

A can opener (Figure 50) should be standard equipment in all canning plants.

One-Half Ton Hand Hoist

A hand hoist (Figure 51) is recommended for small canning plants to handle heavy retort crates. Power-operated hoists are available but the use of the hoist in a canning plant does not justify the additional cost. Furthermore, power hoists usually operate more slowly than hand hoists.

Gauge Tester

In order to check the accuracy of the gauges on the pressure cookers and retorts it is recommended that a gauge tester (Figure 52) be provided. Instructions for testing gauges are provided with each gauge tester.

VII. MAINTENANCE

A. General Clean-Up

A high standard of cleanliness must be maintained in each of the canning operations since the quality of the finished product is affected by the conditions under which it is handled. The processes normally recommended for a particular product may not be adequate to insure safety if general cleanliness is not maintained. Posters telling what is expected of workers in respect to keeping the plant clean and sanitary are valuable in maintaining high standards.

Supplies and equipment must be at hand for the daily clean-up inside and outside the plant. In plants where water is relatively expensive, clean-up of the plant and equipment may be performed in part with recovered water from cooling sprays and cooling tanks. Such water may be used for preliminary washing if it is adequately chlorinated. Only fresh water should be used for the final washing.

In general, it is desirable to have employees on the job who are constantaly doing as much tidying as possible. In cooperative plants, especially the smallest ones, most of the work of cleaning should be performed by the patrons. As soon as the processing is completed each day, the clean-up crew washes floors and equipment, and then treats them with a disinfectant. All equipment such as blanchers, cookers, brine tanks, funnels, tables, pans, and buckets used in the food processing must be thoroughly scoured and scalded with hot water followed by a cold-water wash to prevent rusting. This is one of the most important operations of a general clean-up. It is an insurance against possible spoilage of the canned products. All garbage cans should be washed and, if possible, steamed every day. They should be

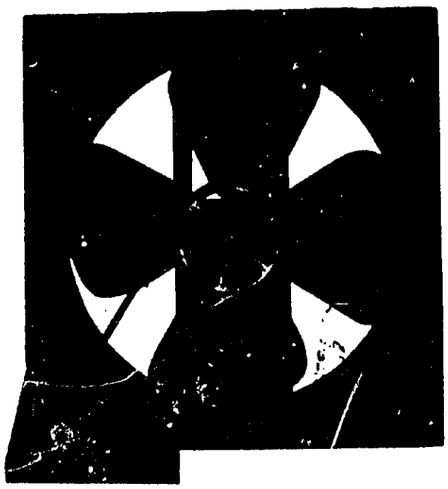

Figure 49. Ventilating Fan
(Courtesy of Dixie Canner Company)

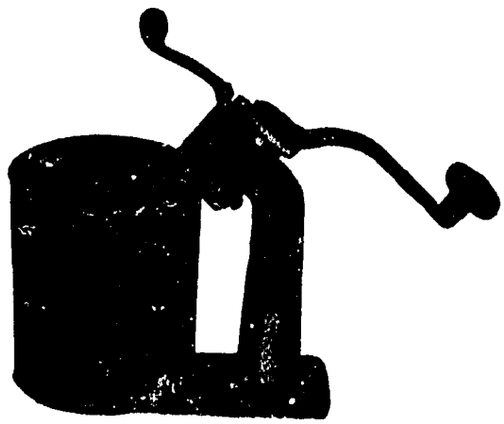

Figure 50. Can Opener
(Courtesy of Dixie Canner Company)

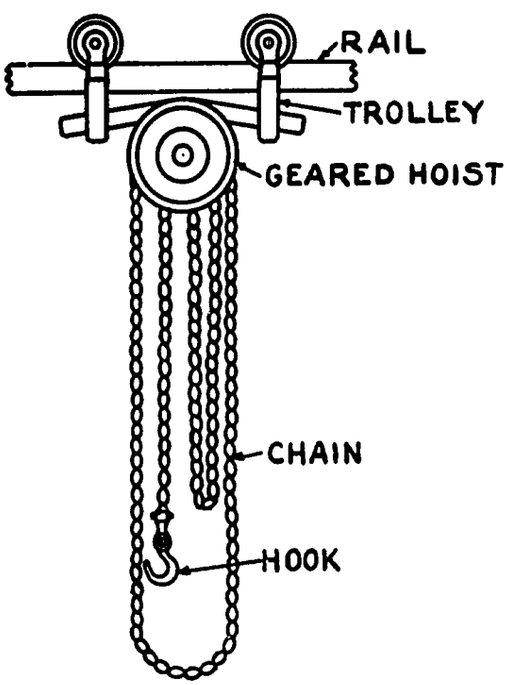

Figure 51. Hand Hoist
(Courtesy of United States Department of Agriculture)

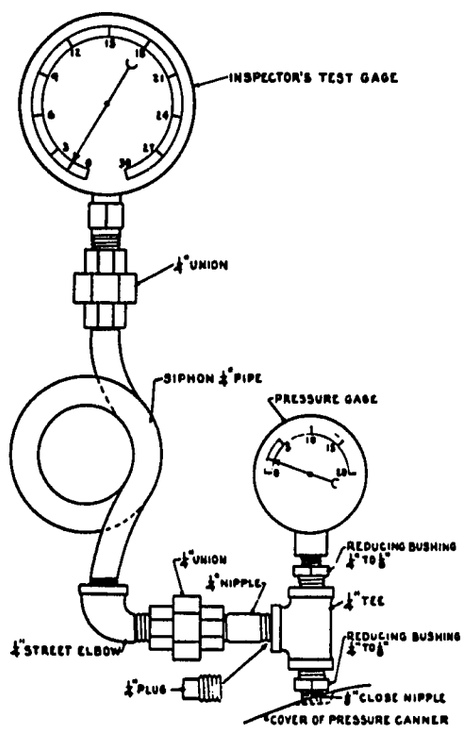

Figure 52. Gauge Tester
(Courtesy of United States Department of Agriculture)

left open until time for use again. It is sometimes desirable to sprinkle the area around the canning plant with oil or cover it with calcium chloride to keep dust down.

B. Building

1. Cupboards, Shelves, and Drawers

Cupboards, shelves, and drawers should be kept in good order. They should be thoroughly cleaned at frequent intervals.

2. Floors

Floors should be free from litter and excess water. They should be scrubbed and dried at least once a day. During shutdown periods or at meal times they can be flushed with water.

3. Metal-Top Tables

Metal-top tables should be washed with hot, soapy water and rinsed with hot or boiling water so that they will dry without rusting. Mineral oil should be applied to the table tops at the end of each day's operation to prevent rusting. Other oils, such as olive oil and motor oil, are not recommended because they will impart undesirable flavors to the food.

4. Steam Pipes

If steam pipes are used in the canning plant they should be located overhead so that they may be easily drained of condensate.

5. Toilets

Toilets and sinks should be cleaned and treated with a disinfectant solution at least once a day.

6. Walls

Walls, woodwork, and windows should be kept clean. The walls should be wiped down weekly to remove dust and should be washed as often as necessary to keep them free from grime. Woodwork should be kept free from dust and finger marks. Walls and woodwork should be painted as often as needed with waterproof paint.

7. Windows

Windows should be washed frequently because of the steamy atmosphere of the canning plant. Screens should be kept free from dust.

8. Wooden Surfaces

Wooden surfaces should be cleaned with special care. Since they are porous, they easily become infected with bacteria which may cause food spoilage. Wooden equipment and wooden tables should be scrubbed with hot, soapy water to remove dirt and grease followed by scalding water, or they should be cleaned with steam if steam facilities are available. Sodium, calcium, or potassium hypochlorite are good disinfectants for wooden surfaces. They should be used after the soap and water cleaners.

C. Equipment

1. General Discussion

Special attention must be given to the care of canning equipment since spoilage of canned foods can often be traced to contamination through carelessness in cleaning the equipment. The manufacturer's instructions should be followed in the care of mechanical equipment. As a general rule, all equipment should be thoroughly cleaned at the end of each day's operation. The equipment should be dismantled, scrubbed, and steamed where practical. The equipment should then be left cold and dismantaled until the beginning of the next day's run and should be well flushed with cold water before using.

During the season that the canning plant is closed down, special care should be given to equipment to prevent rusting and corroding. If a boiler is used in the canning plant it should be thoroughly flushed out and refilled and 1/2 gallon of lubricating oil added. The boiler is then redrained. When the boiler is redrained, the oil will coat the inside surfaces and keep them from rusting. Gauges, petcocks, and thermometers should be removed from the retorts and steam pipes. They should then be wrapped in heavy paper and labeled carefully to indicate the part and location. Such equipment should be cleaned thoroughly and dried. All surfaces that are likely to rust should be coated with a heavy grease. Parts of equipment that are removed should be wrapped and placed with the equipment. Equipment should be inspected for wear and notes of needed repairs should be made. Steam-jacketed kettles and blanching baskets made of noncorrosive materials may be covered with heavy paper for protection from dust when they have been thoroughly cleaned. Sealers should be checked to determine whether they require repair and replacement. They are oiled when needed, and the external parts greased to prevent rusting. Sealers can be stored in their original shipping boxes, keeping all attachments together wrapped and labeled, and stored in the box with the sealer. Small equipment, such as peeling knives and sharpening tools, also needs to be thoroughly cleaned, wrapped in paper, and labeled before storing. Belting and hose should be checked for wear and stored in a cool, dry place. An inventory of all equipment should be made at the close of the season as well as at stated intervals during the operation.

2. Metal Utensils

Metal utensils should be washed with soapy water, rinsed, and sterilized by immersion for three minutes in water at a temperature of at least 170° F. or in a chlorine solution. Utensils of corrosible metals such as cast iron, galvanized iron, and copper should be thoroughly cleaned, before as well as after, each use to remove surface corrosion.

3. Pressure Gauges

Since pressure gauges sometimes get out of order they should be tested at the beginning of the canning season and at frequent intervals throughout the season. Such tests are of particular importance where pressure gauges are the only means provided for controlling the process. Figure 53 illustrates the assembly necessary for using a gauge tester.

The procedure suggested by the United States Department of Agriculture for testing pressure gauges is summarized below. First, the pressure gauge is removed from the retort or cooker which is then filled with two or three inches of water and the lid closed. (Figure 54) Next the test gauge is assembled as shown in Figures 55, 56, 57, 58, and 59. In Figure 57, water is shown being poured into the siphon to prevent steam from later entering the test gauge. Then the retort or pressure cooker is heated until the test gauge registers a pressure of 10 pounds per square inch. The test gauge and pressure gauge readings are compared. Finally, the test is repeated for a test-gauge pressure of 15 pounds per square inch. The pressures shown by the pressure gauge when the test gauge was at 10 and 15 pounds per square inch are the pressures which the pressure gauge should show to give 10 pounds and 15 pounds, respectively, inside the canner. The readings should be recorded on a tag and attached to the gauge. After the test has been completed, the test gauge, siphon, and nipple are removed and the 1/4-inch pipe plug screwed into the tee as shown in Figure 61.

4. Retorts

Retorts, like all pressure vessels, are subject to failure when exposed to high pressures for long periods of time. Therefore, a periodic hydrostatic test of all retorts should be made to detect defects due to rusting and wear. These faults may then be corrected. The hydrostatic test is simple and can easily be made, either by maintenance personnel or under the direction of the plant supervisor. For the test, a gauge tester is installed, replacing the regular retort gauge. The retort is then completely filled with water, all over-flows closed, and water is added until the required testing pressure is reached. This pressure is maintained for a time sufficient to allow a visual inspection for any leaks. Standard retorts are constructed for a maximum operating pressure of 15 pounds per square inch and should be tested to 30 pounds per square inch.

All manually-operated valves should be carefully checked and repaird or replaced when found to be faulty. Valves which do not close properly

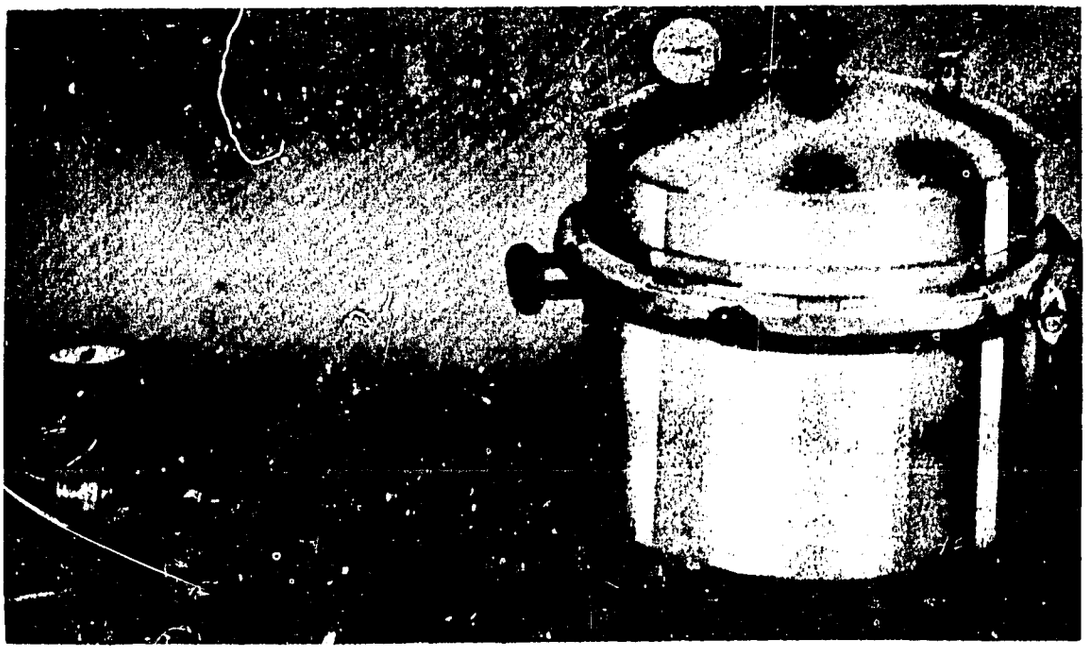

Figure 53. Pressure canner and parts for gauge tester: (1) Pressure canner with the pressure gauge which is to be tested; (2) 1/4-inch tee reduced to 1/8 inch at top and bottom; (3) 1/4-inch pipe plug; (4) 1/4-inch pipe nipple with 1/4-inch union connection; (5) 1/4-inch loop with 1/4-inch union connections; (6) inspector's test gauge with 1/4-inch union connection; (7) two bicycle wrenches. (For details of parts listed above see Figure 52.)
(Courtesy of United States Department of Agriculture)

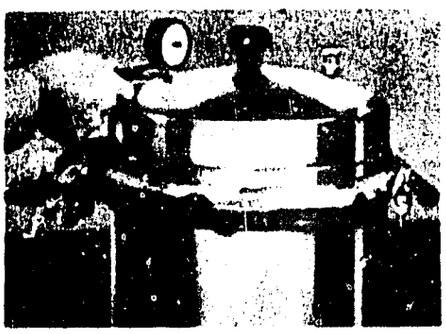

Figure 54. Remove the pressure gauge from the cooker or retort.

(Courtesy of United States Department of Agriculture)

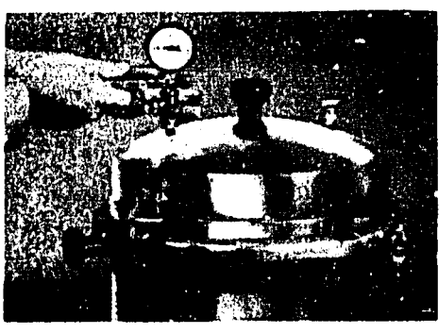

Figure 55. Install the tee and attach the pressure gauge.

(Courtesy of United States Department of Agriculture)

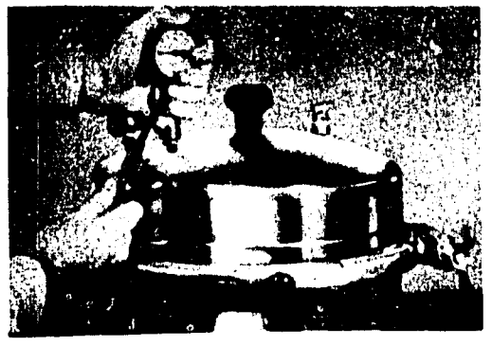

Figure 56. Attach a nipple with union connection to the side opening of the tee.
(Courtesy of United States Department of Agriculture)

Figure 57. Fill the loop of the gauge tester with water to protect test gauge from steam.
(Courtesy of United States Department of Agricutture)

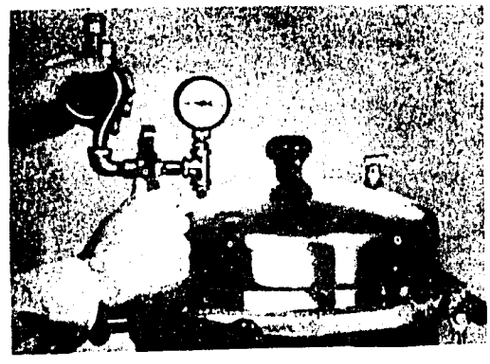

Figure 58. Attach the loop to the union on the nipple.
(Courtesy of United States Department of Agriculture)

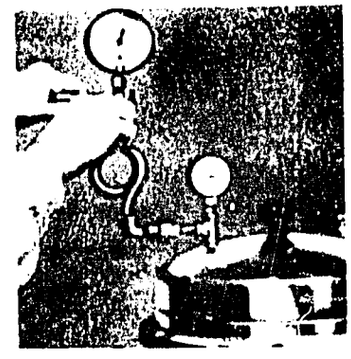

Figure 59. Install the test gauge on the loop.
(Courtesy of United States Department of Agriculture)

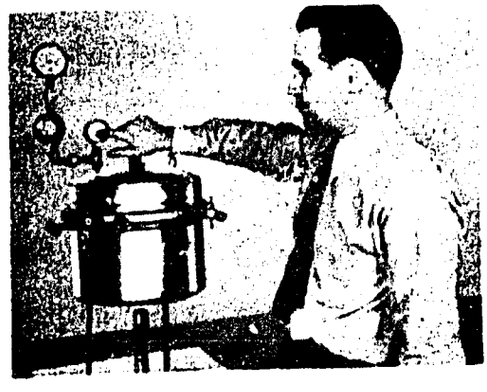

Figure 60. Test the pressure gauge at pressure of 10 and 15 pounds per square inch.
(Courtesy of United States Department of Agriculture)

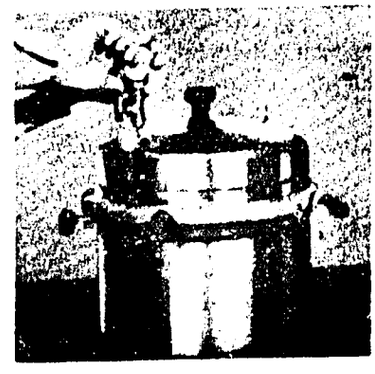

Figure 61. Remove the gauge tester and put a plug in the side opening of the tee.
(Courtesy of United States Department of Agriculture

or tend to stick in any position may be the cause of improper functioning of the retort. Improperly packed valve stems are very annoying and dangerous to the operator, and any leaking packing gland should be repaired immediately.

At the end of each work day, the retorts should be thoroughly drained and permitted to dry to prevent rust and stale odors from forming. Occasionally, the retorts should be filled with boiling water to remove grease or other foreign matter.

5. Sealers

Sealers should be kept clean and oiled. To assure proper adjustment, sealers should be checked at frequent intervals during the day's operation by one person who has been assigned to that responsibility. He should make adjustments on the sealers when necessary. Manufacturers' instructions should be followed carefully in making corrective adjustments. An inexperienced person should never be trusted to adjust the sealer.

6. Spray Nozzles

When spray nozzles are used in the lids of the retorts for cooling large tin cans and glass jars they should be checked before they are required to see that they are functioning properly. If the nozzles become clogged, remove the entire ring before taking nozzles apart so that they can be worked on conveniently. To clean the nozzle, unscrew the end and remove the core with tweezers. Do not attempt to remove the core by pushing a sharp instrument through the hole of the nozzle as this may damage the core or enlarge the hole. Wash the core carefully to remove rust or sediment which may be present. When encrusted from the use of hard water, remove deposits with dilute hydrochloric acid. Wash the end of the nozzle, then replace the core in its original position and reassemble the nozzles. Finally, turn the water on to see if the desired spray pattern is obtained.

7. Pressure Cooker

In general, the maintenance of pressure cookers is similar to that of retorts discussed earlier.

The following are additional maintenance suggestions for steam pressure cookers:

1. Keep the steel ball in the safety valve clean by scouring often.
2. Install a new spring in the safety valve as often as needed.
3. Test the pressure gauge at least once a year.
4. Wash and dry the pressure cooker thoroughly after each use.
5. Do not put the lid of the pressure cooker in water.
6. Leave the lid ajar when the pressure cooker is not in use.

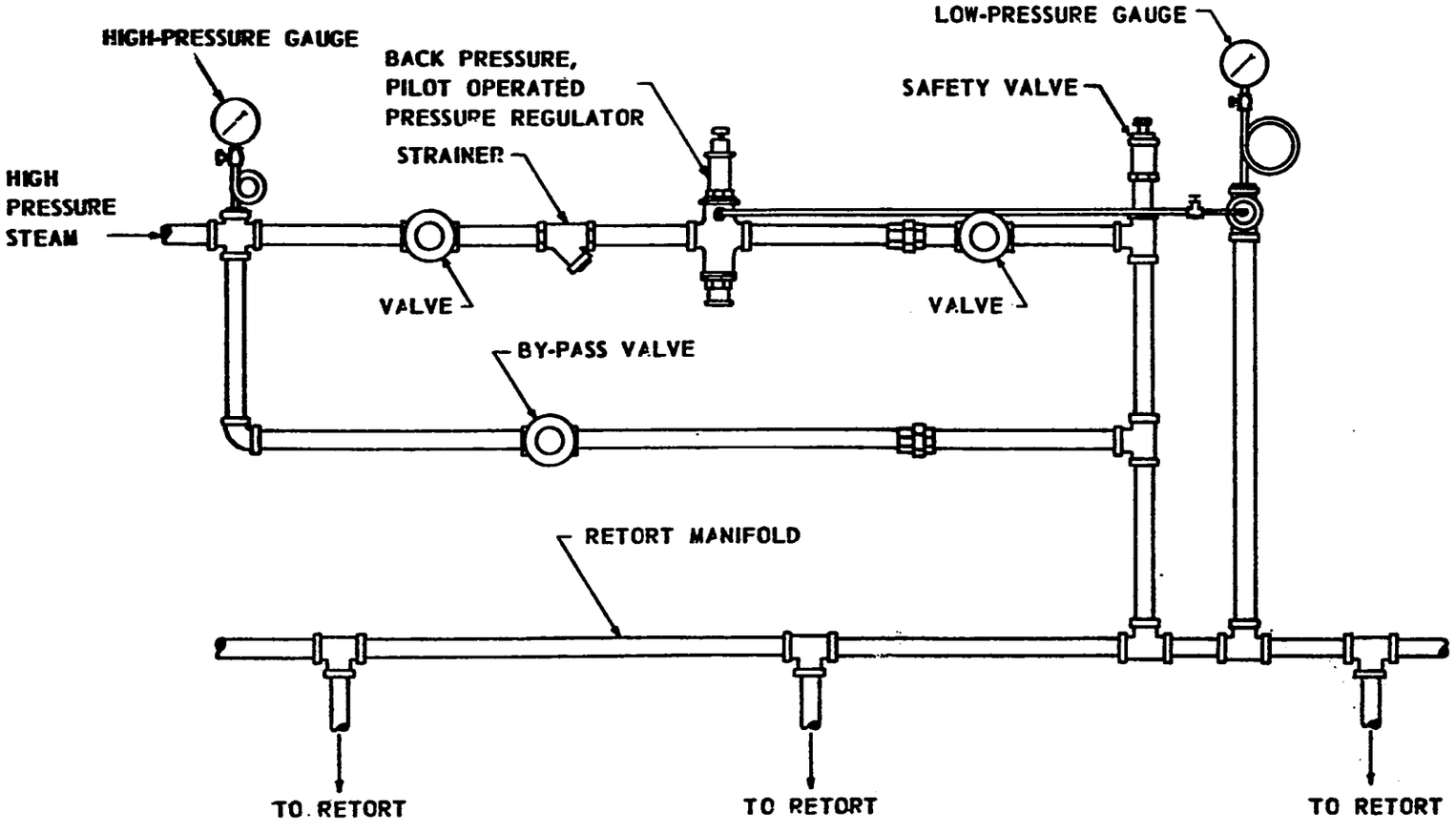

Figure 62. Piping Diagram Showing a Back-Pressure, Pilot-Operated Pressure Regulator Installation, Used Where a Number of Steam Retorts are Installed on One Steamline.

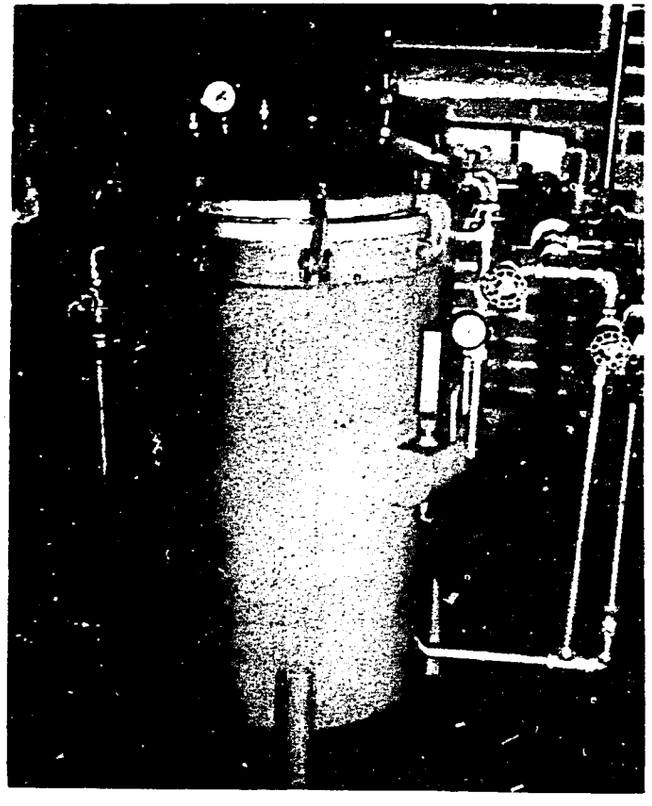

Figure 63. Steam Retort Installation on Steam line Using Back-Pressure, Pilot-Operated Pressure Regulator

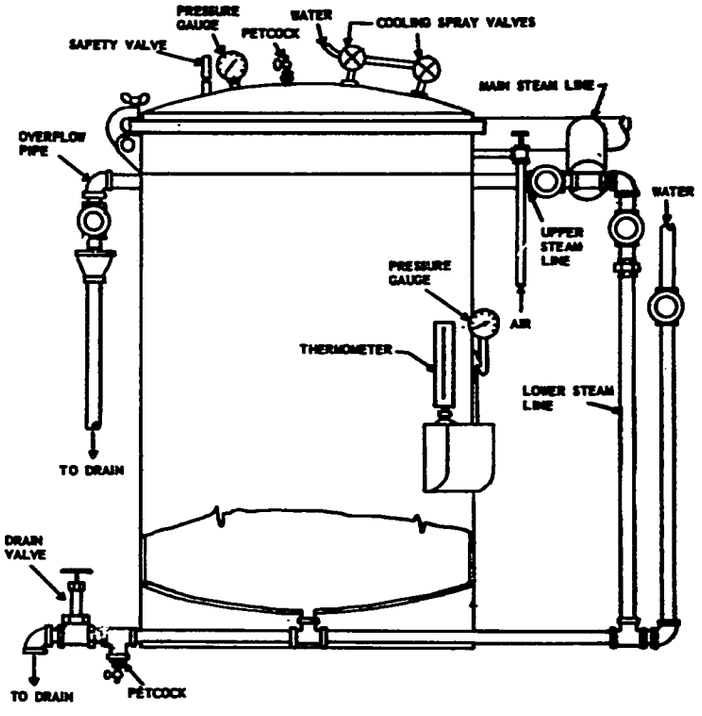

Figure 64. Piping Diagram for Steam Retort Shown in Figure 63.

8. Air Compressor

To keep the air compressor in good working condition, clean the air filter once a week. At that time drain the storage tank of condensate. It is also important to drain the tank at the end of the canning season to avoid possible damage by freezing. For care of the motor or compressor follow the manufacturer's instructions.

9. Miscellaneous Equipment

Such items as seeders, pulpers, grinders, and the exhaust box are left dismantled after use for airing and thorough cooling. They should be flushed with cold water before they are used again.

All equipment used in conjunction with retorts must be frequently tested and adequately maintained to insure satisfactory operation. Safety valves should be checked frequently and tested daily to see that they can emit steam. All control instruments including thermometers and pressure gauges should be checked for accuracy at least once each year and preferably more often if used continuously during the canning season. The instruments should be checked and maintained only by trained personnel. If competent personnel and suitable testing equipment are not available, questionable instruments should be returned to the manufacturer for servicing.

VIII. MATERIALS

A. Raw Materials

1. Foodstuffs

The quality of canned foods will be no better than that of the raw materials. For this reason the canner should endeavor to procure products in prime condition for canning. To do this, it is wise for him to contact the growers and make special arrangements for the planting, harvesting, and delivering, in the case of vegetables, and for the harvesting and delivering in the case of fruits.

Certain varieties of food make better canned products than do others, and the growers in a canning plant area should be encouraged to grow those varieties. Also, the stage of maturity of the food when harvested is important in canning as is the method of harvesting and the transportation of the produce to the factory. Boxes, baskets, or trays which permit the free circulation of air through the produce and prevent bruising should be used.

In order for the canning plant to operate for a longer period of time, it should process a variety of foods. Figure 7 shows the approximate harvesting periods for a number of fruits and vegetables grown in the state of

California in the United States. It is recommended that a canning plant in a particular area prepare a similar chart in order to know which commodities will be available at a particular time. Thus, the plant may be able to extend its canning seasons over a longer period of time.

2. Sugar, Salt, Pepper, and Other Seasoning

Cane or beet sugar is used for the preparation of syrup to be used in canning most fruits. Sugar from cane and beets is identical in chemical composition, and contains more than 99 per cent sucrose. Corn syrup contains about 43 per cent dextrose and may be used to replace 15-30 per cent of sucrose in canning some fruits.

Small amounts of salt, pepper, spices, vinegar as well as monosodium glutamate and other seasoning are also used to give the canned foods the best flavor.

B. Tin Cans

1. General Features

Canning in tin, especially for commercial operations, has many advantages over canning in glass:

1. The initial cost is less.
2. Tin cans are easy to handle because there is no danger of breakage.
3. There is no loss of liquid from tin cans because they are always tightly sealed before they are processed.
4. The processing period is shorter.
5. The containers can be cooled quickly by submerging them in water. This permits better control of cooking time.

When tin cans are used for canning operations, the cans, lids, and gaskets should not be damaged in any way. Bent edges will not make a good seal. Tin cans should be washed with soapy water, rinsed, and drained, unless the manufacturer gives instructions to the contrary. Lids should not be immersed in water. They may be wiped with a damp cloth, but gaskets, especially paper gaskets, should be kept dry to avoid difficulties in sealing.

Tin cans are made in a number of sizes. The following table gives the dimensions and liquid capacities of several standard sizes.

Can Size	Dimensions of Cans Diameter x Height in Inches	Total Capacity Avoir. Ounces of Water
2	3-7/16 x 4-9/16	20.55
2-1/2	4-1/16 x 4-11/16	29.79
10	6-3/16 x 7	109.43

2. Forms Available

a. Preformed. Preformed cans are manufactured in all standard sizes in the United States. 1955 prices for preformed cans in the United States packaged for overseas shipment are listed below.

Can Size	Price per Thousand Cans Packaged for Export Shipment
No. 2	$ 40.00
No. 2-1/2	52.00
No. 10	133.00

However, a large can manufacturing company states that the overseas freight charges on preformed cans are prohibitive. For this reason preformed cans are not exported in any volume from the United States.

b. Collapsed. Since shipping the fully formed cans (particularly in the larger sizes) involves a prohibitive ocean freight rate, can makers have perfected what is known as collapsed cans. Collapsed cans are regular round can bodies, which are formed, soldered, and then flattened. A collapsed can is shown in Figure 65. The can lids are wrapped in rolls of paper and packed in a separate carton. This results in a reduction in cubic measurement of about 75 per cent plus other economies in cartons, handling charges, etc. In addition, the cans are less likely to be damaged than they would be if fully formed.

Not all can sizes are available in collapsed form. Generally, only about 10 of the most popular sizes, including numbers 2, 2-1/2, and 10 are available. In general, the can companies will not prepare and pack small numbers of collapsed cans. If an order for less than 100,000 cans of a given size and type is received, the order will not be filled until additional orders totaling 100,000 of the same style of cans are received.

Special equipment is required at the canning plant to reform the collapsed cans. However, it is estimated that for a single shipment of 100,000 collapsed cans the saving in the overseas freight cost will be sufficient to purchase the reforming equipment.

1955 prices for collapsed cans in the United States packaged for export shipment are listed in the following table.

Can Size	Cost per Thousand Cans
No. 2	$35.20
No. 2-1/2	46.67
No. 10	111.40

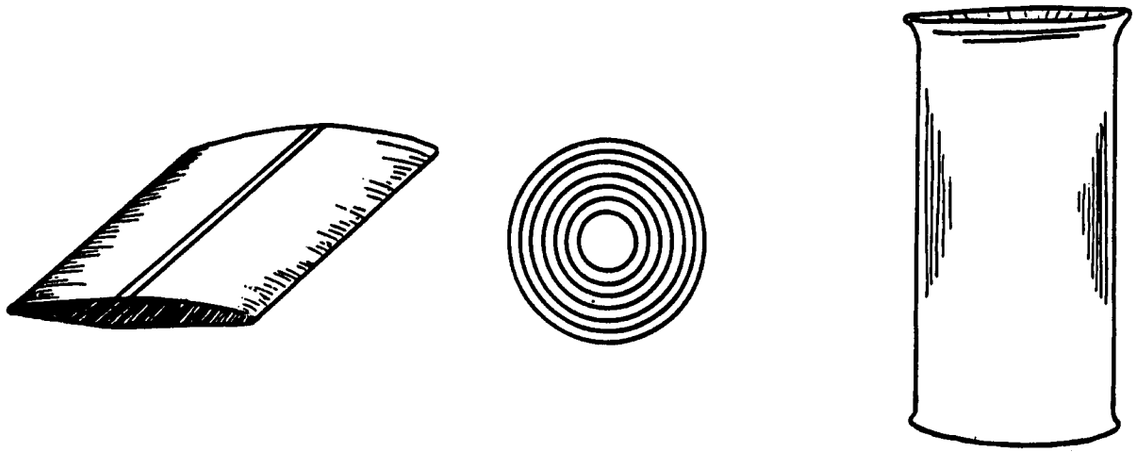

Figure 65. Collapsed Tin Can and Lid. The Reformed Can with Bottom Attached is Shown at the Right
(Based on photograph by Continental Can Company)

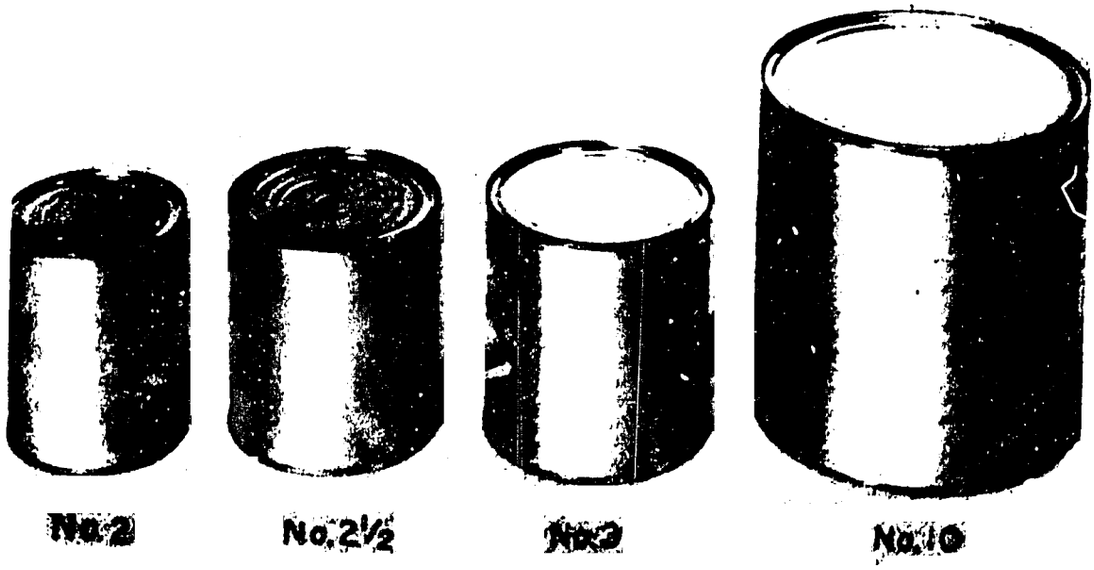

Figure 66. Comparative Sizes of Tin Cans
(Courtesy of United States Department of Agriculture

c. Can Making. A can manufacturing plant requires a large initial investment for machinery such as slitters, body formers, flangers, presses, and special dyes and tools. A manufacturer of can-making machinery estimates that the equipment necessary for producing 1,000 to 3,000 cans per day would cost approximtely $38,000 packaged for export shipment from the United States. The following equipment would be necessary for this production rate.

Quantity Required	Equipment
2	Body blank slitting machine
1	Press with dye for notching corners of body blanks
1	Roll forming machine
1	Machine for forming hooks and locking side seams
1	Machine with tools for flanging ends of can bodies
1	Machine with tools for double seaming end to can body
1	Machine for testing open-end cans for leaks
1	Machine for locating leaks in leaking cans
1	Machine for slitting strips from which can ends can be blanked
1	Press with dye for blanking can ends
1	Machine with tools for double seaming top to filled cans

In addition to the above, equipment is required for soldering the side seam after it has been formed and locked in place. A compound-applying machine is also required to apply a gasket seal to the can ends before they are seamed to the can body. This compound is used to assure a good, air-tight seam.

Approximately 14 operators are required in the can manufacturing plant.

It would not be economical for small canning plants to manufacture their own cans. However, it appears that can manufacturing plants could be located in central points to supply canning plants in the local area.

3. Types of Cans

Three varieties of tin cans are available. These are known as plain, C-enamel, and R- or sanitary-enamel cans. The word "enamel" refers to a lacquer coating applied to the inside of the cans to prevent or retard certain chemical reactions. These chemical reactions generally discolor the product but are not harmful to the canned product

a. Plain.
See Federal Specification PPP-C-29c, February 20, 1967, "Canned Subsistence Items, Packaging and Packing of."

b. C-Enamel. C-enamel cans are used primarily for non-acid foods such as corn, lima beans, and peas and for meats and poultry. They should not be used for acid fruits and vegetables since these foods will cause the enamel to peel off.

c. R- or Sanitary-Enamel. R- or sanitary-enamel cans are used for acid foods, especially red-meated fruits and vegetables, to prevent bleaching of color. Pumpkin, squash, beets, etc., should be canned in these cans to prevent corrosion.

4. Storage

If preformed cans are used, they should be stored in their shipping cases, and every effort should be made to keep them clean and dry. The lids should be packed in lots and wrapped in paper to keep them clean and ready for use.

If collapsed cans are used, only a small supply should be reformed at a time. The remaining collapsed cans should be kept in their cartons. A sufficient supply of cans should be reformed so as not to hamper production. In order to keep the lids clean, they should be left in their wrappers until needed.

C. Glass Jars

1. General Features

Glass jars suitable for canning should be designed so that they can be sealed air-tight and withstand the heat and pressure to which they will be subjected in the canning operation. If this type of glass jar is available it may be safely used for canning any product.

Glass jars have a number of advantages over tin cans:

1. Glass jars may be reused as long as they are not damaged.
2. Foods packaged in glass jars are attractive since the product can be seen.
3. Some highly corrosive products, such as rhubarb and strawberries, react with tin even when it is enameled and tend to lose their color. These products may be canned safely in glass.

Glass jars have a number of disadvantages, however:

1. Glass jars weigh more than tin cans.
2. Glass jars are subject to breakage.
3. Glass jars have slower heat penetration, and they cannot be cooled as rapidly as tin cans.
4. Products canned in glass jars generally must be stored in dark places as the light tends to discolor some products.

When glass jars are used for canning, a number of precautions should be observed:

1. Jars with chipped tops should not be used since they cannot be sealed properly.
2. Lids should fit perfectly.
3. Screw-top lids should be tested. This is done by putting about a cup of hot water into the jar, putting the rubber in place, screwing on the top of the jar, and then inverting the jar to test for leaks. This same test may be used for glass tops but never for vacuum-seal type lids with composition edges.
4. New, good-quality jar rubbers should be used where required.
5. Quart jars should be the largest size used for canning nonacid vegetables.
6. Jars, lids, and rubbers should be sterilized.

In countries where glass jars are not manufactured specifically for canning, special attention should be given to glass jars to be sure that they are not cracked or chipped or that they do not have uneven sealing surfaces, rough edges or rims, or rims that are not perfectly round. Even the smallest defects in the tops of jars may cause a poor seal. As an inspection one should feel the tops of the jars with the fingers and look through the jars while holding them up to the light.

2. Availability

Glass jars are not generally exported from the United States for use in canning plants in other countries. The canning plants must determine whether a supply of glass jars is available. Because of weight and hazard of breakage, storage space for large supplies of glass jars are not usually available in the canning plant. If a supply of glass jars is available locally, the canning plant must then determine if the jars meet the necessary requirements for canning purposes.

3. Types of Jars

Three types of glass jars are recommended for use in canning plants. These types of jars are known as Mason jars, wire-bail jars, and vapor-vacuum seal jars.

a. Mason Jars. In general, glass jars on which the top is screwed down are referred to as "Mason" jars. There are at least three types of closures for this jar. One type has a porcelain-lined zinc screw lid. The cap requires a separate rubber ring which fits on a ledge about an inch from the top of the jar. A second type of closure has a glass lid or disk having a separate rubber ring fitted on a ledge on the under side of the lid. The rubber ring rests on the top of the jar. A metal screw band holds the lid on during processing and cooling. A third type of seal utilizes a metal disk having a sealing compound in a groove on the under

surface of the lid. This disk can be used only once. A metal screw band holds the lid on during processing and cooling. Each of these types of closures are shown in Figure 67.

b. Wire-Clamp Jars. A wire-clamp jar is a jar with a glass lid and separate rubber rings held in place by a wire-bail closing over the lid. The rubber ring rests on a ledge at the top of the jar. This type of jar is shown in Figure 67.

c. Vapor-Vacuum Seal Jars. A third type of glass jar is known as the vapor-vacuum seal jar. This type of jar is used in most large industrial canning plants in the United States. It is similar to the third type of Mason jar discussed above except that it does not have a metal screw band which fits over the lid. Special equipment is required to use this type of lid, and it is not generally recommended for small installations. The approximate cost of equipment for using this type of jar is $10,000.

D. Glass Bottles

Glass bottles with crown caps can be used as containers for juices. Figure 89 shows an operator placing a cap on a bottle.

E. Labels

Attractive and informative labels are necessary if the products are to be sold. It is the label which must tell the customer why that particular product should be selected. A good label should bear the name of the product, the net content, and the name and address of the canning plant. If artificial coloring, artificial flavoring, or chemical preservatives are added to the food product, their presence should be declared. The grade of the product should also be indicated on the label. Each canner should be responsible for the completeness and the accuracy of the statements on his labels. More complete descriptions of the products may be added provided they are truthful. Many new labels are appealing to the customers by including information about how to use the food in the can, that is, the number of servings, recipes, etc.

Advantages of using paper labels which wrap-around the cans are: (1) the cans are made attractive and saleable; (2) the product is easily identified; (3) the can is less likely to rust; (4) the canning plant gains publicity from the label.

Cans can be easily labeled by hand or by portable automatic machines. However, automatic machines are not recommended for use in the canning plants discussed in this manual because even the smallest machines have a capacity much greater than required, and their cost is high.

Glue, casein preparations, dextrin, mucilage, or other adhesives can be used as the label paste.

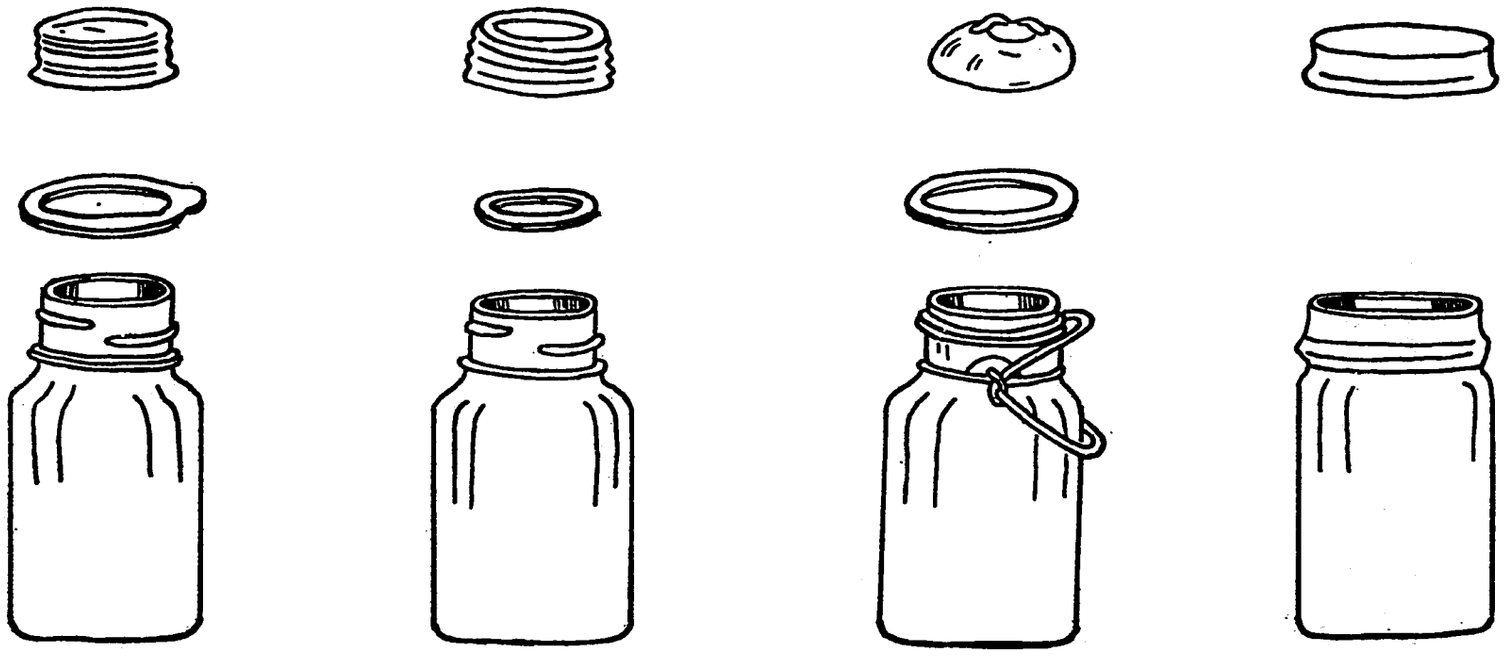

Figure 67. Types of Glass Jars

F. Shipping Cases

When cooled, the labeled cans are packaged at once into cases. Three general classes of cases are used for food products. These are nailed wooden boxes, wire-bound wooden boxes, and fiberboard (including corrugated fiberboard) boxes. In recent years in the United States, fiberboard boxes have almost entirely replaced wooden cases as shipping containers for canned foods.

If wood is used, it is very important that the wood be well seasoned. Green wood will warp and may exert enough pressure on the cans to damage them. In addition, green wood is damp and may cause the cans to rust or it may ruin the labels. The size of the cases should be such that they hold the cans snugly. They should be the exact height of the cans or tiers of cans, and only enough wider and longer to permit easy filling. An excess of 3 mm. in width and 5 mm. in length is ample. Close packing is advantageous both in the lessening of damage to cases and contents as well as in the conserving of shipping space.

Fiberboard shipping cases for canned goods in the United States have been standardized in size. The following table gives the number of cans that are packaged in cartons and also the average inside dimensions of the cartons in inches.

Can Size	Number of Cans Per Carton	Average Inside Carton Dimensions in Inches Length x Width x Depth
No. 2	24	13-13/16 x 10-3/8 x 9-1/8
No. 2-1/2	24	16-5/16 x 12-1/4 x 9-3/8
No. 3	24	17-1/2 x 13 x 10
No. 10	6	18-5/8 x 12-3/8 x 7

IX. PERSONNEL

A. General Considerations

The number of people to be employed in a canning plant depends upon the size and the capacity of the plant. Regardless of the number of people employed, however, a high standard of performance on the part of each worker is essential to make the organization effective.

The supervisor should prepare work plans for each job. These work plans should be simple and specific in order that the workers may easily understand them. Assignments of jobs should then be made in relation to the ability of each individual worker.

B. Job Descriptions

Job descriptions for the three types of jobs in plant A are given in Job Description Numbers 1, 2, and 3. Job descriptions for the eight types of jobs in plant B are given in Job Description Numbers 1, 4, 5, 6, 7, 8, 9, and 10. Job descriptions for the eleven types of jobs in plant C are given in Job Description Numbers 1, 4, 5, 8, 9, 11, 12, 13, 14, 15, and 16.

JOB DESCRIPTION NUMBER 1

PLANT SUPERVISOR FOR PLANTS A, B, AND C

Duties: The plant supervisor's functions are many and varied. He hires and assigns duties to all workers, trains workers in correct methods, performs or supervises all office tasks, maintains high standards of health and safety in the plant, and oversees all plant operations. In addition, he makes adjustments on the sealers and tests pressure gauges. During the period when the plant is closed down, he inspects all equipment and sees that it is repaired as required.

Education: The plant supervisor should have an adequate training course in the field of food technology and should be qualified to perform any operation in the plant.

Experience: The plant supervisor should be familiar with all operations in the plant. His experience should indicate sound business ability and personal integrity and the ability to supervise people.

JOB DESCRIPTION NUMBER 2

FOOD PREPARATION OPERATOR FOR PLANT A

Duties: The food preparation operator prepares all foods, labels the containers and places them in a storage, straightens bent cans, and reforms collapsed cans as required.

Ability and Experience: The food preparation operator need not have previous experience, but he must be capable of following instructions. It is preferable that he have the ability to read.

JOB DESCRIPTION NUMBER 3

PRESSURE COOKER OPERATOR FOR PLANT A

Duties: The pressure cooker operator preheats the product, tends the pressure cooker, seals the containers, and wipes them after they have been cooled.

Ability and Experience: The pressure cooker operator must be thoroughly trained by the plant supervisor or have previous experience. He must be able to follow instructions, and it is highly preferable that he know how to read and write.

JOB DESCRIPTION NUMBER 4

CLERK FOR PLANT B AND C

Duties: The clerk is responsible for the acquisition of materials, handles all correspondence pertaining to orders, keeps inventory records, prepares financial statements for the plant, prepares employee pay checks, and relieves the plant supervisor of routine jobs.

Education: The clerk should have a general clerical education or training in the field.

Experience: The clerk should have experience in the operation of an office.

JOB DESCRIPTION NUMBER 5

JANITOR FOR PLANT B AND C

Duties: The janitor is responsible for the general clean-up of the plant. During the period when the plant is closed down, he assists the plant manager in the maintenance of equipment.

Ability and Experience: The janitor requires no previous experience.

JOB DESCRIPTION NUMBER 6

FOOD PREPARATION OPERATOR FOR PLANT B

Duties: The food preparation operator prepares all foods, labels the cans, and places the finished goods in the warehouse.

Ability and Experience: The food preparation operator need not have previous experience. He must be able to follow instructions, and it is preferable that he be able to read.

JOB DESCRIPTION NUMBER 7

FOOD PREHEATER OPERATOR FOR PLANT B

Duties: The food preheater operator preheats the raw materials, fills the containers, places cans in the exhauster, straightens bent cans, and reforms cans as required.

Ability and Experience: The food preheater operator need not have previous experience, but he must be able to follow instructions.

JOB DESCRIPTION NUMBER 8

SEALER OPERATOR FOR PLANTS B AND C

Duties: The sealer operator seals the tin cans and assists the plant supervisor in making adjustments on the sealers.

Ability and Experience: The sealer operator should be instructed on the importance of proper sealing and on how to make sealer adjustments. No prior experience is necessary

JOB DESCRIPTION NUMBER 9

CODER FOR PLANTS B AND C

Duties: The coder marks each can or glass jar with a code number or symbol after it has been sealed so that the contents of the can can later be identified.

Ability and Experience: The coder requires no previous experience. However, he must be able to follow instructions, and it is preferable that he be able to read and write.

JOB DESCRIPTION NUMBER 10

RETORT OPERATOR FOR PLANT B

Duties: The retort operator tends to retorts and wipes the cans as they are removed from the cooling tank. As time permits, he assists the plant manager in testing gauges.

Ability and Experience: The retort operator requires no previous experience. However, he must be able to follow instructions, and it is highly preferable that he know how to read and write.

JOB DESCRIPTION NUMBER 11

CAN FORMER OPERATOR FOR PLANT C

Duties: The can former operator operates the can reformer, can flanger, and double seamer. In his spare time, he assists in the plant maintenance program.

Ability and Experience: The can former operator should be experienced in operating mechanized equipment. It is preferable that he know how to read and write.

JOB DESCRIPTION NUMBER 12

FOOD PREPARATION OPERATOR FOR PLANT C

Duties: The food preparation operator prepares all foods and assists in the general clean-up of the plant.

Ability and Experience: The food preparation operator requires no previous experience, but he must be able to follow instructions.

JOB DESCRIPTION NUMBER 13

FOOD PREHEATER OPERATOR FOR PLANT C

Duties: The food preheater operator preheats the raw materials and straightens bent cans. As time permits, he assists with the general clean-up of the plant.

Ability and Experience: The food preheater operator requires no previous experience, but he must be able to follow instructions.

JOB DESCRIPTION NUMBER 14

CAN FILLER FOR PLANT C

Duties: The can filler fills all cans, assists the can former operator, and assists in the general clean-up of the plant.

Ability and Experience: The can filler requires no previous experience, but he must be able to follow instructions.

JOB DESCRIPTION NUMBER 15

RETORT OPERATOR FOR PLANT C

Duties: The retort operator tends to retorts, atmospheric cookers, and the boiler. As time permits, he assists the plant manager in testing gauges.

Ability and Experience: The retort operator must be thoroughly trained by the plant supervisor or have previous experience. He must be able to follow instructions, and it is highly preferable that he know how to read and write.

JOB DESCRIPTION NUMBER 16

LABELER FOR PLANT C

Duties: The labeler wipes the cans after they have been cooled, labels them, and places them in storage.

Ability and Experience: The labeler need not have previous experience. He must be able to follow instructions, and it is preferable that he be able to read.

X. TRAINING

A. Technical Skills

The supervisor or manager of a canning plant should be familiar with all the operations involved in the plant and should have an adequate training in the field of canning. This training is best obtained from an extensive course on food technology and practical experience in a canning plant.

It is not necessary that other workers have special technical skills, however, it is essential that the workers be very cooperative and continuously train on the job to develop desirable work habits, especially the habit of following work directions accurately in order to assure good results. To some extent, the quality of the finished product depends on the attitudes of workers. Workers should be ever conscious of this fact.

B. Personal Hygiene

A specific training plan should be established to inform employees of the importance of personal hygiene. Strong emphasis should be given to explaining reasons that the various precautions are necessary. New employees should be indoctrinated thoroughly before they begin work. In addition to the training program, frequent reminders and informal inspections are needed in order to assure continuing compliance with the standards.

Points which should be emphasized in the training program include frequent washing of hands, drying of hands on towels in lavatories, keeping fingernails short and well-cleaned, drinking adequate amounts of water, and taking salt tablets to compensate for perspiration losses in hot processing rooms. In areas where it is customary to drink from a common cup or dipper, the personnel should be taught to use individual cups and discard portions of water not used. Special emphasis should also be placed on the following points:

1. Employees should not work while they have communicable diseases.

2. All cuts and infected areas should be covered with rubber gloves or bandages.
3. Clothing should be clean.
4. Tobacco should not be used in any form in the processing room.
5. Employees should never spit in the processing room.
6. Every precaution should be taken to prevent contamination of the processed foods by any foreign material including perspiration, hair, cosmetics, medicaments, etc.

C. Safety

The nature of the canning operation calls for careful observation of all safety practices if accidents are to be prevented. All employees should be instructed in safety precautions just as they are instructed in personal hygiene.

A number of hazards present in the canning plant merit special attention. Probably the most serious danger lies in handling live steam. Steam, even under the moderate pressures used in canning, can cause very severe burns if used carelessly. Extreme caution must be used in venting and opening retorts and cookers to avoid burns from contact with the escaping steam. Another serious danger from steam is the danger of explosion of boilers or even retorts and pressure cookers. Very careful control must be maintained over steam pressure and boiler water levels. In addition to the automatic control of the boiler burner and water level, safety valves should be provided to prevent excess pressures, and only trained, competent personnel should be permitted to tend the boiler.

Other sources of accidents lie in handling knives and other sharp utensils, lifting hot pots, spilling hot liquids, and moving heavy loads.

Supervisors should watch for unsafe practices and correct them quickly when they occur. All equipment should be maintained in safe operating condition. Employees should be taught the proper precautions to be taken in using the equipment, and they should know when to use protective gloves, clothing, and equipment. Employees should be familiar with at least rudimentary first-aid measures. Finally, a standard procedure should be adopted for dealing with accidents when they occur, and all employees should be thoroughly familiar with it.

CHAPTER THREE. OPERATING PROCEDURE AND PROCESS DATA

I. GENERAL CANNING OPERATIONS AND PROCEDURES

A. Produce

1. Purchasing

In order for a canning plant to run smoothly and efficiently, it is necessary that the plant have available a variety of commodities of acceptable quality throughout the year. To accomplish this, the largest canning plants sometimes employ field men who keep in frequent touch with the growers throughout the year and advise them on planting, pest control, harvesting, and transporting products to the canning plant. The field men inform the growers of the best types and varieties of products for canning and encourage them to plant those varieties. In some instances, the canning plants even furnish the plants or seeds and contract with the grower for the season's crop.

Any purchase contracts between the canning plant and grower should be written to avoid misunderstanding and help in settling disputes.

2. Receiving

Post-harvest deterioration of fruits and vegetables prior to canning cannot be stopped, but it can be slowed down if the products are properly handled and if little delay occurs between the harvesting and the canning operations. If possible, the products should be harvested and transported during the cooler portions of the day, and possibly at night. Bulk handling should be avoided; batch sizes should be kept small so that heat is readily dissipated. Bruises, skin punctures, and other external injuries should be kept to a minimum, especially if the products are to be stored. Containers which are free from dirt and mold should be used for transporting the produce.

Products should be received at the canning plant only during those hours scheduled by the manager. Thus, the plant can operate on a regular schedule. When the products arrive at the plant, they should be examined to determine their suitability for canning. The examination, if properly carried out, improves the quality of the finished product. It is important that the produce showing marked signs of spoilage be rejected at this stage. When available government "standards for grades" of fresh produce should be followed by inspectors.

3. Grading and Sorting

Grading of fruits, vegetables, and meats before canning gives greater uniformity to the finished product and standardizes certain steps

in the canning process. Grading of fruits and vegetables for size and maturity is necessary where lye peeling is practiced.

In some of the larger canning plants, two or more grades of produce are canned. The highest grade is that which represents the quality most desired by the consumer. The lower grades represent products which are not so desirable, but which may have equal food value. Appearance and flavor are the primary factors influencing the grade. The grading system should completely eliminate all culls or unacceptable products.

The condition of meat and fish is determined by a number of factors. The appearance and the odor are important factors in judging the freshness. In grading fish, special attention should be given to the appearance of the gills, eyes, and flesh. The flesh should not be flabby in texture. Shrimp and sardines and similar seafoods must be graded as to size also. Carelessness in sizing results in a poor appearance of the finished product.

Upon arrival at the canning plant, fruits and vegetables are graded roughly according to quality and size. For small-scale operations, this grading can be done entirely by hand. In large canning plants, however, the grading is done mechanically by vibrating screens, rotating cylinders, weighing methods, or various conveyor-grading devices.

Sorting and inspecting do not end in the receiving room; they continue throughout the preparation period. Produce must be sorted according to maturity, grade, size, and freedom from imperfections. All bruised, shriveled, discolored, or soured portions should be removed. Questionable portions of any product should be discarded rather than risk spoilage at a later stage. Foreign material such as dirt, rocks, stems, leaves, or other matter should also be removed to decrease the workload of the washing operation. If the product has been held in preliminary storage, it should be carefully inspected for results of overheating such as sliminess, sweating, or overmaturity.

4. Preliminary Storage

Before the raw materials are processed at the canning plant, delays necessitating preliminary storage of the materials may occur. Every effort should be made to process vegetables, meats, and most fruits on the day harvested or received. However, delays in processing may occur due to any of the following:

1. Accumulation of raw materials in the canning plant
   a. Raw materials should be available in the plant in the morning before the harvest is in.
   b. Raw materials must sometimes be stored over the weekends and holidays. It is usually better to hold fruits and vegetables in the field than in the canning plant. Mondays are usually slack days in a fruit or vegetable canning plant.

c. The raw materials produced at the peak of the harvesting period may be greater than the plant capacity.
d. Raw materials are sometimes accumulated to extend the canning operations beyond the normal period of harvest.

2. Transportation of raw materials great distances;
3. Breakdown of equipment or lack of labor.

Even though the various products are stored prior to canning, the products continue to mature. The loss of water by chemical and physical breakdown is of major consideration. Such processes within the harvested vegetable or fruit will govern its storage life. Respiration is also important in that it goes on continuously. This process produces heat and is frequently the cause of self-heating in harvested produce. Sugar is lost during the storage. Loss of sugar detracts from the flavor, sweetness, and general excellence of certain fruits and vegetables. During storage, especially at high temperatures and humidities, all fruits and vegetables may become susceptible to molds and other diseases, and some vegetables become tough.

Certain precautions should be observed to reduce the degradation or raw materials during preliminary storage. The storage area should be well ventilated in order to readily dissipate the heat generated in the food product. Shade, water baths, precooling, and even cold storage when available should be used. Moldy or dirty containers should never be employed for storage. Many field boxes are sterilized by steaming before being reused.

B. Preparation

1. Fruits and Vegetables

a. Washing. Washing of the raw materials is one of the most important steps in canning. Washing reduces the mucilaginous coating and dirt which are the main materials that contribute to the bacterial load. Washing also removes any spray residue that has been left on the product. For the washing operation, a clean water supply should be available. If the produce is washed in pans or tanks, the water must be changed often enough to insure that the product is thoroughly cleaned.

Fruits and vegetables may be washed in several ways, and to some extent the type of wash depends upon the type of product being cleaned. Soaking is frequently employed as a preliminary treatment. It softens the sticking coating and loosens the dirt which can then be removed more readily by other processes. Hot water is a more effective soaking agent than cold water. The water should be changed frequently otherwise the soaking process may contaminate the product rather than clean it. The efficiency of the soaking process is enhanced if the products are agitated. Long soakings are undesirable because they slow up the preparation processes and reduce the vitamin content of the food. It is necessary to scrub root crops with a vegetable brush after soaking in order to remove all residue.

Figure 68. Grading and Sorting Fruit
(Courtesy of Louisiana Department of Education)

Figure 69. Washing by Dipping
(Courtesy of Colonial Film and Equipment Company)

In small canning plants, washing after soaking is probably best accomplished by hand. The water must be changed often and must be clean. The product should be lifted out of the water rather than be allowed to stand in the water as it drains from the product. When washing small fruits, a large strainer or wire basket of small mesh can be used. The product is placed in shallow layers in the container and cleaned by dipping the basket up and down in water until all dirt and foreign material has been removed.

In large canning plants, washing is usually done by mechanical agitation. A simple form of washing by agitation consists of conveying the product through a current of rapidly running water. Compressed air may be used to agitate the water. In some cases, the soaking tank may be constructed so that a propeller agitates the water and improves the washing process. Rotary washers are also satisfactory. In these washers a drum, or series of drums, through which the products are conveyed rotates in a tank of water in which the water is changed continuously or frequently.

High-pressure spray nozzles are by far the most satisfactory method for washing raw materials in either large or small plants. The efficiency of the cleaning operation depends primarily upon the pressure of the water, upon the fineness of the spray, volume of water and upon the distance of the spray nozzles from the product being washed. A spray in which a small volume of water under pressure is used is more effective than one in which a large volume of water under low pressure is used. An efficient method of cleaning consists of first soaking the material thoroughly in soaking tanks to loosen adhering soil or spray residue and then using spray nozzles. A combination of spray nozzles with a rotating drum is especially satisfactory in large plants.

b. Peeling. The skin or outer covering of some fruits and vegetables must be removed in the preparation process. The operation varies considerably in difficulty with the various products. It is important that the peeling operation be performed efficiently to prevent excessive loss of useful product. All pieces of outer covering should be removed because they influence food spoilage and give the product a poor appearance.

(1) Hand peeling. In small canning plants, hand peeling is normally practiced. The peel of the fruit or vegetable is removed by a paring knife or by special utensils such as a knife with a curved blade and an adjustable guide which permit regulation of the depth of peeling. Hand peeling is somewhat slow and tedious and frequently results in a great amount of waste.

(2) Machine peeling. For large installations, mechanized equipment is used for peeling the product. Mechanical peelers may be either batch or continuous. Many of the mechanical peelers are of the abrasion type. This type of peeling is particularly useful in peeling potatoes, carrots, and other root products which can withstand rough handling.

These peelers consist essentially of rough surfaces which rotate against the product to be peeled. This type of peeling entails considerable waste especially with products that have irregular shapes. If waste is cut to a minimum the amount of hand trimming involved is considerable. Where large outputs are required, however, abrasion peeling is often practical.

(3) Aids to peeling. There are several practical procedures for loosening the skin of fruit and vegetables in order to make peeling simpler.

(a) Scalding. Scalding is a heat treatment which aids in the removal of peel from products such as tomatoes and peaches. Boiling water is used to soften the skin of these products so that it can be removed easily. It is important that the water be boiling because water at lower temperatures tends to soften the fruit rather than loosen the skin. In order to scald the produce, it should be placed in a wire basket and dipped in boiling water only long enough to heat the skin. The product should then be dipped quickly into cold water, after which the skin can be easily removed by hand, by machine, or by jets of water. The cold-water dip prevents partially cooking the product, facilitates handling, and shrinks the peel causing it to crack. A cold spray is sometimes used instead of the water dip. In either case, cooling should last only long enough to cause shrinking and cracking of the peel. The produce should not stand in the cold water; it should be taken immediately out of the water and drained.

(b) Steaming. Steaming is similar to scalding in that heat treatment is used to aid in the removal of the outer covering of the product. Instead of boiling water, steam under pressure is used to supply the heat. In order to obtain uniform peeling, the products should be graded as to size and the heating time adjusted accordingly. The product should not be cooked, however.

For small-scale operations, the processing retorts can be used for steaming. In larger plants, steaming units may be used. These units may be either batch or continuous types. A batch-type unit consists of a closed vessel in which the material to be peeled is subjected to the action of steam for about 1-1/2 to 2 minutes. A continuous-type steam peeler consists of a conveyor which passes the product to be peeled through the peeler where it is subjected to a steam treatment.

After the skins have been steamed, they may be removed either by hand, by abrasion-type peelers, or by jets of water.

(c) Flame peeling. Flame peeling is normally employed in large canning plants. The process is used for products such as potatoes and pimientos. The process consists of passing the product through a furnace where the skins are charred or blistered by the action of direct gas flames. The charred skins are then easily removed either by hand or by jets of water. The advantage of such a process is that the peeling loss is very low.

(d) Lye peeling. Lye peeling is widely used for the peeling of fruits and vegetables and gives very satisfactory results. The process is frequently used on peaches, sweet potatoes, white potatoes, apricots, and carrots. The process consists of passing the product through a bath of boiling, dilute sodium hydroxide solution. The boiling lye solution causes the outer skin of the product to separate from the flesh beneath it. The flesh is insoluble in the dilute lye solution. The lye acts most vigorously when hot, and therefore should be kept at the boiling point.

The concentration of the lye and the time of immersion depend upon the type and quality of the product being treated. For this reason, it is important that the products be graded prior to this process for size and maturity. Underripe fruits require a more concentrated solution than fully-matured ones. The concentration of lye can be kept at a minimum for a given degree of effectiveness if the produce is first heated by dipping it in boiling water. The concentration of the solution and the time for immersion can be found in the canning instructions for specific products. It is important not to exceed these specified concentrations and immersion times.

After an immersion time of from 1/2 to 5 minutes, the product is immediately washed. Washing is necessary to prevent the lye from attacking the edible tissues and also to prevent the lye from impairing the quality and flavor of the product. It is also important to remove traces of lye to prevent browning of the treated material. In lye peeling, the loosened skin is removed by washing with jets or by tumbling in a rotary washer.

The equipment used for lye peeling need not be elaborate. Simple equipment consists of a tank to hold the lye solution and some means of transporting the material to be peeled through the solution. Slate or granite containers should be used because lye solutions disintegrate wood and react with aluminum. The transporting device can be a screen basket which may be lowered into the solution or it can be a conveyor belt or other mechanical device.

It is frequently desirable to employ lye peeling in the processing of certain products. Lye peeling reduces the cost of peeling, permits more rapid handling of the product, and reduces the loss frequently encountered in other means of peeling. When lye peeling is used, however, it is important that workers understand the process, in order to avoid injury.

c. Cutting and Breaking. In the preparation of fruits and vegetables there are many and varied operations which must be performed. Cutting, breaking, removing stems, husks, and other inedible portions are all operations which pertain to the various products. These preparation operations should be performed as rapidly as possible in order to prevent or lessen discoloration. A specific procedure tends to assure that the finished product is of high quality. In the small canning plant the operations are normally performed by hand. As the size of plant increases however, more and more specialized equipment is frequently utilized.

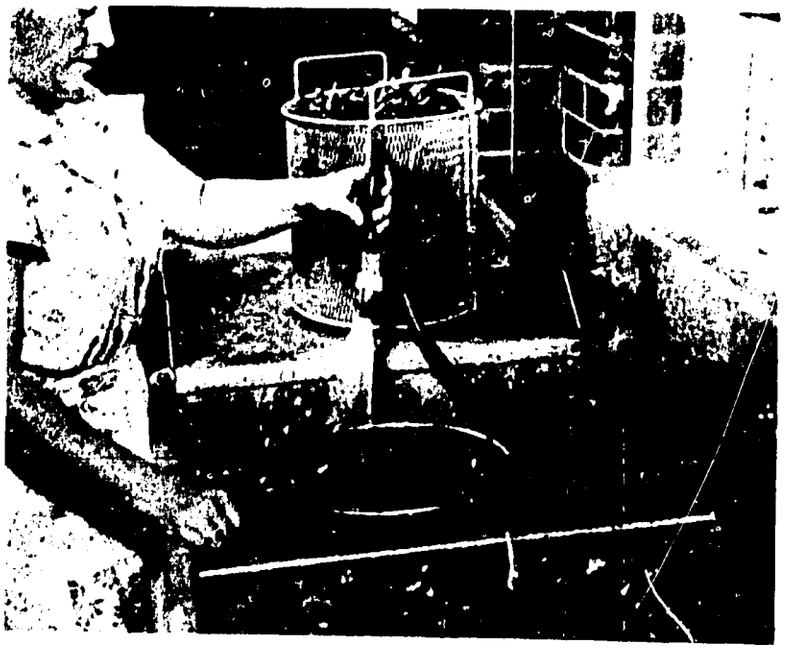

Figure 70. Washing with Spray
(Courtesy of Colonial Films and Equipment Company)

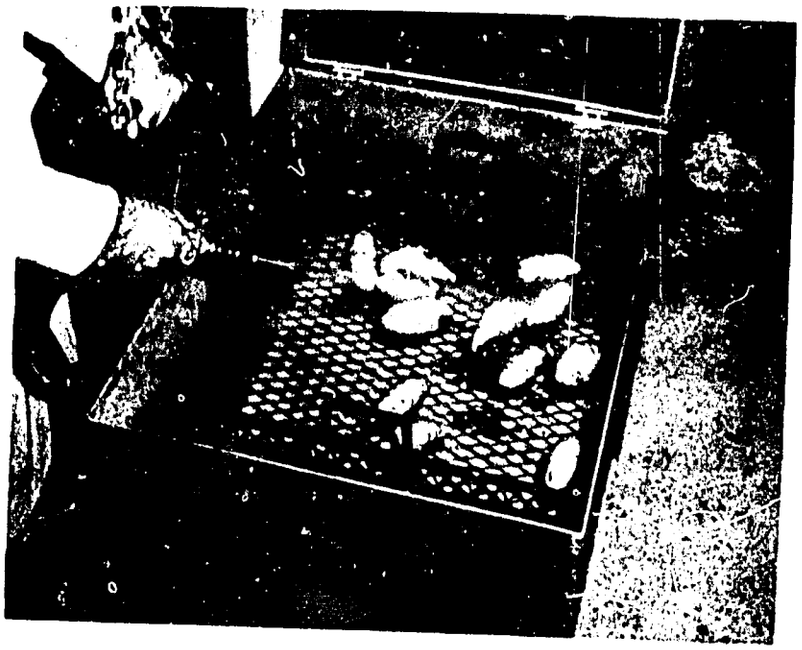

Figure 71. Lye Peeler in Operation
(Courtesy of Louisiana Department of Education)

It is important to achieve uniformity in size during the cutting and breaking operations. Uniformity is essential in obtaining a product having a good appearance, and it is an aid in the processing of the product. Heat penetrates more evenly during the processing when the produce is cut or broken into uniform sizes.

d. Shelling. Hand shelling of peas and beans is economical only for very small operations. For operations of more than two or three bushels, shelling is more economically performed by automatic shelling devices. Even for small plants whose input of pea and bean products is relatively large, the automatic shelling devices should be utilized. Such devices rapidly produce large quantities of shelled products. Care should be taken in the use of such machines that foreign material and broken shells are not included in the fill. The product shelled in such a manner may be bruised and should be handled rapidly.

e. Coring. Coring, like shelling, is usually performed by hand in small plants. Several specialized utensils, such as pear loop corers and peach pitting and tomato coring knives, are available for such work. In larger plants, coring machines are available which can core fruit automatically.

f. Preventing Discoloration. There are several causes of discoloration of foodstuffs during the canning operation. The most frequent cause of discoloration is due to oxidation of the food itself. Peeled or cut fruits and vegetables, in particular, tend to oxidize if there is delay in the preparing process. Some products are discolored through the use of iron or copper equipment or utensils; other products become discolored if the improper type of can is used. Light causes some canned food to fade and others to darken; overcooking causes many foods to become brown.

Once fruits and vegetables have been peeled, sliced, or cut, oxidation may be reduced to a minimum if certain precautions are taken. Most frequently, if delay cannot be avoided in the process, the peeled fruits and vegetables are dipped in water or various solutions depending on the product involved. Solutions of brine, ascorbic acid, citric acid, vinegar, or lemon juice are often used. The solution used for a specific product is specified in the canning instructions. The time that the product should remain in the solution depends on the concentration of solution and the product. Prolonged soaking may cause the product to become too salty, too acid or water logged. If no delay is expected in the preparing operation this special treatment is not required.

In order to prevent discoloration due to copper or iron utensils, it is recommended that aluminum, tin, unbroken granite, wood or porcelainized containers be used. Stainless steel knives and other cutting utensils should also be used.

The proper can or container must be utilized if discoloration is to be prevented in the canned product. Products containing large amounts of sulfur must be processed in C-enamel cans. If plain cans are used, the sulfur in the product may combine with the metal to form sulfides which in turn discolor the product. Such discoloration is not harmful when eaten but causes the finished product to be unattractive. Plain tin cans tend to bleach some foods, especially red fruits.

Discoloration may also occur in any type of tin container or glass jar in which the head space is too large. In such a condition, a brown discoloration of the product frequently occurs due to oxygen in the head space which combines with the food. This type of discoloration may be avoided by reducing the head space or packing under vacuum.

g. Pulping. Pulping is a process used to break down such products as pumpkin, apples, tomatoes, sweet potatoes, and others. The product is usually steamed to soften it for pulping. A steam-jacketed kettle or retort may be used. The produce should be of the highest quality and should be washed carefully and cut into uniform pieces in order to assure uniform steaming. Peels and rinds may be left on since they are removed in the pulping process. The product is subjected to steam pressure until it is of the desired consistency. Retorts used in this process are operated in the same manner as when used for processing.

After the product has been steamed, it is passed through a sieve where the skins, seeds, cores, and fibrous materials from the pulp are removed. For small operations, hand-operated sieves may be used. Pulping machines are desirable where large quanitites of produce are to be processed. In this operation, the work must be carried out rapidly in order that the product does not become oxidized.

h. Reducing. After products such as pumpkin have been pulped it is frequently desirable to evaporate the liquid from the pulp mass. This may be accomplished by heating the material in a steam-jacketed kettle or similar container until it reaches the desired consistency. The texture of the product is improved by such reducing. It is also desirable to reduce soup stocks to improve their flavor and to decrease the number of cans required for a given volume of initial product.

i. Blanching. Blanching is a heat treatment in which the raw food material is immersed in hot water or exposed to live steam. The process is generally followed by a cold dip or a spray. Blanching serves a number of purposes. One of the main purposes is to shrink the raw product. Such action allows the packer to place more product in the container. At the same time, the product becomes more pliable and is more easily packed into the container. Blanching also expels gases from the plant cells, which tend to improve the final product. It cleans the raw material and reduces bacterial contamination. Blanching of products such as peas and beans removes the thick mucilaginous substances from the surface. It

inhibits further enzymatic action, retards browning of the product, and gives rise to a superior quality. Blanching may facilitate peeling, cutting, or slicing. It improves the flavor and color of some products. Frequently, the objectionable raw flavor is removed and the natural color of some products, particularly the green or yellow ones, is fixed. The operation may cause a reduction in the swelling in cans due to the water absorbed during the operation. Blanching acts as a final cleaning of the product before it is packed in the cans. Finally, the heat associated with blanching hastens processing if it is processed before it is cooled.

Blanching may be accomplished either by steam or by hot water. Hot water blanching causes a loss of nutrients due to the leaching action of the water. Nevertheless, due to practical difficulties of steam blanching, hot water is frequently used.

Hot water blanching may be carried out either in batches or continuously. Small canning plants generally use batch blanching. Blanching in batches is carried out by placing the material in wire baskets and immersing them in boiling water for a given length of time depending upon the product being blanched. Best results are obtained when the baskets are filled only one-half to two-thirds full. Overfilling results in an unevenly blanched product. Leafy vegetables tend to mat during the blanching operation, and for this reason the baskets should be moved back and forth in the blanching water. The blanching should continue only long enough to obtain the desired texture and the color change. Overblanching in water tends to produce a slimy texture, reduces the color and flavor, and causes a loss in nutrient value.

For large-scale operations, blanching should be of a continuous nature. It is frequently found that the blanching equipment is especially designed for individual products. In general, however, after the product is prepared, it is conveyed through water or steam by various mechanical devices which can be adjusted to subject the raw material to the desired temperature for the desired period of time.

After blanching, most products are cooled by cold dip for a short period of time or by a spray of water. It is essential that the cooling take place immediately in order to avoid cooking the food. Cooling also facilitates the separation of the individual pieces of the product.

If a delay is expected in the processing of the blanched product, the blanching operation should be postponed. Spoilage occurs more readily in heated products than in cool ones. Rather than risk spoilage, the prepared product should be left in the medium which prevents discoloration.

For some small scale operations, raw products such as greens may be steamed in the pressure cooker in order to blanch the product. A tightly covered kettle in which water has been placed to prevent burning may also be used for this blanching. Such blanching is sufficient to make products such as greens pliable enough to pack into the containers.

Figure 72. Coring by Hand
(Courtesy of Louisiana Department of Education)

Figure 73. Pulping
(Courtesy of Louisiana Department of Education)

Figure 74. Dressing and Trimming Meats
(Courtesy of Dixie Canner Company)

2. Meats, Fish, and Poultry

a. Dressing and Trimming. All meat for canning, including fish and poultry, should be from healthy animals of good quality. The quality of the animal or the fish is determined in the grading and sorting operations. The dressing and trimming procedures depend on the type of product being prepared.

In preparing meat, the choice sections are cut into pieces which will fit into the cans. Most of the fat, the gristle, and bone are removed. Tough portions of the butchered animal can be ground together with limited amounts of fat and prepared and canned as ground meat or hamburger. Bones, fat, and particles of meat can be cooked to produce a broth for use as a canning medium.

Poultry can be canned either with or without the bones. Young birds may be canned, but the texture and flavor of the meat are not as good as mature birds. The quality of the bird is determined in the grading operation. Chickens or other types of poultry should be dressed as for cooking. The gall bladder should not be broken because it will spoil the meat. Lungs, kidneys, and eggs should be removed. The poultry should then be cut into sections containing the meaty portions, such as breasts, thighs, and legs. These sections are best for canning. The bony pieces such as the backs, wings, and necks, can be used in preparing broth for the canning medium. Giblets, particularly livers, should be canned separately.

Fish should be cleaned and the head, fins, viscera, and other waste material removed. The backbone is also removed in some types of pack. Large amounts of water should be used in cleaning fish. They should be cleaned by soaking, washing by agitation, or by spray washing. As with fruits and vegetables, tank washing may act as a source of contamination rather than a cleanser if the water is not changed often. Soaking removes blood effectively but tends to soften the texture of the meat, unless brine is used. Agitation and spray washing increase the efficiency of the washing operation. Fish are normally cut into container-length pieces after washing, depending upon the type of pack.

The preparation of shell fish and crustaceans are discussed later in this manual under individual products.

b. Boning. Poultry is sometimes boned before canning. Birds should be selected which have been prepared and thoroughly chilled. The meat is completely removed from the bones. It is desirable to keep the meat from the various sections intact as much as possible.

c. Precooking. Precooking of meats is performed where exhausting facilities are not available and where a hot pack is desired. The meat is cooked prior to filling the can, or it is precooked in the can. The amount of precooking is determined by the individual meat being prepared.

3. Juices

a. Washing. Washing of fruits and vegetables in the preparation of juices is carried out in the same way as in preparing these products for direct canning. It is just as important to have a complete wash in preparing products for juicing as with the canning of the fruits and vegetables directly.

b. Crushing. Some fruits, such as apples and grapes, contain the juice throughout the fruit. In order to extract the juice, the fruit must first be crushed. For small-scale operations the fruit can be crushed by various types of grinders. For larger-scale operations, specialized equipment is available. Other fruits, such as citrus fruits, are not normally crushed. The juice from these fruits may be extracted without crushing.

c. Extraction. Juice is extracted from fruits by pressing the fruit in one of many different ways. For large-or small-scale operations, crushed fruit can be placed in heavy cloth bags and the juice extracted by exerting pressure on the filled bag. Juice can be extracted directly from some fruits, such as tomatoes and berries, in hydraulic presses.

For fruits such as apricots, peaches, and tomatoes, pulpy juices are normally prepared. The raw fruits are passed through some sort of pulping machine or device to produce a puree-like liquid containing a lare proportion of suspended solids. It is frequently unnecessary to remove the peeling or outer skin from the fruit when prepared in this way. However, if the skin produces an undesirable flavor, it must be removed prior to this operation.

In citrus fruits, the juice-containing sacks are surrounded by a thick, heavy skin which must be removed prior to extracting the juice. This skin contains undersirable components which would impart a bitter flavor to the extracted juice. There are many devices which can be employed to extract the juice. Such devices ream the juice from the fruit. A glass or porcelain juice cone may be used in preparing small amounts of juice. For larger quantities, a mechanical juice extractor should be employed. By use of the reaming method, much of the rag and cell tissue is kept out of the juice. This improves the flavor of the prepared juice. It is important that the amount of aeration be kept to a minimum during the extraction of juices by any method.

d. Filtration. Some juices are improved in appearance if they are filtered or clarified. Normally, juices such as citrus, apricot, peach, and tomato are not filtered.

Many types of filters are available. A simple filter that can be used for a small-scale operation consists of a bag of any heavy cloth. The bag serves to remove the suspended solids that are not desired in the finished

product. Other and more intricate filters are available for large-scale operations. Filtering may frequently be improved by the addition of certain filter aids to the fruit as it is crushed, such as infusorial earth. By using such a filter aid, filtering is more rapid, the cloths are kept cleaner, and the resultant liquid is much clearer.

e. Settling. Settling accomplishes the same objective as filtering in addition to removing undesirable tartrates. However, the time required is much greater than that required for filtering. The juice that is to be clarified is placed in a tank or vat. When the suspended solids have settled, the cleared liquid is syphoned from the tank or vat.

C. Preparing Containers

Containers should be inspected and cleaned before they are used for canning. These operations, if properly carried out, will minimize spoilage of the prepared product.

1. Tin Cans

It is important to use the type of can which is recommended for the product being canned in order to prevent discoloration of the product.

Tin cans should be carefully inspected for broken seams, rust spots, and dents. Cans with defects should not be used.

The good cans should then be washed in warm water and rinsed in clear water. The can ends should not be washed as this may damage the gaskets. The ends should be kept in the cartons until the cans are ready to be sealed. The cartons protect them from dust and moisture until they are used. They should be taken directly from the carton and placed on the can just before sealing.

2. Glass Jars

Glass jars should be tested because the canned products will spoil if the seal is imperfect. Glass jars and caps should be inspected. All jars with cracks, chips, or imperfect rims and all lids with cracks, chips, or dents and surfaces which would prevent an air tight seal should be discarded.

After testing, jars, lids, and rubber rings should be washed in warm, clean water and rinsed well in clean water. The manfacturer's instructions should be followed for scalding or boiling metal lids that have a sealing compound. If no directions are given, they should be scalded in boiling water just before they are placed on the jars.

After the jars and the lids that have separate rubbers are tested and cleaned, they should be placed in boiling water. The rubbers should

be placed on the jars before they are placed in the water. The jars should be kept in the boiling water for at least 15 minutes prior to filling in order to sterilize them. If the jars are to be filled hot, they should be kept hot until filled. Boiling water should be poured over lids with composition gaskets to rinse them and allow them to stand until used.

D. Filling

Filling of containers with the prepared product should take place immediately after preparation. In packing all types of canned foods it important that the filling operation be carried out accurately and uniformly. The product is filled to the desired level in the container, and the proper head space maintained. The canning medium is added, and the container is then ready for the next operation.

1. Methods of Filling

Filling may be carried out by hand or with automatic or semi-automatic machines. The choice of the method is governed to some extent by the products involved. Delicate products such as asparagus or berries, are often too fragile to withstand completely automatic machine handling. The principal objection to machine filling is that it is not always neat. For this reaon, when good workmanship in filling is desired, hand filling should be used even though it is slower and possibly more costly.

Hand filling is normally practiced in all small-size plants. When tin cans are used, the product is labeled, funneled, or placed piece-by-piece into the can to the desired level. Some products such as fruits may be packed into the cans as they are prepared. They are packed closely to obtain a well-filled can. Cans may be filled quickly with peas, beans, or corn by using the can as a scoop and dipping up the prepared product with one hand while using the other hand to press the product into place. Only one dip of the can into the product is required, and the container can be filled at a much higher temperature than when done by other methods. The bottom of the can should be tapped lightly to settle the product in it. The product is added to the desired head space. A scoop may be used for filling berries into cans in order to avoid unnecessary handling.

When glass jars are used, they may be filled in much the same manner; however, they require more specialized treatment. The jars must be preheated or tempered if hot products are placed in them. The hot jars should not be placed on cold surfaces while being filled. A board or pan containing hot water can be used. For jars utilizing rubber rings, the rings must be in place. The hot food is then quickly filled or placed in the jars to the desired level. The food is well covered with the canning medium, and air bubbles are worked out with a knife blade.

For hand filling in larger plants, the containers may be placed on a conveyor belt passing down the center of a long table. Workers are located

on both sides of the table. They either remove the containers from the conveyor belt, fill them, and replace them on the conveyor belt or fill the containers as they pass down the belt. Frequent checks must be made to see that the containers are being properly filled.

In plants where very high daily outputs are required, fully automatic fillers are used. These machines handle liquids, semi-solids, and solids. They fill the products uniformly and accurately into the containers with a minimum of spilling and dripping even at high speeds.

2. Checking the Weight

Containers are sometimes filled to a given weight of product. This weighed quantity of product is usually referred to as the drained weight packed into the container. Most commercial canning plants follow this practice. Accurate scales or weighing machines are utilized in order to obtain the proper fill. Accuracy in the weighings is an economy in that it reduces the amount of "give away." With some products, the drained weight is important because subsequent processing is dependent upon this weight.

3. Head Space

Regardless of the method of filling, it is important that proper head space be allowed. Head space is the distance between the lid of the can or the lid of the jar and the contents of the container. It varies with the product and the style of pack. For most products packed in liquids, a 1/4-inch head space is sufficient when cans are used. A greater head space is recommended when glass jars are used. The head space should never be less than 1/4-inch when a canning medium is used. When no canning medium is used, however, the products are filled as close to the top as possible, leaving a minimum of head space. This reduces the amount of discoloration of the product.

Head space in tin cans is very important. If the head space is too small, there is danger that the can ends may become permanently distorted by expansion of the contents during processing. Furthermore, if there is insufficient head space, the rate of heat penetration is decreased due to the increase in the density of the pack. The processing time must therefore be increased accordingly. If the head space is too large, a relatively large amount of air accumulates in the can which may cause oxidation and discoloration of the contents.

If the containers are filled by hand, the head space should be checked occasionally. Normally, in small-scale operations, containers are filled to an approximate level as judged by experience. For mechanical filling machines, however, the machines automatically adjust the head space of the filled containers.

4. Canning Medium

A canning medium, such as brine, syrup, broth, oil, or other similar ingredient, is added to the product at the time of filling. Brine is used as a canning medium for most nonacid products; syrup is used for fruits; broth is used for meats; and oil is sometimes used for fish products. The canning medium may add flavor to the canned product, and it may bring out the natural flavor. In addition, it reduces the amount of processing required by improving the heat transfer in the processing operation and may also reduce corrosion of the tin plate by excluding air.

In making brine, a good grade salt should be used. Canners salt is preferred since it dissolves faster and stays in solution better than table salt. Conventional table salt is acceptable although iodized salt is not normally recommended for canning. A water that is free from calcium and magnesium salts should be used. In some locations, it may be necessary to preheat, settle, and filter the water. The brine can be made up prior to canning by adding a weighed amount of salt to a given volume of water. A 2 per cent solution is satisfactory for most products. It can be made by adding 1-2/3 pounds of salt to 10 gallons of water. It is essential to use stainless steel or glasslined mixing tanks in order to prevent metallic corrosion.

In the canning operations, the brine is heated to boiling and added to the product which has been packed into the cans or containers. In small canning plants, the brine is poured or ladled by hand into the container. In large canning plants, the brine is added either by hand or by automatic filling machines. In any instance, the cans and glass jars are filled as specified in the processing instructions with the medium. It is generally better to have the canning medium overflow the cans in sealing them than to leave an air space between the product and the lid.

In many canning plants, both large and small, it is customary to add salt tablets to each can instead of using brine. The salt tablets are placed on top of the product after it is placed in the can, and boiling water is then added to fill the can completely. For large-scale operations, salt tablets can be dispensed automatically into the filled container. Some small plants add the salt in granulated form in the same manner. Instructions for preparing brine and for adding salt tablets are given in the appendix of this manual.

Syrup is used as a canning medium for most fruits except those that are packed solid. The syrup is prepared prior to canning. Sugar and water are boiled together for five minutes to dissolve the sugar and to remove air from the syrup. Any scum formed on the surface of the liquid is removed. The syrup is then ready to be used for canning. The cans containing the product should be almost filled with syrup before exhausting, and after exhausting sufficient hot water added to fill the cans to

the top. Fill glass jars as specified. Tables of syrup and syrup consistencies are given in the appendix of this manual.

Broths, gravies, and oils are added as the canning medium for meats, poultry, and fish products. The broth or gravy is prepared from the skins, bony pieces, and the fat taken from the meat in trimming. These trimmings are cooked together in a steam-jacketed kettle or other type of container, and seasoning is added. The scum of fat formed on the surface is removed, and the broth is then ready to be used for canning.

E. Exhausting

Most air and other gases should be excluded from the raw food material and the container prior to sealing. In the sealed container, oxygen is undesirable because it reacts with the food and the interior of the can and adversely affects the quality, nutritive value, and market life of the canned food. Blanching removes some of the gases from the food tissues; exhausting removes the other gases. Exhausting also serves to expand the product in the can prior to sealing and processing. Overfilling and defects caused by foods expanding during processing are thereby eliminated. Finally, exhausting raises the temperature of the product in the can to the initial processing temperature.

1. Methods of Exhausting

The exhausting operation can be accomplished by passing the open can continuously through a tunnel exhaust in which steam is used or by placing the open cans in a batch exhauster. The time and temperature of exhausting vary with individual products. Batch exhaust boxes consist of tanks of boiling water in which the open containers are placed. The water level is maintained approximately 2 inches below the top of the cans. In small plants, instead of exhausting in exhaust boxes, many products are preheated or precooked in kettles or similar devices and the cans are filled and sealed while the products are hot. Some products can be partially exhausted merely by adding boiling water, syrup, or brine to the food in the can.

In some large commercial canning plants in the United States, exhausting is accomplished by mechanical rather than thermal means. This procedure is called vacuum packing. Specifically designed equipment is used to withdraw air and other gases from the containers when they are sealed.

When products are packaged in glass jars, the gases from the food cells and from within the container are expelled during processing. No separate exhausting process is needed.

Figure 75. Filling Cans by Hand
(Courtesy of Louisiana Department of Education)

Figure 76. Adding Canning Medium and Seasoning
(Courtesy of Dixie Canner Company)

Figure 77. Exhausting--Cans Emerging from a Continuous Exhauster Just Before Sealing
(Courtesy of Colonial Films and Equipment Company)

2. Vacuum

After the containers have been exhausted, they are sealed, processed, and cooled. During cooling, the condensation of water vapor in the head space and the contraction of the hot contents create a partial vacuum within the container. The vacuum is the reduction in the internal pressure within the container as compared to the pressure of the atmosphere. It is usually measured in inches of mercury. Under normal climatic conditions, atmospheric pressure at sea level is approximately 30 inches. Therefore, a can having a vacuum of 15 inches has an internal pressure only one-half that of the atmospheric pressure. The vacuum produced after processing varies with the average can temperature, the type of product, the time for exhausting, the altitude, and the amount of head space. The average can temperature is the temperature of the contents of the can obtained by thoroughly mixing the product after sealing. Vacuum in the container can be measured by means of a vacuum gauge made especially for the canning industry. However, if the vacuum in the processed can is sufficient, the ends of the can should contract on cooling and remain slightly concave under average storage conditions. For canning in glass jars, one can detect whether the proper vacuum is obtained by tapping the top of the container. A container with suitable vacuum will produce an audible ping when tapped; one with insufficient vacuum will produce a flat sound.

Under certain conditions, such as having too high a closing temperature or too great a head space, the vacuum will be too large and will cause the filled cans to collapse. This action is called panelling. Panelling is a permanent inward distortion or drawing-in of the sides of the cans due to excessive external pressure or excessive vacuum. For the most part, this effect occurs in cans that have been pressure cooled.

To avoid panelling, the instructions should be followed carefully with regard to head space, exhausting to the desired center can temperature, sealing, and processing. Approximately 8 inches of vacuum is typical for No. 10 cans, and approximately 20 inches of vacuum is typical for No. 2 cans. In order to reduce panelling in No. 10 cans, the vacuum may be as low as 5 inches. If the vacuum is much greater than these values, the cans may show excessive panelling. If the vacuum is much lower the presence of an excessive amount of air is indicated. Low vacuum may lead to shorter storage life as a result of more rapid internal corrosion.

3. Center Can Closing Temperature

The temperature of the contents of the container at the slowest heating point at the time the can is sealed is referred to as the center can closing temperature. This temperature must be attained during the exhausting or precooking operations in order to insure a satisfactory vacuum. For products that are sealed and processed immediately after exhausting, this temperature also establishes the time necessary for processing.

The closing temperature should be checked occasionally to determine that it is at least as great as that specified in the instructions. The measurement is taken at the slowest heating point of the product. In products that heat by convection, this point is about halfway between the center and bottom of the container. Such products are green beans, peas, and other foods with a medium which can circulate freely. In products that heat by conduction this point is at the center of the container. Conduction-heated products include pumpkin, sweet potatoes, and other solid or nearly solid packs. The method for making this measurement is illustrated in Figure 79.

4. Initial Temperature

The initial temperature is the average temperature of the can contents at the time the processing is begun. Most processing time specifications are based on starting at a given initial temperature. In this respect, the initial temperature and not the center can closing temperature is the important factor from the standpoint of determining the processing time. However, if the exhausted containers are sealed and processed immediately, the closing can temperature is essentially the same as the initial temperature.

If a can is held for some time at room temperature before being processed, the contents may cool to a temperature somewhat less than the closing temperature. For this reason, it is important to determine that the initial temperature of the coldest can in any batch is not less than that specified in the processing instructions. The coldest can in the batch is set aside for measurement. One means of determining the temperature of the coldest can is to set aside the first two cans from the exhauster and place the tops on them while the others are being sealed. These cans are the coldest in the lot since they have been at room temperature for the greatest time. The lids of these two cans are removed just prior to starting the process, the contents thoroughly mixed, and the temperature measured. The time for processing is then based upon this observed reading.

F. Sealing

After the containers have been exhausted, they must be hermetically sealed. A good seal is important to prevent food spoilage. When tin cans are used, a good seal also prevents leaking of the product from one can and subsequent rusting of adjacent cans.

1. Tin Cans

Sealing of tin cans is frequently referred to as "double seaming." The machines for double seaming vary from hand-operated machines to fully automatic machines. These machines are similar in action in that they perform two basic operations. The first operation serves to

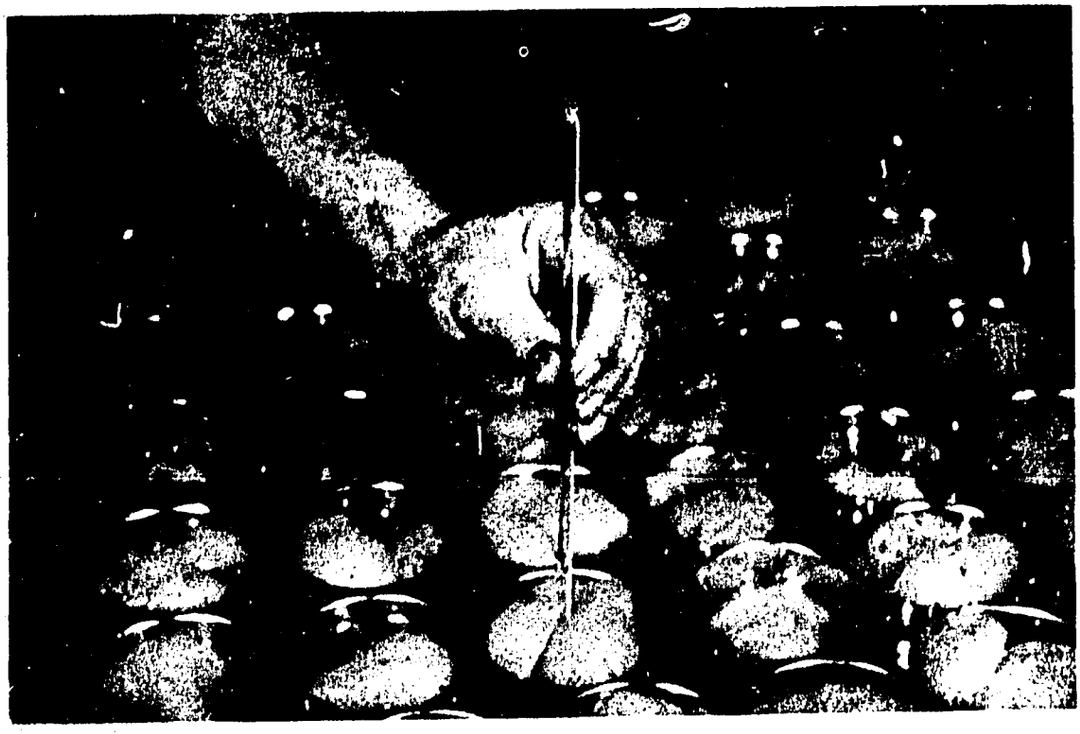

Figure 78. Exhausting--Taking Center Can Temperature of Cans in a Batch Exhauster
(Courtesy of Colonial Films and Equipment Company)

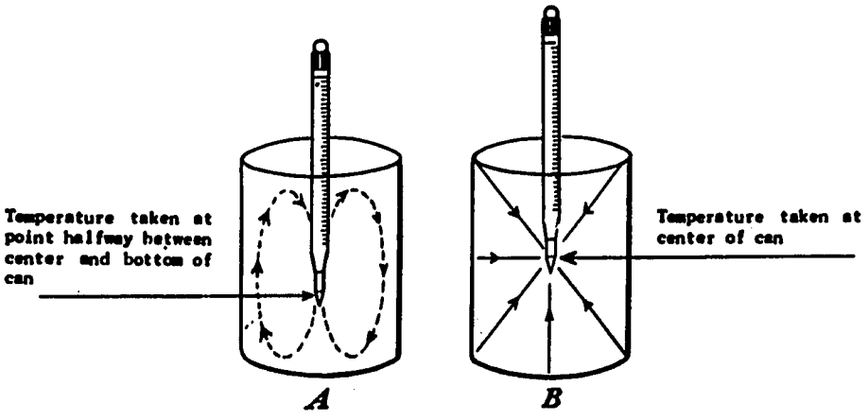

Figure 79. Exhausting--Method of Taking Center Can Temperature of: A. Products Heated by Convection; B. Products Heated by Conduction
(Courtesy of United States Department of Agriculture)

properly shape or roll together the edges of the can top and can body. The second operation flattens the bead of the first roll produced on the can by the first operation. The seam is made by highly polished rolls of exacting dimensions. Should there be any wear in the rolls they should be adjusted or replaced.

The sealing machine should be adjusted prior to preparing a batch of cans. When the first operation roll is adjusted, an empty can should be put through the machine and the seam examined. If the first operation is satisfactory, a similar procedure should be used in adjusting the second operation roll. It is important to make regular and frequent checks of can seams during the production. For large scale production, samples should be inspected every 15 or 20 minutes.

It is suggested that the sealing machine operator himself know how to adjust the machine. When the machine parts become worn so that proper adjustments cannot be made they should be replaced by new parts.

2. Glass Jars

Glass jars unlike tin cans are not sealed hermetically until after processing. Tin cans are sealed permanently before the processing is begun, but glass jars merely have the lids adjusted on them at this time. Jar lids that employ rubber rings are adjusted by placing the ring in the proper place and screwing the lid down firmly over it, then reversing the lid for a portion of a turn. Two-piece jar lids, which employ self-sealing gaskets, are adjusted by placing the lid with the sealing compound next to the glass and screwing the metal band down over it. These operations are necessarily done by hand. After processing, the jar with the rubber ring is hermetically sealed by firmly screwing down the lid. However, the two piece, self-sealing lids are not tightened further after removing the jars from the cookers. Tightening may result in a broken seal. For jars with caps and wire clamps or bails, place the cap on the jar and put on the clamp. After processing complete the seal by adjusting the wire bail.

Glass jars should be inspected to see that they are properly sealed after processing. The metal lid is sealed properly if the center of the lid is pulled inward or if a clear ringing sound is produced when the center of the lid is tapped. If a dull sound is produced, it does not necessarily indicate an improper seal. Either the vacuum may be too low or the product may be too close to the top of the jar. When there is any doubt that a proper seal has been made, the jar should be turned over in the hand to see whether it leaks. In the case of the self-sealing lids, the edge of the lid should be lifted to see whether the seal holds. Jars that have not been properly sealed should be emptied and the food recanned immediately.

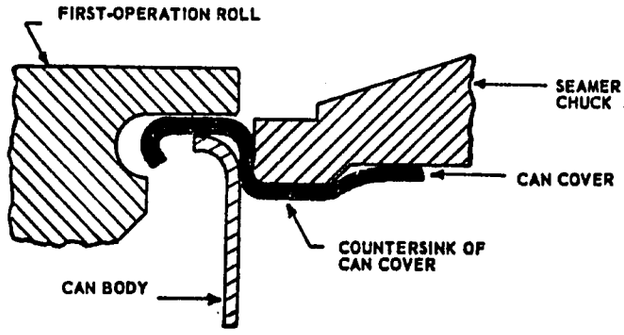

Figure 80. Position of Can and Cover in Relation to Sealer Part Before Seaming
(Courtesy of United States Department of Agriculture)

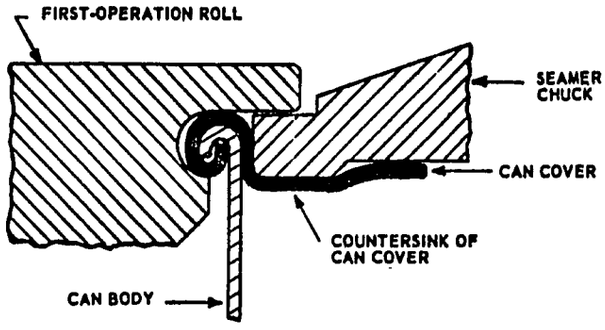

Figure 81. Innermost Position of First-Operation Roll in Relation to Chuck for Forming First-Operation Seam
(Courtesy of United States Department of Agriculture)

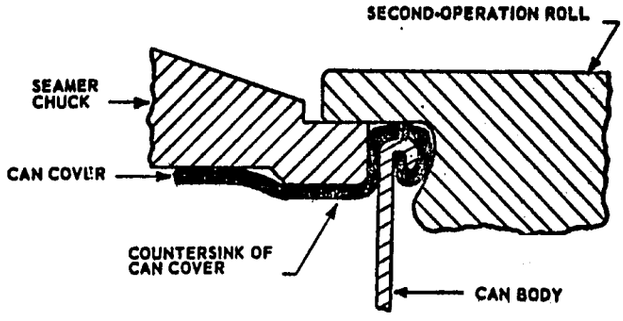

Figure 82. Innermost Position of Second-Operation Roll in Relation to Chuck for Forming Second-Operation Seam
(Courtesy of United States Department of Agriculture

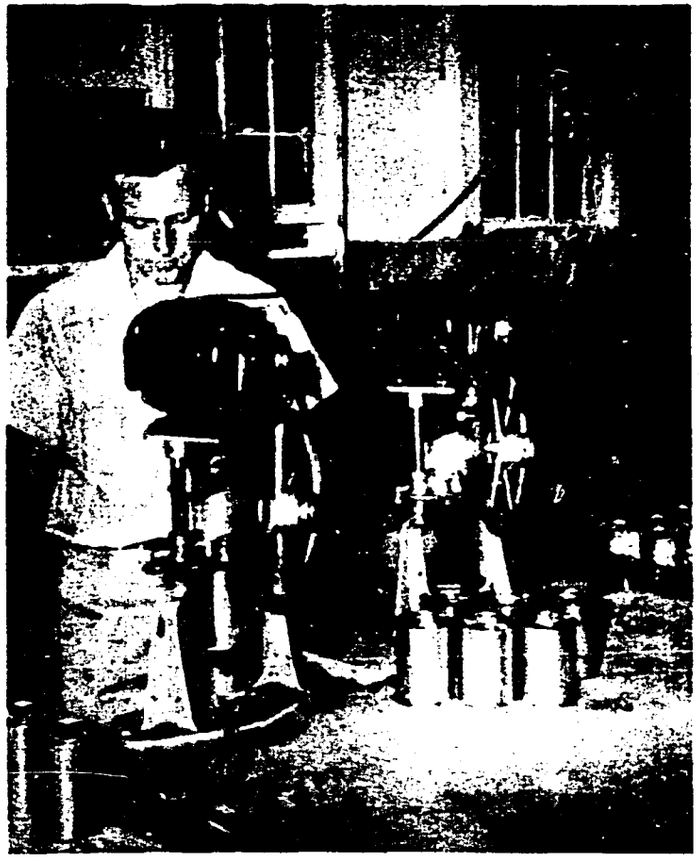

Figure 83. Sealing Tin Cans with a Motor-Driven Sealer
(Courtesy of Dixie Canner Company)

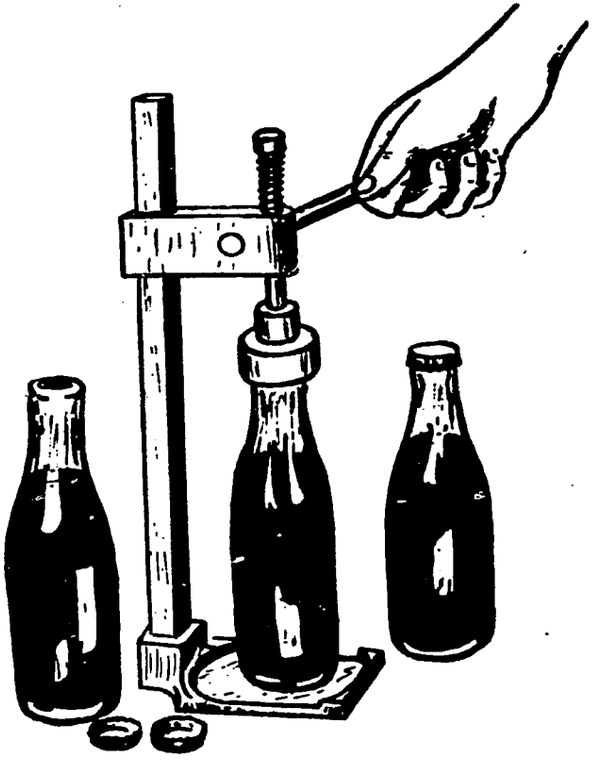

Figure 84. Hand-Operated Capper Putting Crown Caps on Beverage Bottle
(Based on California Agricultural Extension Service Circular 65)

3. Glass Bottles

Glass bottles used for canning juices are sealed after the liquid has been pasteurized. Crown caps are applied by a hand-operated device such as that shown in Figure 89.

G. Washing Sealed Containers

It is particularly important that the exterior of tin cans be bright and clean. Otherwise, the can will present an unattractive appearance. More important, however, the presence of food particles or other contaminants on the outside of the cans tends to induce corrosion. For this reason, the sealed cans are washed at some stage in the operation. Ideally, washing should take place both before and after processing. However, it is sufficient to clean the containers thoroughly prior to processing. Washing at this point avoids contamination of the retort or cooker with undesirable material accumulated on the outside of the containers during filling and sealing. It also prevents some of these materials from being baked on the cans during processing and thus being carried to the cooling tanks and thereby contaminating the cooling water.

The washing of cans containing fruits and vegetables does not normally present any great difficulty since traces of syrup and brine are easily removed. Much more difficulty is encountered, however, in washing containers in which meat and fish are packed. The oil and broth used as a canning medium for such products is sometimes quite difficult to remove from the outside of the containers.

For small operations, the containers may be wiped with a cloth after they have been sealed. A mild alkali or synthetic detergent should be used in cleaning cans especially when grease is found on the outside of the container.

A convenient arrangement for washing consists of two locally manufactured narrow tanks of sheet metal, one containing a cleaning solution and another containing rinsing water.

The washing operation should be performed as quickly as possible in order that the average temperature of the product in the can does not become so low that the process time must be modified.

H. Marking and Coding

After the containers have been sealed and washed, they should be coded or marked to identify the product. Marking and coding should be done as rapidly as possible so that there will be no delay in the process. The identification of containers is desirable in commercial canning plants so that the canner can check back on his output and test the quality of the various batches. In cooperative plants where more than one patron's products or more than one type of food may be processed simultaneously, coding

is necessary in order to avoid confusion. In some plants it is customary to mark the lids before sealing the cans. In such cases, care should be taken to avoid contamination of the lid. Many different systems can be used to mark and code the canned product. The code may consist of a series of letters and numerals marked on the end of the container. The canning plant operator can establish his own system of coding. He should devise a code which identifies the type of product, the date of canning, and the batch in which the container was processed.

For small-scale operations, marking can be done with a soft lead pencil. The eraser of the pencil can be used to roughen the surface of the can so that it can be marked in this manner. The code may also be applied by means of a rubber stamp using an ink specially formulated to withstand processing. If this is done, care must be taken to be sure that the ink does not contaminate the food. Inks employing phenolic bases should not be used.

For large-scale operations, marking can be done by an embossing operation. However, an embossed code has disadvantages that the printed code does not have. Excessive embossing pressure will produce sharp imprints which promote external rusting of the cans due to fracture of the tin or enamel coating. Corrosion is particularly serious in the case of lacquered or plain cans used with acid products. For this reason, pencil or ink markings are preferred.

I. Processing

Processing or sterilizing is one of the most important operations in canning. Processing not only renders harmless those microorganisms likely to cause spoilage but also provides a product properly cooked, i.e., it has a desirable texture, flavor, and appearance. The processing should be sufficient to deactivate all the organisms but not to overcook the food. There are many factors which influence the process: (1) the types of organisms to be destroyed; (2) the rate of heat penetration to the slowest heating point; (3) the initial temperature of the food; (4) the size and type of container used; (5) the temperature at which the processing is carried out; (6) the pressure at which the process takes place; and (8) the acidity of the product. Processing instructions are determined by the various food processing laboratories after considerable experimentation. The canning plant operator must follow the prescribed instructions in order to obtain a safe and attractive product. If any deviations from the recommended process conditions are desired, a research laboratory connected with the canning industry should be consulted. Also, such a laboratory should be consulted if products are to be canned which are not included in this manual.

The processing operation involves exposing the container to hot or boiling water or to steam under pressure for a prescribed length of time. In general, the processing conditions depend on the type of food being

canned. Fruit juices other than tomato juice are pasteurized at the temperature of boiling water or less. All other products can be divided into two classes: those which can be processed at 212° F. (the temperature of boiling water at atmospheric pressure) and those which require a temperature in excess of 212° F. The division is based upon the degree of acidity of the food. The acidity of various products, referred to as the pH factor, can be found in the appendix of this manual.

The acid foods, those with pH values below 4.5, include fruits and certain vegetables. Ordinarily, these foods can be canned by heating them in containers long enough to reach a center can temperature of 200° F. or more. Under these conditions microorganisms capable of causing spoilage of acid products are destroyed.

The other class of product consists of those foods with pH values greater than 4.5. This class includes nonacid vegetables, soups, meats and meat products, fish, and poultry. These products require processing under pressure for adequate sterilization. Attempts to sterilize low-acid products at the atmospheric boiling point are never safe or practical and should not be attempted. In processing low-acid products, it is sometimes impractical to kill all the organisms, as a long process time would change the product so that it would not be salable. However, the processing must be sufficient to destroy all organisms that grow at ordinary temperatures.

At one time, acidified brines were added to nonacid foods in order to permit processing at atmospheric pressure. By using acidification, nonacid products can be processed in boiling water. It has been found advisable to discourage the use of this method except in the isolated instances indicated in the processing insturctions (for example, figs).

1. Heat Penetration

For proper processing of canned goods, the slowest heating point of the contents of the container must reach a temperature sufficient to kill the bacteria. Processing data are then based partly on the rate at which heat is transferred to the slowest heating point. As mentioned earlier in this manual, heat is transferred in containers by convection, by conduction, or by a combination of the two. The rate of heat transfer depends on the type of product, the method by which it is packed, the size of the container, and the processing temperature and pressure.

For proper heat transfer, the time and the temperature and pressure are important factors that may be varied according to the process. In the processing of canned food, the time and temperature must be carefully controlled. In specifying the processing temperature it is essential that the time also be indicated. This is important because bacterial spore destruction at 250° F. is approximately 100 times faster than at 212° F. It is worth noting that an error in either time or temperature in a short, high temperature process will have a much greater effect on the total steri-

lizing value of the process than a like error in a longer process at a lower temperature.

Several factors tend to reduce the rate of heat penetration for a given process. Over blanching and overfilling of cans may retard the heat penetration rate and therefore may result in underprocessing. Overripe fruit sometimes softens and forms a compact mass in the can and retards heat penetration.

2. Stacking of Containers

Containers should be stacked in the cooker in such a manner as to permit free circulation of the heating medium. In large vertical retorts containers are usually stacked many layers deep. Under these conditions, it is best that the containers be staggered so that they do not rest directly over one another. In all types of cookers, the jumble method of filling is the most desirable except in the case of certain products which are stratified such as spinach and asparagus. In the jumble method of filling, the cans are placed randomly in the baskets instead of being stacked. However, the jumble method of stacking reduces the efficiency of the operation in that fewer containers can be processed at one time. In large retorts where crates are stacked several deep, none of the cans in the basket should project above the rim. If space is not left between the baskets, steam circulation between them is considerably hindered. In addition, the cans in the lower basket are apt to be deformed if they must support the weight of the upper baskets.

If it is desired to keep batches or types of containers separated during processing, separators should be used. Separators consisting of sacks or boards or even perforated plates should not be permitted since they hinder heat transfer. Wire screen or mesh is the most suitable material for this purpose.

Rough handling during the placement or stacking of the containers in the cooker may account for considerable spoilage. Spoilage hazards can be eliminated to a great extent if care is taken in placing cans in the cooker. Care should be taken to see that crate bails do not dent or crush cans protruding from overfilled crates, that crates are not dropped or allowed to crash into one another, or that cans are not haphazardly dropped or pushed into the crate in filling it.

3. Water Bath Processing

A boiling water bath can be used to process acid foods because a temperature of 212° F. is sufficient to kill all non-spore forming microorganisms contained in such foods and the acidity prevents the growth of heat resistant spores. The time required to process acid foods in the boiling water differs with the particular product. These times are included later in this manual in the insturctions for canning individual products.

Any type of boiling water bath may be used to process acid foods provided it is properly operated. Although open process tanks are preferred for processing fruits during the peak of the season, open retorts are frequently used. Regardless of the type of bath used, it should be constructed so that the containers do not rest on the bottom. Instead they should be placed on a perforated false bottom. The water must be boiling when the cans are placed in the bath, and it should be brought back to boiling before the timing of the process is begun. The boiling water should cover the containers by at least two inches. It is important that the water be boiling vigorously and not simmering or rolling. Rolling is a false boiling and will occur at temperatures considerably below the boiling point. Food cooked in water at this temperature may be seriously underprocessed.

The temperature at which water boils varies with the altitude. At sea level, water boils at 212° F. Since the processing times appearing in the tables are based on conditions at sea level the actual processing times should be increased 10 per cent for each 1000 feet of elevation change. The retort operator must adjust for this longer processing time to compensate for the lower temperature at which water boils at altitudes above sea level if the microorganisms are to be destroyed and spoilage prevented. This correction factor applies only to atmospheric cooking.

4. Steam Processing

Atmospheric Processing (acid products). Some canning plants have steam generating facilities available and are able to make use of steam as a cooking medium. Steam can be used at atmospheric pressure for processing acid products or it can be used under pressure to cook nonacid foods.

Atmospheric cookers, utilizing steam at atmospheric pressure, are frequently used for processing acid foods. An atmospheric cooker is illustrated in Figure 40. The cooker, which functions as a steam bath at atmospheric pressure, is preferred over water-bath processing for several reasons. This cooker is considered to be safer than the water-bath cooker because there is no danger of splashing a hot liquid. Also, the time required for an atmospheric cooker to reach processing temperature is much shorter than that required for a water-bath cooker.

The steam atmospheric cooker consists of a base, an insert rack and crate, and a cover. The containers to be processed are placed in the crate, and the crate is placed on the insert rack which is placed in the base section of the cooker. Water is added to the base and the cover is placed over the crate in such a manner that the bottom of the cover is sealed by the water. Steam at atmospheric pressure is then admitted into the cover through the steam hose connection, and the temperature is allowed to rise to the required value. The temperature is measured by a thermometer in the side pocket of the cover. The steam enters at the top of the cover, forcing the air downward and out through the water seal. The steam in the cooker during processing is actually about 0.05 pounds per square inch above atmospheric pressure. After the processing time has elapsed, the steam is turned off, and almost immediately the cooker can be unloaded.

5. Pressure Processing (Low-acid products)

All nonacid (low-acid) foods require processing at high temperatures, generally 240°F. or higher, in order to kill the microorganisms associated with these foods within a reasonable length of time. The most practical means of obtaining a temperature of at least 240°F. is by use of steam under pressure. The steam may be produced either in closed vessels in which water has been placed or in boilers.

The temperature of steam is directly related to its pressure. By regulating the pressure of the steam its temperature is easily regulated. As with boiling water, the temperature of steam changes with the changes in elevation. At sea level, steam at 10 pounds per square inch pressure has a temperature of 240° F., and at 15 pounds per square inch pressure it has a temperature of 252° F. At altitudes higher than sea level it is necessary to increase the pressure approximately 1/2 pound for each 1000 feet in elevation to attain the required temperature for the process. Pressures corresponding to changes in altitude can be found in Table XLVIII of the appendix of this manual.

Processing at 240° F. is sufficient to product a safe, wholesome product. However, the processing time can be shortened if a higher temperature is used. For some products which require long processing times at 240° F., this is advisable not only because of the savings of time, but also because of the improvement in quality of the product. At the higher temperatures, however, an error in either temperature or time will have a much greater effect upon the total sterilizing value of the process than will a similar error at the lower temperatures.

If the temperature (pressure) drops during the process, the process must be modified. For every degree the temperature is subnormal, two minutes should be added to the specified processing time. However, if the drop is greater than 5 degrees below that specified, or if the temperature is subnormal for more than five minutes, the process should be begun again. If products must be reprocessed, they must be reprocessed promptly for the full length of time specified in the processing instructions.

Only pure steam free from air should be employed for processing because the heat transfer from an air-stream mixture is much less than that from pure steam. The process instructions contained in this manual are based on an atmosphere of pure steam at the given pressure. A mixture of air and steam may indicate the same pressure as a pure steam atmosphere, yet have a temperature considerably lower than that required for the process. In addition to causing a low temperature, a mixture of air and steam may be present in large pockets around containers in the cooker or in thin films around individual containers and thus partially insulate the containers. Both effects temd to cause underprocessing. <u>It is necessary, therefore, to follow procedures specified by the manufacturer in order to remove all air from the cooker before starting to time the process.</u>

Processing is divided into three stages: (1) "coming-up time" or time required to vent the air from the cooker and to raise the temperature of the retort or cooker and the contents to the processing temperature, (2) holding time or time the cooker is maintained at the processing temperature, and (3) cooling time. The coming-up time should be as short as possible and yet all air must be removed from the cooker. In order to be sure that all air has been removed from that vessel the temperature and pressure inside the cooker must be checked to see that they correspond to normal values for pure steam. Correspondence between the gauges is in general a reliable indication that all air has been removed from the retort.

For small-scale canning, the pressure cooker is usually used. Two or three inches of hot water should be placed in the bottom of the cooker, and the filled containers arranged so that steam can circulate around them. The cover should be securely fastened so that no steam escapes except through the petcock or weighted gauge opening. After the steam has escaped through the petcock or gauge opening for 10 minutes to insure that all the air has been flushed from the canner, the petcock should be closed or a weighted gauge placed on the gauge opening. When the desired pressure has been reached, the timing of the processing is begun. The pressure should be kept as uniform as possible by regulating the heat under the canner.

The coming-up time procedure for retorts is approximately the same as that for pressure cookers. However, more care should be employed because of the difference in size of the cookers. There is a minimum limit for the coming-up time because of the necessity for removing air from the retort by venting during this operation. A shorter coming-up time than the minimum which has been found to give satisfactory results should not be used. The retort operator should be well versed in the coming-up procedure in order to insure that the air is fully bled from the vessel. At the time the steam is turned on, all bleeder valves and vents should be wide open. The bleeder valves should be left open during the entire processing period. The vents should be left open for a sufficient time after the steam is turned on to be sure that all air is swept from the retort and that no pockets of air remain among the cans. As the air is flushed from the retort both the pressure and temperature gauges rise until the required values are reached. The timing of the process should not begin until both pressure and temperature gauges give the readings corresponding to those in the processing tables. Once the processing time has begun, a time should be started and the steam should be regulated either by hand or by automatic controllers so that the pressure and temperature of the cooker are maintained constant at the proper value for the required time. Once the processing time has elapsed as determined by the timer, the retort is shut off and the cooling operation is begun.

J. Cooling

Containers should be cooled as rapidly as possible after the processing time has elapsed in order to assure a uniformity of processing and to

maintain a high quality of the finished product. If cooling is too slow, the product tends to overcook with the result that flavor and texture are harmed. Also, while the product is at temperatures between room temperature and processing temperature, the growth of heat-resistant spores and the formation of rust are encouraged.

Several methods of cooling are available. These methods include air cooling and water cooling. The method used will depend upon the facilities available and the type of container to be cooled.

It is of utmost importance in water cooling that the water be pure. If there are impurities, spoilage may result since contraction of cans during cooling may cause water to be drawn in through nearly microscopic holes in the seams. Impure or unclean water may also lead to external corrosion of tin cans.

1. Tin Cans

Tin cans can be cooled by air or by water. If cans are cooled by air, they are placed in the cooling area until they are sufficiently cool; then they are labeled and stored. No effort is made to control the cooling and no additional facilities are required to handle the containers. Even though this method of cooling is simple and inexpensive, more space is required and the products are frequently overcooked. This method of cooling tin cans is not recommended. However, in instances where the water supply is critical this method may be resorted to.

Tin cans are most frequently water cooled either in external cooling tanks, under external sprays or under pressure in the cooker. All tin cans processed in boiling water can be water cooled in external cooling tanks or sprays. All cans of No. 3 size or smaller which are processed under pressure can also be water cooled in this way. However, cans larger than No. 3 that are processed under pressure should be water cooled under pressure, otherwise buckling may occur.

Atmospheric water cooling may be accomplished by simply immersing the hot cans in tanks of cold water or by utilizing sprays of cold water. If retorts are used as atmospheric cookers, the retorts themselves can be used as the cooling tanks by admitting cold water into them after processing. If the cans are pressure processed, the pressure in the cooker should be allowed to return gradually (10 minutes) to approximately atmospheric pressure before atmospheric cooling is begun. This practice will reduce the tendency of the containers to buckle because of rapid reduction in external pressure.

Large tin cans such as the No. 10's that are processed under pressure and even smaller tin cans that are processed at pressures as high as 15 pounds per square inch are most satisfactorily water cooled under pressure. Water cooling in the cooker under pressure usually prevents permanent damage to the cans. Buckling that occurs as a result of excess pressure developed

within the cans during processing is reduced if a sufficient pressure is maintained in the cooker during cooling. The pressure should be adjusted to maintain the pressure in the cans and that in the cooker nearly equal throughout cooling. Actually, at the initial stages of cooling the pressure in the cooker is made equal to or, slightly greater than the pressure at which the cans were processed. As cooling proceeds, the retort pressure is gradually reduced as the internal pressure of the cans become less.

Pressure cooling is accomplished in one of two ways. The cooling may involve the use of steam and water, or it may involve the use of air and water. In the first method, pressure is maintained on the cans by steam entering the cooker from the top as water is admitted slowly through the bottom. The retort pressure is raised slightly above the processing pressure after the processing time has elapsed, and water is allowed to enter slowly at the bottom of the cooker. The water must be admitted carefully so that a sudden vacuum is not created in the cooker as a result of rapid steam condensation. This would cause buckling of the cans and might collapse the cooker. As soon as a cushion of hot water is formed additional water should be allowed to enter the cooker as rapidly as possible without causing the retort pressure to drop. Steam pressure is maintained above the water level until the retort becomes filled with water. The cooling is then completed by gradually reducing the pressure by lowering the water level in the retort.

In the second method of pressure cooling, compressed air is used to maintain the required pressure within the retort during cooling. After the processing time has elapsed, compressed air is admitted to give a retort pressure of approximately 3 pounds per square inch above processing pressure. Cooling water in spray form is then admitted as rapidly as possible without causing the retort pressure to drop more than 2 pounds per square inch. Only a mistlike spray from one jet should be used initially. The air admitted should be controlled so that the retort pressure is maintained at 3 pounds per square inch above processing pressure as the cooling takes place. Air replaces the steam condensed by the cooling water. If this pressure is maintained, buckling is avoided.

After the retort has been filled with water, cool water is allowed to circulate slowly through the retort for several minutes. The pressure of the cooling water in the retort is gradually reduced to correspond with the reduction of internal pressure of the cans. Pressure is reduced in approximately four steps; the time required varies from a total of approximately 10 minutes to 30 minutes depending upon the product, the size of the container, and the temperature of processing. The retort pressure is reduced to atmospheric pressure, and the containers remain in the retort until they are cooled to 100° F.

2. Glass Jars

Glass jars can be cooled either by air, by external water sprays, or with water under pressure in the cooker.

If jars are to be air cooled, they are taken from the atmospheric cooker and placed so that air can circulate freely around each container. The jars are allowed to cool in this manner until they can be stored.

When cooling glass jars under external water sprays, care must be taken to avoid breakage from thermal shock. Jars taken from atmospheric cookers are initially placed under fine mistlike sprays. If the sprays are not first tested to see that they produce a fine mist, breakage may occur. After the jars are partially cooled, heavier sprays may be used to speed up the last of the cooling.

Cooling glass jars under pressure is carried out in the same way that tin cans are cooled using compressed air. Air pressure is used to maintain the retort pressure at approximately 3 pounds per square inch above processing pressure. A fine, mistlike spray is first used to bring the retort temperature to approximately 190° F. and then heavier sprays are used to lower the temperature further. When the required temperature is reached the pressure is allowed to drop to atmospheric pressure and the jars are removed. The jars are then placed under external sprays and cooled completely.

K. Storage

It is frequently necessary for the canning plant to store canned goods because of the heavy production schedule during the normal canning season. For this reason, properly designed warehouse facilities must be available.

The conditions of storage, particularly the storage temperature, have a pronounced effect upon the quality of the canned material.

As the temperature rises the flavor, color, vitamin content, and texture of the canned goods deteriorates because of the continuation of chemical reactions. In addition, as the temperature rises, the vacuum in the container becomes less, and hydrogen springers and swells are produced. Finally, bacteria not destroyed in processing tends to grow as the temperature is increased. Because of these actions, the temperature of storage must be carefully controlled. Canned foods should be stored in a cool place having a temperature of 50° to 70° F. in order to prevent deterioration and spoilage.

Chimneys, steam pipes, stoves, and the boiler should be located so that they do not supply heat to the storage area.

The humidity of the storage area should be kept as low as possible in order to prevent rusting of lids or cans and to prevent mold growth. Rusting can be prevented by storing canned foods in a place where the humidity is low and where the temperature is not subject to frequent and

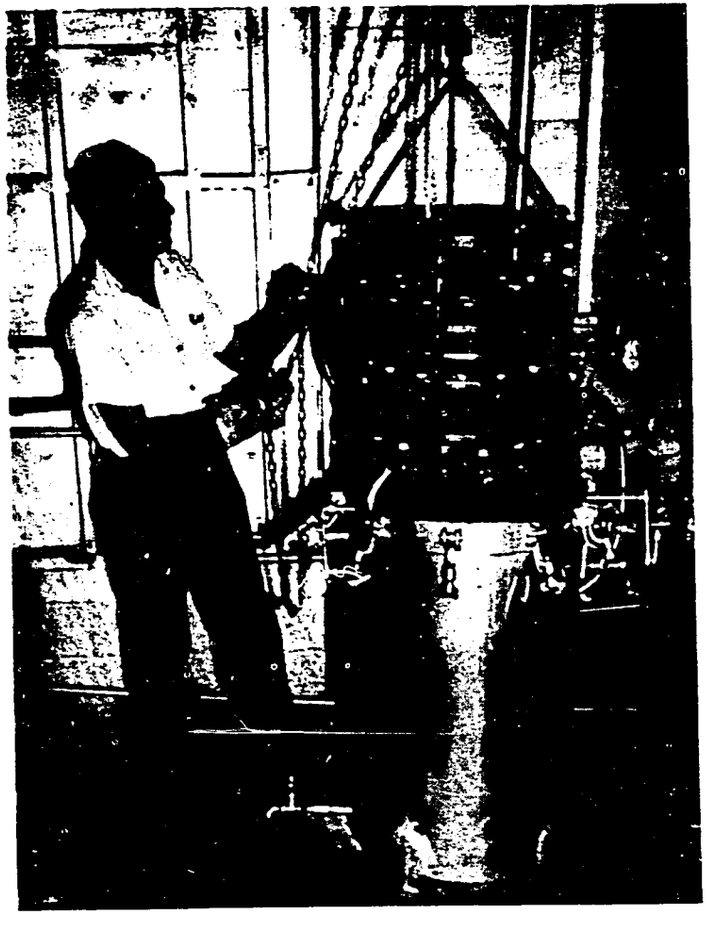

Figure 85. Processing--Loading the Retort.
(Courtesy of the University of Georgia)

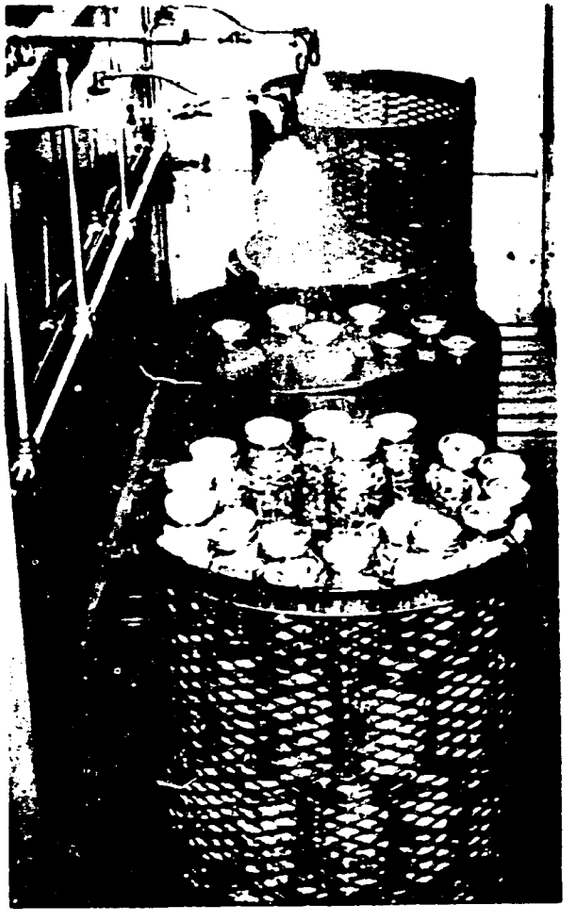

Figure 86. Cooling Glass Jars with External Sprays
(Courtesy of United States Department of Agriculture)

wide variations. If the temperature fluctuates widely, cans that are colder than the surrounding atmosphere will become coated with condensed water and will rust and gradually corrode through the tin plate. If cans are stored underground, they should not be placed directly on the floor but should be placed at least a few inches above it. Freezing does not normally affect the wholesomeness of the canned material, but it does injure the texture, appearance, and the flavor of some foods.

Foods that have been canned in glass jars should be stored where they are protected from light. Light causes some food to lose quality, particularly loss of color.

Freezing softens food, but otherwise there is no harmful result unless the container is cracked or the seal is broken.

When storing on shelves, ample and sturdy shelves should be provided. The canned goods should be stored systematically in order to preserve space and to permit ready identification. In large warehouses, the blocks of canned goods should be readily available for inspection because the ease of access has an important bearing on the reduction of loss from spoilage.

Canned goods in storage should be inspected at frequent intervals. Inspecitions should be made in order to detect springers, bulging of the ends of cans, rusting, and broken seals. Containers with broken seals which allow the contents to spill out are likely to ruin other containers on which the contents are spilled.

Properly canned and stored canned goods should remain satisfactory for long periods of time. However, the canning plant should not hold the goods in storage for too long a time since such storage represents unproductive capital.

L. Testing and Examination of the Finished Pack

Careful supervision and inspection should take place throughout the food preparation and processing. However, in order to determine whether the finished pack is of the desired quality and whether or not there is a tendency for spoilage to occur or the shelf life to become shortened due to any one of several factors further testing is necessary. Testing and examinations may be divided into two categories: (1) bacteriological examination, and (2) physical and chemical examination. In some cases a laboratory examination of the canned products must be made in order to determine the quality of the product. However, in many instances elaborate analytical techniques are not required; only a few simple tests are needed.

In any case, the testing should be thorough and systematic. If a sample is found to be faulty, the particular lot and possibly even the retort load from which the faulty container or product was obtained should

Figure 87. Storage--Cans Should be Stored in a Cool, Dry Place
(Courtesy of Colonial Films and Equipment Company)

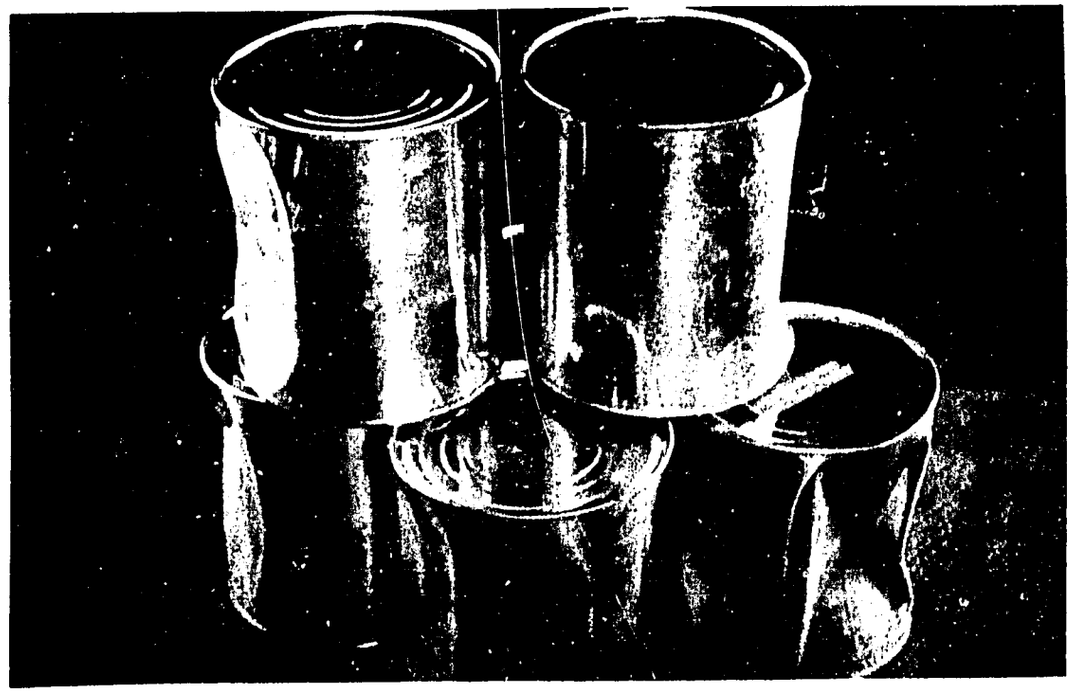

Figure 88. Panelling--Caused by Excessive Vacuum
(Courtesy of Dixie Canner Company)

be examined. The code or marking adopted by the canning plant should make it possible to locate the questionable cans in the warehouse.

1. Physical and Chemical Examination

The physical and chemical examination should provide information on the following points: (1) mechanical soundness of the container, (2) appearance of the contents, and (3) presence of metal salts found in the contents. Special consideration should be given the ends and body of the container. Dents in tin cans and cracks and chips in glass jars should be noted. The condition of the label should also be noted. The containers should be tested for leaks, and the seals and seams inspected carefully. Such inspection should be performed during the canning processes in order to correct the cause with a minimum of lost product. Glass jars can be checked for leaks by turning them partly over in the hand to see whether air bubbles form or, when self-sealing lids are used, the jars can be lifted by the edges of the lids to see whether the seal holds. A representative number of jars should be opened occasionally, and the seal tested for uniform impressions in the sealing compound. A representative number of tin cans should also be opened, and the seams inspected to see that the proper adjustment of the sealing machine was made. Any abnormal odors associated with the product usually indicate spoilage. Samples that are opened should be inspected for proper color and odor. Substantial changes in color usually indicate a reaction between the container and the contents.

In some cases, commercial plants use a tasting panel consisting of impartial and trained observers to check the quality and flavor of the output of the canning plant. Such a panel may provide useful information on the acceptability of new products.

2. Bacteriological Testing

Bacteriological examination of the finished product is carried out in order to determine the effectiveness of the heat process, the quality of the pack, the types and quantity of microorganisms remaining in the container, and the cause of spoilage if present. Such examinations should be made occasionally. In general, bacteriological testing requires the use of more specialized techniques and equipment than does physical testing and should be performed by a competent canned foods laboratory.

a. Types of Spoilage. Spoilage in canned foods may be caused by underprocessing, leakage through a faulty seal or seam, or allowing the product to stand too long during the period in which it is prepared for the canning operation. Spoilage is due primarily to microorganisms found in the food, such as yeast, molds, and bacteria. These microorganisms, the individual cells of which can be seen only under the microscope, present a very serious problem in canning because of the large number of kinds and the range of temperatures at which they grow. Under favorable conditions

of temperature and moisture the organisms may grow very rapidly and produce undesirable changes in the food before the canning operation. Some of the microorganisms are easily killed during the processing, however, others may form heat resistant spores which may survive the heat process. If the process temperature is insufficient, the resistant spores may continue to grow and spoilage results. Molds and yeasts are destroyed at relatively low temperature.

Spoilage is not always indicated by the appearance of the can or of its contents, and it is not always accompanied by swells or bulging of the can. Some of the common types of spoilage determined by tests are as follows:

(1) Flat-sour. If the contents of a can develop a sour flavor due to the action of microorganisms without generating a gas, the spoilage is known as flat-sour. This type of spoilage is due to the action of heat resistant bacteria spores not destroyed in the process. There is no indication that the spoilage has taken place until the container has been opened. Once the container is opened the spoilage is indicated by a sharp, sour odor and flavor and a cloudy canning medium. Flat-sour usually results because of poor sanitation practices or underprocessing. It may develop during storage if the temperature becomes too great, that is, at a temperature that favors the growth of the flat-sour bacteria. The defect may also be the result of insufficient cooling after the process.

(2) Swells. Swells are the result of gas produced within the containers. The internal pressure becomes sufficient to distort the ends of the container and possibly to burst them. The condition is also referred to as springers, flippers, and hydrogen swell. The gas produced by the spoilage of the contents of the can results from the growth of microorganisms present in underprocessed food or from microorganisms which have entered after processing. Swelling that occurs in containers which originally had good vacuum and which have good seals and solid seams indicates underprocessing.

A swell passes through several stages of development. A condition known as flipper is the first stage. A normal-appearing can can be struck on the end or on the seam and one end will spring out. The end can be pushed back with light pressure. Overfilling or improper exhausting as well as gas pressure produced in spoilage may produce this phenomenon. At a later stage in the development of a swell, a condition known as springer results. One end of the can may bulge, and when the bulged end is forced back into place the other end of the can bulges. In a more advanced stage of swell, both ends of the can bulge but may still be returned to normal by exerting light pressure. When the pressure is released the ends spring back to their bulged position. In the final stage of swell, it is no longer possible to push in either end of the can. If the swell increases the container will burst. There is an objectionable sour odor with this type of spoilage except where hydrogen gas is involved. A darkening of the product usually takes place.

(3) Hydrogen swells and springers. This type of swell is a special case of swell in which hydrogen gas is generated inside the can due to the corrosion of the can by its contents. Hydrogen swells develop more slowly than swells due to bacteriological action. The product may appear normal or somewhat bleached in appearance but will have no further indication of spoilage. Although the contents of the can are usually sterile, hydrogen swells cannot be distinguished readily from swells produced biologically and therefore they must be considered unfit for use. Hydrogen swells occur most frequently when fruits and other acid products are canned in cans that have been damaged.

(4) Stack burn. Stack burn occurs as a result of placing cans that are insufficiently cooled in stacks or in cases. The product softens, darkens, and possibly becomes unpalatable.

(5) Botulinus. Certain spore-forming bacteria present in soils and in foods continue to grow in nonacid foods which are not properly processed. The temperature most conducive to the growth of these bacteria range from 50° to 100° F. The spores are heat resistant and can survive for long periods of time in boiling water. For this reason, nonacid foods must be processed at 240° F. or higher in order to kill these bacteria. One particular bacteria (Clostridium botulinum) produces a toxin which is an extremely poisonous substance. There may be no visible evidence of this toxin. Heating the canned food may indicate this spoilage by a disagreeable odor. Boiling the food for ten minutes will destroy the toxin in most vegetables and boiling for 20 minutes is sufficient to destroy the toxin in vegetables such as corn and spinach. Foods suspected of being spoiled, however, should be destroyed.

b. Methods Employed for Testing. As with the physical testing in a great many cases elaborate methods and techniques for examining the food are not required. Simple tests and observations can be made within the canning plant itself. Before the products are distributed or permanently stored, they should be held at room temperature for about ten days. During this period of time containers from the various lots should be examined from time to time for evidence of spoilage. Bulged cans, swells and faulty seams all indicate the presence of spoilage. Any containers which seem to indicate spoilage should be examined by a competent laboratory.

II. INSTRUCTIONS FOR CANNING SPECIFIC PRODUCTS

A. General Discussion

The instructions and data included in this manual for preparing and processing the various foods should be followed if a safe, salable product is to be produced. There should be no deviations from these instruction unless recommended by a laboratory associated with the canning industry. The processing times included are basei on an initial temperature measured

at sea level. Canning plants operating at altitudes other than sea level should correct their processing times accordingly. Charts for correcting processing times are found in Table XLVIII in the appendix of this manual. If products are to be processed which are not found in these instructions, the processing data should be obtained from a reliable laboratory associated with the canning industry.

B. Acid Foods

Acid foods such as fruits and tomatoes are processed in boiling water at 212°F. The time for processing at 212° F. recommended in these instructions is sufficient to kill the actively growing microorganisms which cause spoilage.

The canning medium added to the particular product being processed should be prepared in advance of the time that it is to be used. Syrups are prepared by boiling the proper amount of sugar and water together for five minutes to dissolve the sugar and remove air from the syrup. The amount of sugar required for a particular syrup may be found in Table XLV in the appendix of this manual. The syrup or other medium is reheated to the boiling point before the cans are filled.

It should be noted that sugar is not necessary in order to preserve fruits and fruit juices from spoilage. However, the use of sugar helps to retain the color, texture, and flavor of the fruit.

1. Apples

a. Container. Use plain tin cans or jars.

b. Quality of Product. The best apples for canning are the ones which are best adapted for cooking purposes. They should be tart, have a good flavor and color and a firm texture. The fruit should be of fairly uniform shape and size and should be free from mold, bruises, and worm holes. For best quality, sort the apples into the various varieties and discard the unripe fruit.

c. Preparation. Wash apples thoroughly before undertaking the other preparation steps in order to remove dirt and spray residue. Peel and core the apples either by machine or by hand. If large quantities of apples are to be canned, paring machines may be desirable. Cut away any blemishes and bruised portions and slice using stainless steel knives. Iron utensils stain apples and should not be used. Dip the sliced fruit in a weak salt solution for five minutes to prevent discoloration before processing. The salt solution is made by adding one pount of salt to approximately five gallons of water. Furthermore, if tin cans are to be used and the canned product is to be held or stored for several months, soak the sliced fruit in the brine an additional time of approximately 20 minutes at room temperature for soft varieties and at 130° F. for

hard varieties. Soaking the fruit in this manner reduces the tendency for the formation of springers in storage and also reduces the perforation of the containers. If the fruit is to be canned in glass jars, this additional soaking operation is not necessary. In either case, drain the apples and wash them thoroughly to free them of the salt solution. Blanch the fruit from two to four minutes in hot water or with steam and then cool. The time will vary with the variety of the apple being processed.

d. Filling. Pack apples to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Use a canning medium of light syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 190° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 190° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for apples can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. Apple Sauce

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Poorly shaped apples as well as properly shaped apples may be used for apple sauce as long as they are sound and have a good flavor. The fruit should be free of mold, blemishes, and bruises.

c. Preparation. Wash the apples thoroughly in order to remove dirt and spray residue. Apples need not be peeled in preparing apple sauce; however, unpeeled apples produce a sauce of darker or more reddish color. Remove blemishes and bruised portions and core the fruit. Slice the apples into quarters.

Precook the apples in a steam-jacketed kettle or stock pot long enough to soften them. Use only enough water to steam the fruit.

Put the softened fruit through the pulper in order to remove seeds and skins. Add sugar as desired and heat the pulp to boiling.

d. Filling. Pack the boiling apple pulp into the container leaving only enough head space to allow placing the lid on tin cans. Leave approximately 1/4 inch of head space in glass jars.

e. Exhausting and Sealing. If the boiling apple pulp is added to the containers immediately there is no necessity for exhausting.

Immediately after the boiling pulp is added, seal tin cans and adjust the lids of glass jars for processing. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for apple sauce can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

3. Apricots

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Apricots that are to be canned should be firm yet fully ripe. Care must be taken to avoid bruising the fruit in handling or in transportation.

c. Preparation. Sort the produce, remove green, overripe, bruised or defective fruit and wash the fruit to be canned thoroughly. Separate apricots that are overripe and use this fruit for preparing as a sauce. Fruit of different ripeness should not be canned in the same container. The fruit may be canned either as pitted halves unpeeled, pitted halves peeled, whole unpeeled, or whole peeled. It is not necessary to peel apricots because their skin is so tender. If peeling is desired, however, dip the apricots in boiling water for about one minute, then plunge them into cold water and peel.

d. Filling. Pack apricots to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling medium syrup to completely fill tin cans or to cover the fruit in glass jars.

Use a canning medium of medium syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for apricots can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

4. Berries

a. Container. Use R-enamel tin cans or glass jars. The color of the fruit tends to bleach rapidly if plain tin cans are used.

b. Quality of Product. Can berries as soon as possible after they are harvested. In order to reduce spoilage due to bruising, transport harvested berries in shallow boxes. The fruit should be ripe, firm, and free from mold and other signs of spoilage when received at the canning plant. Berries cannot be stored or held long without high loss of the fruit.

c. Preparation. Sort and pick over berries in order to remove unripe, overripe, and defective fruit, and foreign materials such as leaves and stems.

Wash the berries gently in a small-mesh wire basket which may be dipped up and down in the cleaning water. Gentle sprays may also be used for washing. Wash berries in very cold or ice water in order to give a firmness to the relatively soft fruit. Only a few berries should be washed at a time. Do not let any berries stand in the water for more than a few minutes. Red raspberries are sometimes not washed as they are very tender and break apart readily. After washing the berries carefully, lift them out of the washing water. Remove caps and stems.

d. Filling. Pack the berries into the containers by hand to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Pack the berries as close as possible without crushing the fruit. The container itself may be used as a scoop in filling with berries that are firm and are not easily crushed.

Fill tin cans completely and glass jars to within 1/4 inch of the top with a boiling medium syrup. Instructions for syrup preparation are given in Table XLV of the appendix.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for berries can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. Cherries

a. Container. Use R-enamel cans or glass jars for sour cherries. For sweet cherries that are light-colored use plain cans, and for dark-colored cherries use R-enamel cans. Glass jars may also be used for sweet cherries.

b. Quality of Product. Use cherries that are fully ripe and firm for canning. Sour cherries are generally picked without the stems and for this reason should be canned immediately to prevent loss due to contamination or mold. Discard fruit that shows bruises, blemishes, signs of rot or that is worm-eaten.

c. Preparation. Sort cherries and discard worm-eaten, overripe underripe, and defective fruit. Remove foreign material from the fruit such as stems, leaves, etc. Wash the fruit thoroughly to remove dirt and spray residue. If the fruit is to be pitted for canning, chill it in cold or iced water so that it does not lose juice during the pitting operation, and so that it is easier to pit. Discard fruit that floats for it is usually defective or worm-eaten. Pitting may be accomplished either by hand or by machine. One method of hand pitting consists of inserting a u-shaped wire through the stem scar and lifting out the pit. Cherries pitted in this manner remain whole with no loss of juice.

d. Filling. Pack cherries to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or boiling medium syrup to fill tin cans completely and to cover the fruit in glass jars.

Use a canning medium of boiling water or boiling medium syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

e. Exhausting and Sealing. Cherries are highly acid and for this reason should be thoroughly exhausted. All air should be removed from the fruit and from the container by the exhaust or, in the case of glass jars, by agitating the jar or by inserting a knife and stirring the contents.

Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for cherries can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

6. Cranberries

a. Container. Use R-enamel tin cans or glass jars.

b. Quality of Product. The fruit should show no bruises or signs of rot and should not be worm-eaten.

c. Preparation. Discard bruised, overripe, rotted, or inferior fruit. Remove foreign material such as leaves and stems. Wash the fruit thoroughly. Cook the fruit in heavy syrup in steam-jacketed kettles or stock pots with the desired flavoring and then pass the pulp through a mechanical pulper in order to remove the skins.

d. Filling. Pack the cooked and strained sauce or jelly while hot to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars.

e. Exhausting and Sealing. There is no necessity for exhausting when the containers are filled hot.

Seal the cans immediately after they are filled with hot fruit. Adjust the lids of glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for cranberries can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. Figs

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Figs for canning should be ripe but firm, free from blemishes and mold and other signs of spoilage. If the figs are too green, the finished product will have an unsatisfactory flavor. If they are too ripe, they will break up badly during canning and present a poor appearance. Avoid the use of bruised and crushed figs.

c. Preparation. Sort the figs in order to remove overripe, green, or defective fruit. Wash the fruit thoroughly. The fruit is generally left unpeeled but requires blanching in hot water. Blanch the fruit until it is pliable.

d. Filling. Pack the figs by hand to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Fill the containers with water and exhaust for 30 minutes at 200° F. Then drain the water from the containers. This operation removes the milk from the skins and makes the skins translucent. Add one tablespoon of lemon juice to each No. 2-1/2 can.* Fill can completely and jars to within 1/4 inch of the top with a boiling medium syrup or heavy syrup. Instructions for syrup preparation are found in Table XLV in the appendix of this manual.

e. Sealing. Seal cans immediately after the hot syrup is added. Do not permit the contents to cool after sealing and before processing. Adjust the lids of glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for figs can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

NOTE: Figs are frequently preferred in a heavier syrup than is usual for canning. For this reason the fruit is prepared as preserves rather than as described above. Fruit that is sound but overripe or that is damaged may also be cooked in syrup and packed as preserves. Sprinkle one cup of

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* NOTE: U.S. Std. of Identity requires acidification with lemon juice or citric acid to pH 4.9 or less. (Needed for safety!)

soda over six quarts of firm, sound figs and add a gallon of boiling water. Let the figs stand in this soda solution for approximately five minutes, drain and rinse thoroughly. Add the figs to a boiling medium syrup, and boil the fruit for approximately one hour. Pack the fruit and syrup hot into the containers, leaving 1/2 inch head space in jars and 1/4 inch head space in cans. Cover the fruit with boiling syrup and seal cans or adjust jar lids immediately. No. 2 and 2-1/2 tin cans and pint and quart jars are all processed in a boiling water bath for approximately five minutes, after which they are cooled as described (see Table XXXVIII).

8. Grapefruit

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Canning of grapefruit does not result in a very satisfactory product. If grapefruit is to be canned, however, it should be free from blemishes and signs of decay. Grapefruit may be stored approximately one week before processing if the fruit is kept in a well ventilated storage area. Decay is promoted if fruit is moved from cold storage into humid and warm areas.

c. Preparation. Peel grapefruit, cut into sections and pack in the containers. For small operations grapefruit is usually peeled by hand. Cut off both ends of the grapefruit to the depth of the peel but not deep enough to cut the fruit. Slit the peel parallel with the center at several points and tear off the peel removing as much of the white membrane as possible. Remove the remaining white membrane since it imparts a bitter flavor to the grapefruit. For larger operations, grapefruit are lye peeled. It is recommended that lye peeling be used only when slightly underripe grapefruit is canned. In lye peeling, place the whole fruit in boiling water for approximately 35 minutes in order to loosen the outer yellow peel from the inner layer. Remove the outer layer as in hand peeling. This leaves the fruit with a covering of the inner membrane. Remove this membrane by passing the fruit through a boiling 2-1/2 per cent lye solution. The time of submersion is around 25 to 35 second. Remove the fruit from the lye bath and wash in cold water. Remove the membrane. If sprays are used for washing, the membrane can be removed by impact of the water.

After peeling, divide the fruit into its natural segments.

d. Filling. Pack grapefruit to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Add boiling heavy syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans

at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Pasteurize grapefruit in a water bath of 180° F. for 10 minutes for No. 2 cans and pint jars. The temperature of the water bath should remain at about 180° F. throughout the pasteurizing operation. Higher temperatures tend to soften the fruit and destroy the natural flavor. Temperatures lower than 180° F. give an insufficinet process with resultant spoilage.

Processing instructions for grapefruit can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operaton immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry. Canned grapefruit should be stored at 50°-60° F. otherwise segments will crumble and develop a bitter taste within a few months.

9. Grapes

a. Container. Use R-enamel cans or glass jars.

b. Preparation. Wash grapes thoroughly in order to remove dirt, dust, and spray residue. Remove the stems from the fruit by hand and discard defective berries.

c. Filling. Pack grapes to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. When exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

e. Processing. Processing instructions for grapes can be found in Table XXXVIII in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and

wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

10. Guava

a. Container. Use plain tin cans or glass jars.

b. Preparation. Prepare only fully matured guavas for canning. Wash and remove the stem and blossom end. Peel the guava; scoop out the seeds, and precook the shell two to three minutes in medium syrup.

In preparing guava sauce, wash and trim the fruit, and run the prepared fruit through a sieve to remove the seeds. Precook until thickened and add sugar. Cook the sauce rapidly for ten minutes.

c. Filling. Pack guavas to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Fill containers as completely as possible with hot sauce.

d. Exhausting and Sealing. If shells and sauce are hot when added to the containers, exhausting is not necessary. Seal tin cans immediately. Adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

e. Processing. Processing instructions for guavas can be found in Table XXXVIII in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

11. Loquat

a. Container. Use plain tin cans or glass jars.

b. Preparation. Remove the stem and blossom end of the loquats and peel them. Seeds may be either left in or removed. Precook the fruit for two to four minutes in a medium syrup.

In preparing loquat sauce, remove the seeds but leave the skins on. Run the fruit through a sieve or food chopper with a medium blade. Add water and precook until tender, then add sugar. Cook an additional five minutes.

c. Filling. Pack the loquats to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Add the boiling

syrup to completely fill tin cans and to fill glass jars to within 1/4 inch of the top. In canning loquat sauce, fill containers as full as possible.

d. Exhausting and Sealing. No exhaust is necessary if the fruit or sauce is added boiling hot to the container. Seal tin cans immediately and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

e. Processing. Processing instructions for loquats can be found in Table XXXVIII in the appendix of this annual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

12. Mango

a. Container. Use plain tin cans or glass jars.

b. Preparation. Peel the fruit from stem end to blossom end, slice, and allow to stand in a hot thin or medium syrup for approximately two minutes.

c. Filling. Pack mangoes to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Use a canning medium of hot light syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

d. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

e. Processing. Processing instructions for mangoes can be found in Table XXXVIII in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

13. Mayhaws

a. Container. Use plain tin cans or glass jars.

b. Preparation. Mayhaws are prepared as a sauce. For canning, gather the fruit when the first color shows. The fruit should be used as soon as it is gathered. Wash, add water and precook the mayhaws until they are soft. Put the fruit through a sieve in order to remove seeds and add sugar to the pulp. Cook the mayhaw pulp, stirring constantly, until the desired consistency has been reached.

c. Filling. Pour the pulp into clean containers while hot. Fill the containers as completely as possible.

d. Exhausting and Sealing. No exhaust is necessary if the pulp is poured into the containers while boiling hot. Seal tin cans immediately after the hot product is added. Adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the containers to cool before processing.

e. Processing. Processing instructions for mayhaws can be found in Table XXXVIII in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

14. Orange

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Canning of orange segments produces a relatively poor product, but they may be satisfactorily made into a marmalade or conserve. If they must be canned, they should be well ripe. The fruit should neither be underripe nor overripe for such fruit imparts a disagreeable flavor to the finished product.

c. Preparation. Oranges are prepared for canning in a manner similar to that used for preparing grapefruit. Cut the skin into segments parallel to the stem. The skin is then easily removed without breaking the fruit. Break the fruit into segments and remove the remaining portions of the inner white layer. Wash the unbroken segments and boil them in a heavy syrup for several minutes at 175° to 185° F.

d. Filling. Pack oranges to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling heavy syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. The containers do not need to be exhausted if the product is added to the containers at 185° F.

Seal tin cans immediately after the hot fruit and syrup is added. Adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for oranges can be found in Table XXXVIII in the appendix of this manual.

Canned oranges are pasteurized at not greater than 185° F.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

15. Papaya

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Papayas are canned either ripe or green. Use only well ripened fruit when ripe papayas are being canned.

c. Preparation. Wash the ripe fruit, cut it and remove the seeds. Slice the fruit into cool syrup and bring to a boil slowly and cook for two to three minutes. Wash and peel green papaya. Precook for four minutes and add seasoning as desired.

d. Filling. Pack papayas hot to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. No exhaust is necessary if the fruit is packed hot.

Seal tin cans immediately after the hot fruit has been packed into the containers. Adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for papayas can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed.. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

16. Peaches

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Peaches for canning should be firm but ripe. For best flavor of product the fruit should be tree ripened. Do not use unevenly ripened fruit or green fruit ripened in storage. Overripe fruit should be used for preserves.

c. Preparation. Remove green, overripe, or defective fruit. Wash the fruit thoroughly and then peel. Peeling may be accomplished by hand with paring knives, by scalding, or by lye. Lye peeling is recommended where large quantities of peaches are to be peeled.

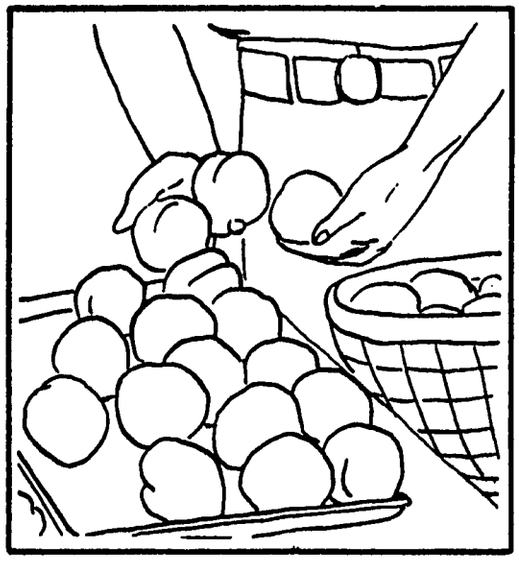
If peaches are to be peeled by scalding, place peeches which have been allowed to mellow for one or two days in a blanching basket and dip into boiling water for about one minute or until the skins slip easily. Care should be taken not to put the peaches in water cooler than boiling temperatures since this tends to cook the fruit rather than loosen the skins. Remove the fruit from the boiling water and dip into cold water in order to crack the skins and to stop cooking action. The peaches should not stand in the cold water. After scalding the skins may be removed from the fruit either by hand or with the aid of a knife.

Peel large quantities of peaches by the lye bath method. Peel the peaches by immersing in a hot lye solution with a concentration of about 1 to 2-1/2 per cent until the skins are loose. Immersion times range from 30 to 60 seconds. If the solution is too strong, too much of the flesh is removed, while if it is too weak, the operation requires too much time. In order to insure uniform peeling, sort the fruit as to variety, ripeness, and size before peeling. Care should be taken not to allow the peaches to stand in the lye solution for periods longer than those designated, as the peaches absorb the solution and the flavor of the product is imparied.

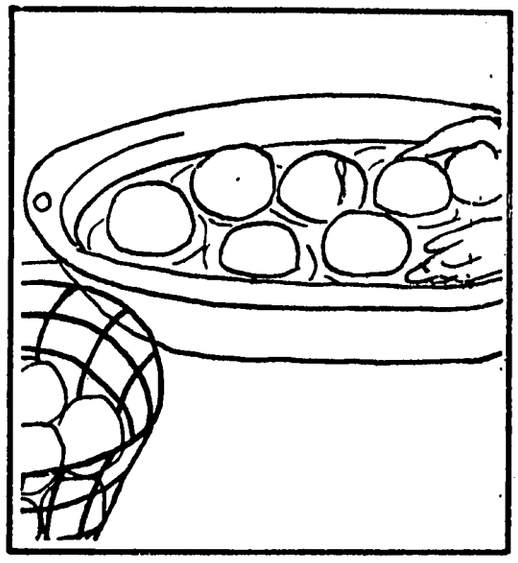
After treating the peaches in the lye solution, wash them thoroughly and remove the skins. Somewhat severe washing is necessary in order to remove adhering lye completely and to remove the skin. The use of spray washing after the lye peeling is generally recommended. If sprays are not available, however, wash the peaches in a tank of cold water by lowering and raising the wire basket in which the fruit is placed several times and shaking them slightly, and slip the peels from the fruit with the fingers.

After the peaches are peeled, slice the peach in desired segments and remove the pit. Peach-pitting spoons or knives must be used with clingstone varieties.

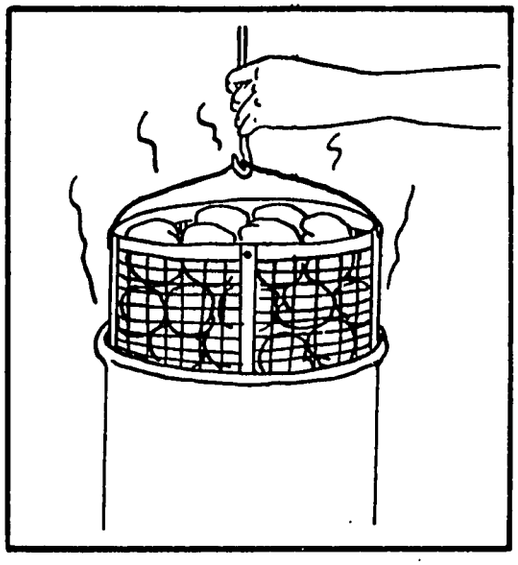
d. Filling. Pack peaches to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.



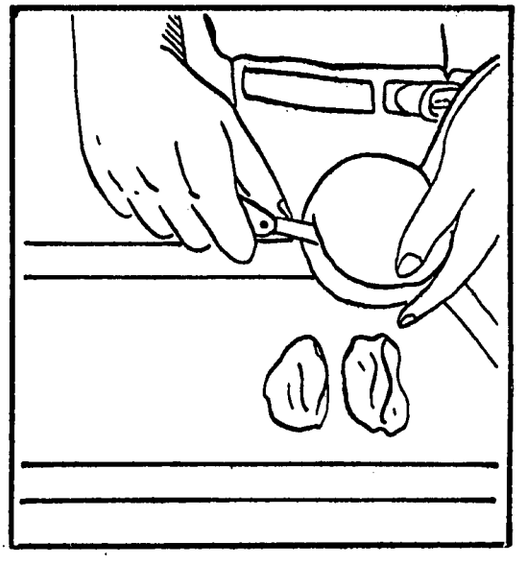
1. SORT THE FRUIT, CHOOSING ONLY THAT WHICH IS WELL RIPENED BUT FIRM.



2. WASH THE FRUIT WELL TO REMOVE DIRT AND SPRAY RESIDUE.

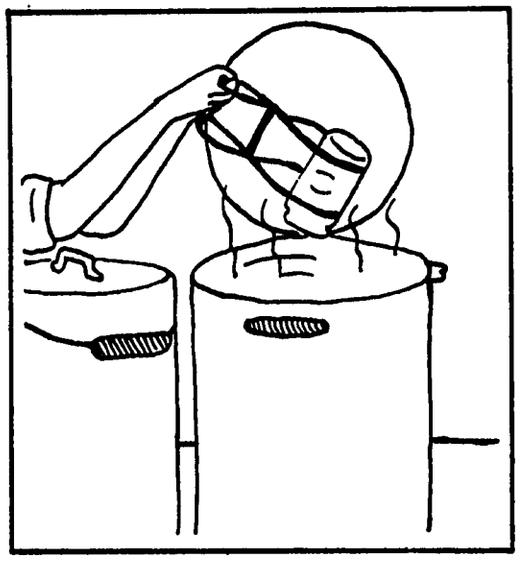


3. SCALD THE PEACHES IN BOILING WATER TO FACILITATE REMOVAL OF SKINS. COOL QUICKLY IN COLD WATER TO PREVENT COOKING THE FLESH.

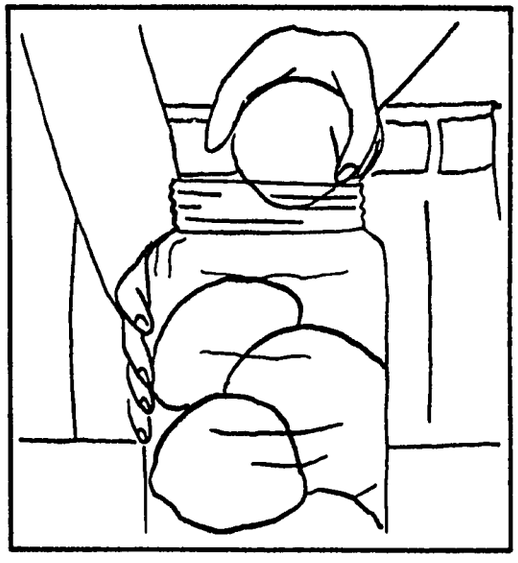


4. REMOVE THE SKINS AND PITS AND SLICE INTO DESIRED SECTIONS. DIP SECTIONS IN WEAK SALT SOLUTION TO PREVENT DISCOLORATION.

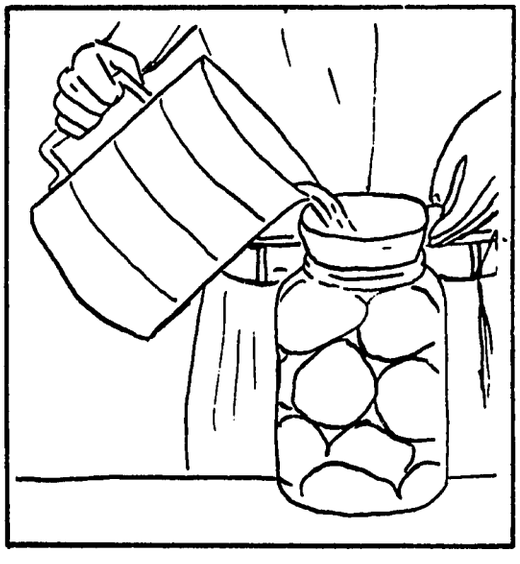
Figures 89-92. Steps in Canning Fruit in Glass--Peaches



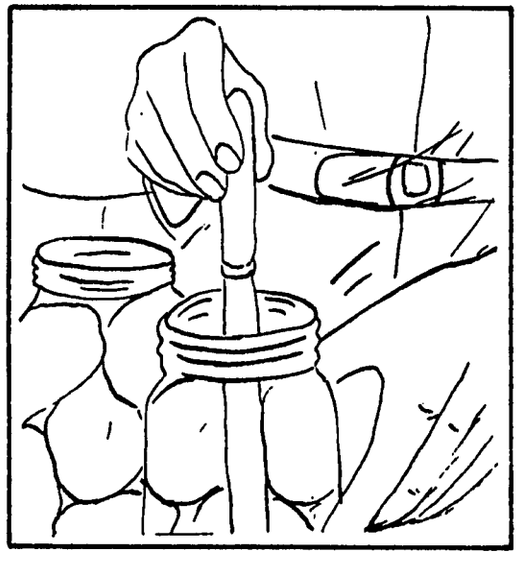
5. TEMPER AND STERILIZE THE GLASS JARS IN BOILING WATER BEFORE FILLING.



6. DRAIN THE FRUIT AND PACK IN JARS TO WITHIN ONE-HALF INCH OF THE TOP.

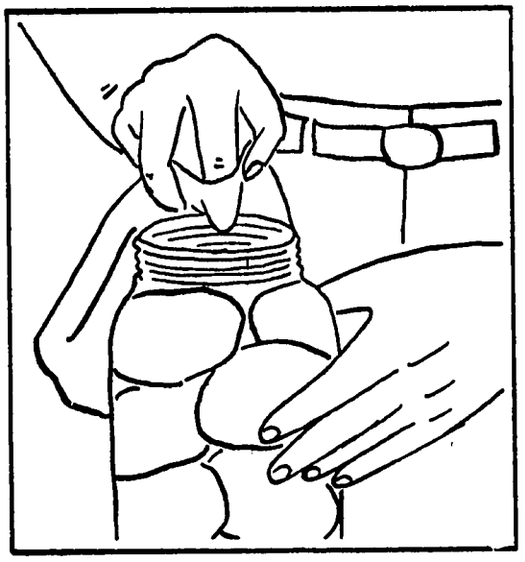


7. COVER THE FRUIT WITH THE CANNING MEDIUM TO WITHIN ONE-QUARTER INCH OF THE TOP.

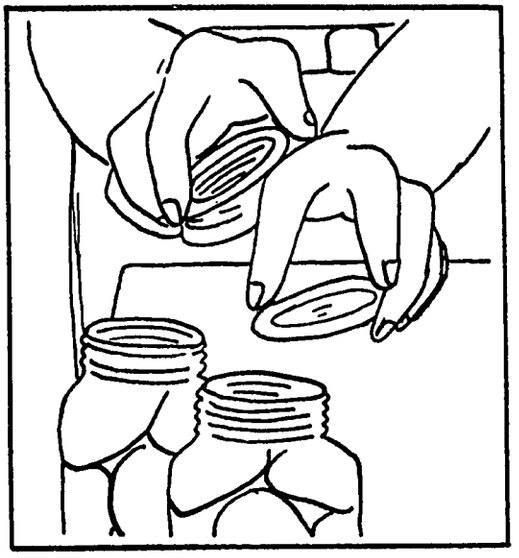


8. REMOVE AIR BUBBLES WITH A KNIFE OR SPATULA AND PRESS THE FRUIT DOWN WITHOUT CRUSHING. ADD MORE CANNING MEDIUM IF NECESSARY.

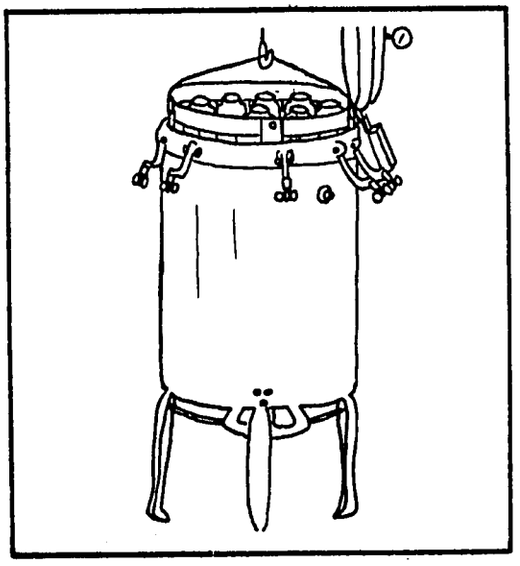
Figures 93-96. Steps in Canning Fruit in Glass--Peaches



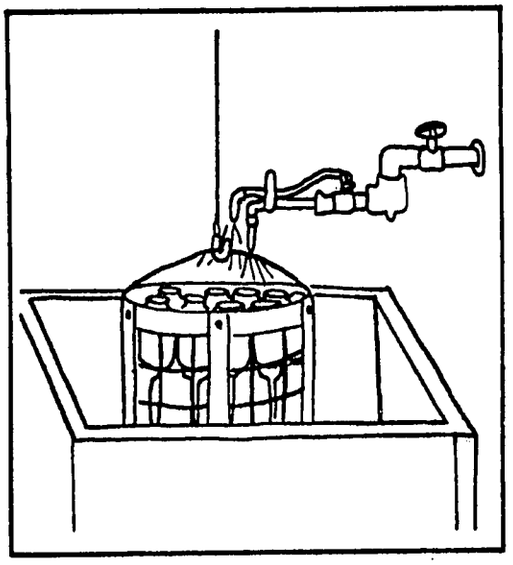
9. WIPE THE TOP OF THE JAR FREE OF FOOD PARTICLES AND SYRUP WITH A DAMP CLOTH.



10. PLACE THE SELF-SEALING CAP ON THE JAR AND SCREW THE RING DOWN FIRMLY OVER IT. PROCESS IMMEDIATELY.



11. PROCESS THE JARS IN AN ATMOSPHERIC COOKER, WHICH MAY BE AN OPEN RETORT, TIMING THE PROCESS FROM THE TIME THE WATER BOILS.



12. AFTER PROCESSING, COOL THE JARS IN AIR OR IN A FINE SPRAY OF WATER.

Figures 97-100. Steps in Canning Fruit in Glass--Peaches

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for peaches can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

17. Pears

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Pears develop a better flavor and finer texture if they are taken from the tree when somewhat underripe and held in containers for 5 to 10 days for ripening.

c. Preparation. Sort the fruit and remove bruised, rotted, worm-eaten, and inferior fruit. Because of the irregular shape of pears and the ease with which they may become bruised and discolored, their preparation requires a great deal of hand work. Peel the fruit by hand. Expert labor is required if the fruit is to be peeled well and uniformly. After peeling, cut the pear in half, remove the core with a loop pear corer or coring hook, and cut out the remainder of the core with a paring knife. Trim away blemishes as the fruit is pared. Dip the fruit in a mild brine solution to prevent discoloration.

Small quantities of pears may also be satisfactorily peeled by scalding them in boiling water for two to three minutes. This water should not be below the boiling point as it will tend to cook the fruit rather than loosen the skin. After scalding, dip the fruit in cold water to stop the cooking action and loosen and crack the skin. After peeling and slicing, dip the fruit into a mild brine solution to prevent discoloration.

If large quantities of pears are to be canned, they may be peeled whole with lye, similar to peaches (page 172), with the exception that pears require two or three times longer for peeling. Subsequent coring and handling should be done by hand.

Blanch the pears for one minute in boiling syrup.

d. Filling. Pack pears to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Use a canning medium of a thin or medium syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for pears can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

18. Pineapple

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. The pineapple should be fully mature since green fruit lacks the desired flavor. Overripe fruit ferments rapidly and should not be used for canning.

c. Preparation. Wash the fruit thoroughly. Cut off the butt end of the pineapple with a sharp knife and twist off the top. The fruit may be prepared by either peeling and cutting to about half the depth of the eye, then slicing to remove the rest of the eye and core, or by placing the pineapple on its side and slicing crosswise and paring each slice. If the latter method is employed, cut out the core with an instrument similar to a biscuit cutter. For large-scale operations, peeling and coring of the pineapple is performed by machine. These machines are entirely automatic and perform the operations of cutting, sizing, coring, and removing the outer shell. Pineapples can be canned as slices or as chunks or finger-size pieces or it may be crushed and grated.

d. Filling. Pack pineapple to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Use a canning medium of a light or medium syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for pineapple can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

19. Plums

a. Container. Use R-enamel cans or glass jars.

b. Quality of Product. Plums for canning should be ripe, yet firm. Underripe plums lack flavor and are sour, while overripe plums disintegrate in the process.

c. Preparation. Sort the plums and remove any soft and defective fruit. Wash the fruit thoroughly to remove dust and spray residue. If plums are canned with the skins, remove the stems, wash, and grade for size. Prick the skins with a needle to prevent bursting during the processing. Blanch the fruit for about 15 seconds in boiling medium syrup in order to insure a firm pack.

If the fruit is to be packed without skins, remove the skin from the plum by plunging it into boiling water for one minute and then into cold water. If the skins are removed immediately, the plums will be green or yellowish, but if allowed to stand they become reddish from contact with the skin. If they stand too long they become brown.

d. Filling. Pack plums to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling medium syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 180° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 180° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for plums can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

20. Quince

a. Container. Use R-enamel tin cans or glass jars.

b. Quality of Product. Quinces, like oranges, produce poor canned product because of their woody texture and bitter flavor, but are excellent if prepared as preserves. If they must be canned, however, use ripe quinces free from blemishes.

c. Preparation. Wash the fruit thoroughly, peel and cut in segments similar to pears. Precook the fruit in boiling heavy syrup until almost tender.

d. Filling. Pack quince hot to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling heavy syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Use a canning medium of heavy syrup. Instructions for syrup preparation are given in Table XLV in the appendix of this manual.

e. Exhausting and Sealing. No exhaust is necessary if the product is packed hot.

Seal tin cans immediately after the hot fruit is added to the containers. Adjust the lids of glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for quince can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

21. Rhubarb

a. Container. Use R-enamel tin cans or glass jars. Because of the high acidity of rhubarb, glass jars are recommended in preference to the tin cans.

b. Preparation. Wash and cut the rhubarb into even lengths without removing the skins. Add sugar to the rhubarb and cook in boiling water.

c. Filling. Fill the containers with the hot rhubarb. Fill tin cans to within 1/4 inch of the top and glass jars to within 1/2 inch of the top. Fill tin cans completely with the cooking juice and glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. No exhaust is necessary if the product is packed hot.

Seal tin cans immediately after the hot fruit is added to the containers. Adjust the lids of glass jars as described in section I, F of Chapter III.

e. Processing. Processing instructions for rhubarb can be found in Table XXXVIII in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

22. Roselle

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Use full grown calyces for canning.

c. Preparation. Prepare roselle as a sauce. Remove the stem and the seed and, using equal amounts of calyces and water, cook slowly until tender. Run the pulp through a sieve. Add sugar and bring to a boil. Cook to the desired consistency.

d. Filling. Pack the hot pulp into containers as close to the top of tin cans as possible and within 1/4 inch of the top of glass jars.

e. Exhausting and Sealing. Tin cans filled with hot roselle pulp need not be exhausted if the container is sealed immediately.

Seal tin cans immediately after adding the hot pulp and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the containers to cool before processing.

f. Processing. Processing instructions for roselle can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

23. Sauerkraut

a. Container. Use R-enamel cans or glass jars.

b. Quality of Product. Saurekraut is cabbage which has been subjected to a fermentation process to convert the natural sugar in the cabbage to lactic acid. Late summer or fall cabbage is usually best for kraut. The cabbage head should be solid, free from decay and discoloration or damage from freezing.

c. Preparation. Wash the cabbages to free them from dirt and dust. Trim the heads to remove the defective leaves and bruised spots, and remove the outer green leaves. Core and shred the cabbage. Shredding is accomplised by cutting the cabbage in slices. Slaw cutters or hand-operated shredding machines may be used. The shreds should be cut approximately 1/32 of an inch thick and as long as possible.

Use tanks, barrels or small stone jars for curing sauerkraut. The containers should be water tight to insure against loss from leakage. Place the cut cabbage in the container and salt at the rate of about 2 to 2-1/2 pounds of salt per hundred pounds of cabbage. Sauerkraut will soften if less than 2 per cent salt is used and will become pink if greater than 2-1/2 per cent salt is used. Spread the salt over thin layers of cabbage in alternate layers. Mix the layers to give an even distribution of the salt throughout the cabbage. Press the cabbage firmly into the containers using a weight if necessary to pack it closely. Brine is formed as the salt draws juice from the cabbage.

After the container is filled, cover it with a clean cloth and a clean wooden cover. Weight down the cover to sink the sauerkraut about one inch beneath the surface of the brine which forms. Allow the cabbage to ferment for about three to four weeks at a temperature of approximately 65° F. Remove any scum which forms during the fermentation process once or twice each week. The fermentation process is complete when the cabbage develops a translucent appearance and when bubbles no longer rise at the sides of the container. When the fermentation process is complete, remove the cabbage for canning. Discard any discolored or dark sauerkraut.

Heat the well-fermented crisp sauerkraut to approximately 160° F. before packing into the containers. Do not boil, as this causes the kraut to darken.

d. Filling. Pack sauerkraut to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Add boiling brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for sauerkraut can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

24. Strawberries

a. Container. Use R-enamel cans or glass jars.

b. Quality of Product. Strawberries, like quinces or oranges, make excellent preserves, but are unsuited for canning. Canned strawberries are very soft, pale in color, and lack flavor. If they must be canned, however, use strawberries which have firm texture, good color and flavor, and are large. The flesh should be pink to red with no white centers.

c. Preparation. Pick over and remove faulty or green strawberries. Hull by removing the caps, wash, and drain.

d. Filling. Pack strawberries to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling heavy syrup to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food in a heavy syrup, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for strawberries can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

25. Tomatoes

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Tomatoes for canning should be well ripened but firm. The tomatoes should be free of green areas around the stem end but not overripe. Vine ripened tomatoes give the best flavor and color. Smooth and regularly shaped fruit is preferred since it is more easily prepared than irregularly shaped fruit.

c. Preparation. Sort tomatoes to remove green, rotten, or undesirable fruit before washing. After sorting, wash the tomatoes thoroughly to remove dirt, mold, or rot that has adhered to the skin due to contact with faulty products. Sprays are usually preferable for washing tomatoes since they are less likely to break or bruise the product.

Peel tomatoes by scalding them for 30 to 45 seconds in boiling water or under steam for about 30 seconds. This scalding loosens the skin on ripened tomatoes and facilitates peeling. The temperature of the water should not be below 212° F. as cooler water tends to cook the tomatoes without loosening the skins. Immediately after scalding the tomatoes, dip them in cold water or under cold sprays in order to cool them for convenient handling and to crack the skins.

First remove the entire core and core particles taking care not to cut so deep as to penetrate into the seed cell. The core must be removed since it is hard and tends to retard heat penetration and thus may cause spoilage. Remove the skins by slipping off or by twisting the tomatoes in the hand, or by using special spoon-shaped knives. Strip off the entire skin and remove the black tip at the blosson end of the fruit. Cut the tomato into conveniently sized pieces as desired.

d. Filling. Pack tomatoes to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. If the tomatoes are fully ripe, enough juice will be released during packing to cover the pieces. Excess juice in the preparation container should be poured over the product to completely fill tin cans and fill glass jars to within 1/4 inch of the top. When tomato juice is used as the canning medium, the product has a better flavor than when water or brine is used. Salt in granulated or tablet form is frequently added to the product.

e. Exhausting and Sealing. Exhaust the filled tin cans for raw pack to a center can temperature of 140° F. and seal them immediately. Where exhaust facilities are not available, precook the raw food, add it to the cans at 140° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the product and medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for tomatoes can be found in Table XXXVIII in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

C. Nonacid Foods

Nonacid foods require processing at temperatures in excess of 212° F. The relatively high temperatures are required in order to kill the actively growing microorganisms found in these foods.

Brine is the canning medium normally added to nonacid vegetables. Brine is added to take away the raw vegetable flavor and make the product more palatable. The brine, usually a two per cent salt solution, may be made and added in one of several ways. The salt solution may be made prior to canning by adding the specified amount of salt to potable, soft water. Salt may also be added to the individual containers in granulated or in tablet form. The required amount of salt is placed on the product in the containers, and the product is covered with boiling water. The quantity of salt to be added in either tablet or granulated form can be found in Table XLVI in the appendix of this manual.

1. Asparagus

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Use young, tender stalks for canning. Hard or deformed stalks and stalks showing evidence of rust (a reddish fungus) should not be packed.

Asparagus wilts rapidly after it is harvested, and for this reason it should be brought to the processing plant as quickly as possible after cutting. If it is necessary to hold asparagus from one day to the next, it should be refrigerated at about 36° F.

c. Preparation. Wash the asparagus, trim off scales and tough ends. Make certain that washing has been thorough; the tips and leaflets

should be examined carefully for sand. Washing is accomplished more satisfactorily under sprays than by dipping. Floating the stalks in warm water facilitates cleaning exceptionally dirty asparagus. Can only the tender portions of the stalk. Cut the stalks either into container-length pieces or into one-inch pieces. The container-length pieces should be about 1/4 inch less than the height of the container. Use tender portions cut from the stalk or trimmings from the container-length pieces may be used as asparagus cuts.

Blanch the cut and washed asparagus in steam or hot water from two to four minutes, depending on the size of the stalks. Blanching removes the mucous material from the stalk and reduces the bitter flavor. At the same time, blanching softens the stalk and thus allows the container to be filled more completely. Cool the blanched asparagus quickly under water sprays or by dipping in cold water to facilitate packing. Do not allow the asparagus to remain in the cooling water for more than a few seconds.

d. Filling. Before filling the asparagus into the cans, sort it into grades according to both color and uniformity of size. If the asparagus is to be packed whole, gather sufficient stalks in a bundle. Work the bundle of stalks into the container with the cut ends down. Settle the stalks by tapping the container on the table. The pack should be firm in order to insure that the stalks will not break in subsequent handling. Leave a space of 1/4 inch at the top of tin cans and 1/2 inch at the top of glass jars. Use boiling water or brine to fill tin cans completely or to just cover the product in glass jars. Where brine is not used add salt as specified in Table XLVI in the appendix of this manual.

If asparagus cuts are packed, fill the container by scooping the sections up and pouring them into tin cans to within 1/4 inch of the top or to within 1/2 inch of the top of glass jars. Brine or boiling water is added as above.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as decribed in section I, F of Chapter III.

f. Processing. Processing instructions for asparagus can be found in Table XXXIX in the appendix of this manual. Containers of spears must be processed in an upright position.

g. Cooling. Begin the cooling operation immediately after the processing time has elasped. Cool tin cans rapidly to 100°F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. Artichokes

Pressure processing of artichokes and artichoke hearts produces a product that is of poor quality. For this reason, this product is usually preserved by acidifying it with vinegar. The acidification permits safe processing in boiling water at 212° F. which does not reduce the quality of the product. Care should be taken in all steps of the operations. For this reason, a research laboratory must be consulted if the product is to be canned. Spices may be added to artichokes if they are to be prepared as pickles.

3. Beans, Baked

a. Container. Use plain tin cans or glass jars.

b. Preparation. Dried white beans, navy beans, or red kidney beans may be prepared with sauce. First soak the beans in tanks of cold water from 10 to 15 hours with frequent changes of water. Cook the soaked beans in steam-jacketed kettles or stock pots for approximately 40 minutes.

Various sauces may be prepared for baked beans. Plain sauce for the beans may be prepared from molasses, sugar, salt, and water. Tomato sauce may be made from the same ingredients with the addition of tomato puree and spices. If the beans are to be canned with pork, place a piece of pork in each can before it is filled with the beans. Then add the sauce.

c. Filling. Pack hot baked beans to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add sauce to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. No exhausting is necessary if the baked beans and sauce are placed in the containers while hot (150° F.).

Seal tin cans immediately after the hot product has been added and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the containers to cool before processing.

e. Processing. Processing instructions for baked beans can be found in Table XXXIX in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

4. Beans, Snap (Green or Wax)

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Snap or green beans for canning should be harvested while tender and before the seed tends to separate from the pod during the processing. When the individual beans leave the pods during cooking, they are too mature to have good flavor and texture for canning use. The bean pods should be as free as possible from strings or fiber and from blemishes and rot. Beans, if held in storage for too long a time after harvesting, become wilted, darkened, and tough.

c. Preparation. Remove the ends of the beans and the strings, and break or cut the beans into pieces approximately one to one and one-half inches long. Discard overmature, bruised or otherwise undesirable beans during the snapping operation. If large quantities of beans are to be canned, a mechanical "snipper" can be used to remove the ends.

Blanch the beans in hot water at approximately 195° F. The length of blanching depends upon the type and maturity of the beans and is usually less than five minutes. The beans should become pliable in the blanching process, but should not become slimy. Sliminess is an indication that the product has been over-blanched.

After blanching, dip the beans quickly into cold water or under water sprays to stop the blanching process and make the product easy to handle. Do not allow the beans to remain in the cooling water more than a few seconds.

d. Filling. Pack beans to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 165° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 165° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for beans can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. Beans, Green Lima

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Lima beans should be harvested when the bean reaches mature size but before it loses its green color. The best time for harvesting lima beans is when the pods are still green yet the beans shell out well. Only young, tender lima beans should be canned. The older beans with high starch content are undesirable for canning but may be preserved by drying. Lima beans should be handled in small quantities and as rapidly as possible in the smaller operations so that spoilage will not occur.

c. Preparation. Lima beans must be shelled during preparation if they are not separated from the hull by vining machines during harvesting. Lima beans can be shelled either by hand or with the mechanical pea sheller with the proper accessories. Pea or bean shellers are highly recommended where large quantities of beans are to be prepared. If these machines are used, the product must be handled rapidly to avoid spoilage. After shelling, wash the beans thoroughly in running water or under cold water sprays. Do not store beans for further operations after they are washed since they discolor and spoil within a few hours. If they must be held, hold them in shallow trays where air can circulate through them to prevent spoiling, and do not wash them until just prior to the blanching operation.

Sort the beans in order to remove old, discolored, or dried beans. Blanch the sorted and washed beans at approximately 195° F. Blanching may take place either in hot water or in a steam blancher. The blanching time will vary with the maturity of the beans. Small beans may be blanched in less than three minutes whereas the older beans will require a longer time. Drain the beans at once.

d. Filling. Pack beans to within 1/2 inch of the top of tin cans or to within one inch of the top of glass jars. Add boiling brine or water to completely fill tin cans or to fill glass jars to within 1/2 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 140° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 140° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for green lima beans can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time for elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

6. Beets

a. Container. Use R-enamel cans or glass jars.

b. Quality of Product. Beets for canning should be tender and young, and should be canned as soon after harvesting as possible. Beets that must be stored for any length of time develop a bitter flavor. The beets most desirable for canning are of a uniform dark red color, not light colored. Beets that have developed in dry weather usually have fibrous and woody portions and should not be used in canning.

c. Preparation. In general, beets of approximately two inches in diameter are canned whole, whereas beets of larger sizes may be sliced or quartered. First remove the tops or leafy portions of the beets. The tender tops are often canned as greens. Leave about one inch of both root and leaf stalk on the beet to prevent bleeding during the steaming operation. Wash the beets thoroughly to remove adhering dirt. A strong water spray is desirable for this purpose, particularly if considerable dirt it present. In some cases, it may be necessary to soak the beets in order to remove the adhering dirt. Use vegetable brushes in washing if necessary but take care not to break the skin of the vegetable.

Grade the beets roughly into two sizes, smaller than two inches and larger than two inches in diameter. This grading gives a uniformity to the finished product and simplifies the subsequent preparation steps.

To permit peeling, steam the washed and trimmed beets at about 225° F. for from 15 to 25 minutes, the time depending upon the size of the beet. Boiling water may be used instead of steam to loosen the skins but it removes considerable sugar and other soluble compounds from the beets. Steaming is accomplished in the retort at the required pressure or in specialized apparatus. Chill the steamed beets in water to stop the cooking action and to crack the skins. After steaming and cooling the beets, grasp them firmly with both hands, and twist in opposite directions with the hands. This removes the peeling except around the stem and the small root at the tip of the beet. Trim to remove all traces of the skin and root tip. Do not allow the beets to remain in the cold water for more than a few seconds before peeling begins. Prompt handling is then necessary or the skin may be difficult to remove.

Quarter, slice, or dice large beets. Slices are usually about 3/8 of an inch thick.

d. Filling. Pack beets to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or completely cover the product in glass jars.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for beets can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. Broccoli

a. Container. Use C-enamel cans or glass jars.

b. Quality of Product. Use only fresh broccoli with the florettes and buds tight and not in flower. Do not use thick stems unless they are tender.

c. Preparation. Wash the broccoli thoroughly to remove dirt and foreign material. Cut the broccoli to a length of about 1/2 inch less than the height of the container. The larger stalks should be halved or quartered. Blanch the product at about 195° F. for approximately 3 minutes, depending on the thickness of the stalks. Dip the blanched product in the cold water to stop the cooking action and to allow ease in handling.

d. Filling. Pack broccoli with heads up to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling brine or water to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for broccoli can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

8. Brussels Sprouts

a. Container. Use plain tin cans or glass jars.

b. Preparation. Break sprouts from the heads, wash, sort, and blanch for about four minutes. Chill the sprouts thoroughly in cold water to prevent matting in the can.

c. Filling. Pack brussels sprouts to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill the tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

d. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

e. Processing. Processing instructions for brussells sprouts can be found in Table XXXIX in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

9. Cabbage

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Cabbage for canning should be firm and well developed. The heads should not be shriveled, bruised, or discolored.

c. Preparation. Wash the cabbage thoroughly to remove dirt and foreign material. Trim the head, cut into sections and steam until tender. Steaming is preferable to blanching in water as less of the soluble food elements are lost.

d. Filling. Pack cabbage to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Add boiling brine or water to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the containers. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for cabbage can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

10. Carrots

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. A well shaped, deep orange-colored carrot is most desirable for canning. The carrots should be crisp and tender, and only fully matured one should be used. Dispose of any vegetable that has become fibrous or woody.

c. Preparation. Remove the leaves from the carrot, leaving about 1-1/2 to 2 inches of the stalk at the top (the tops can be

removed from the carrots before delivery at the cannery to eliminate the waste disposal problem). Soak the carrots in water to loosen dirt before washing. Scrub the carrots with a stiff brush until they are clean. If large quantities of carrots are to be handled, sprays expedite washing.

Peel carrots after they are washed. Carrots may be peeled either by hand or by lye. In peeling by hand, use the stub of the carrot stalk to hold them with while removing the thin peel from the carrot with a sharp peeling knife. Remove the top remainder after the peeling is complete. If carrots are to be lye peeled, trim them, removing tops and small root tip from the point of the carrot. Carrots that have been freshly dug are lye peeled with a very short treatment of about one and one-half minutes. Carrots that have been shipped or held in storage for up to ten days require about two and one-half minutes or more. The skins should slip off freely and leave the carrots smooth and clean after this time. After lye peeling, practically no trimming is necessary. A 4-1/2 per cent lye solution is required for peeling carrots. It is brought to a rolling boil before adding or immersing the carrots. Wash the carrots thoroughly in cold water after the lye treatment. If the skin still remains on the carrot, it should be removed by holding the carrot underwater and brushing with a vegetable brush.

Cut the carrot into the desired size. Can small carrots whole if desired. Cut or slice larger carrots for canning.

d. Filling. Pack carrots to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for carrots can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

11. Cauliflower

a. Container. Use C-enamel cans or glass jars.

b. Preparation. Cut the head into convenient-size pieces to fit the cans, wash, sort, and blanch for approximately four minutes. It is advised that the cauliflower be blanched in boiling 1 per cent citric acid in order to prevent greying in the cans. After blanching, chill the cauliflower thoroughly in cold water to prevent matting in the can.

c. Filling. Pack cauliflower to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

e. Processing. Processing instructions for cauliflower can be found in Table XXXIX in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

12. Celery

a. Container. Use plain tin cans or glass jars.

b. Preparation. Separate the large stalks and use the hearts whole. Wash carefully, cut into one- to two-inch lengths, and precook approximately two minutes.

c. Filling. Pack hot celery to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling brine or water to fill tin cans completely or to fill glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. No exhaust is necessary if celery is precooked and packed immediately into the containers.

Seal tin cans and adjust the lids of glass jars as described in section I, F of Chapter III immediately after the precooked product has been added. Do not allow the contents to cool before processing.

e. Processing. Processing instructions for celery can be found in Table XXXIX in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

13. Corn (Whole-Grain)

a. Container. Use C-enamel cans or glass jars.

b. Quality of Product. The maturity and quality of corn for canning is determined by a test of the kernel. The kernels should be fully grown but tender. The milk from the kernels should appear creamy for the most desirable corn.

c. Preparation. Process corn as soon as possible after it is picked. Husk the corn, and remove as much of the silk as possible during husking. Remove the remaining silk with a medium stiff brush or a mechanical corn silker. Mechanical silkers are used only when a great deal of corn is to be processed. Inspect the ears and remove blemishes and undesirable portions. After this trimming, wash the corn thoroughly.

Precook the ears of corn in steam or boiling water for approximately five minutes to allow the milk to set. The time of precooking may be checked by testing the kernels with a sharp implement to see whether the milk has set. Cut the kernels from the cob. This operation is accomplished either by hand or with mechanical corn cutters. If cut by hand, a sharp bladed knife is used. Remove the grains from the cob in one cut, cutting only one or two rows at a time. If too many rows are cut at one time, portions of the cob may be unintentionally included. Normally about 2/3 of the total depth of the kernel is cut during the one stroke. Do not scrape the cob in preparing whole-grain corn.

Wash whole-grain corn prior to putting it into the cans in order to remove all chaff and small particles from the kernels. This wash is necessary since the processing time for whole-grain corn is based on a product free from these fines and one that contains a clear medium. Corn cut with a knife has many cut grains which are lost in washing, and in this case washing is omitted.

d. Filling. The fill of whole-grain corn is based upon its maturity. The more mature the corn, the less should be the fill.

In general, pack corn to within 1/2 inch of the top of tin cans or to within approximately 1 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 180° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 180° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for corn can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

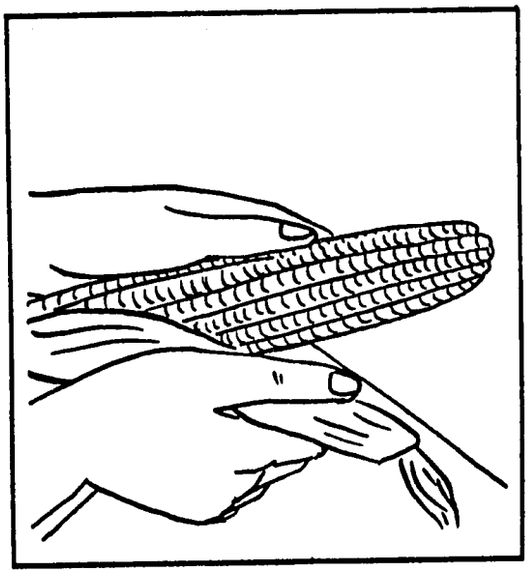
14. Corn (Cream-Style)

a. Container. Use C-enamel cans or glass jars.

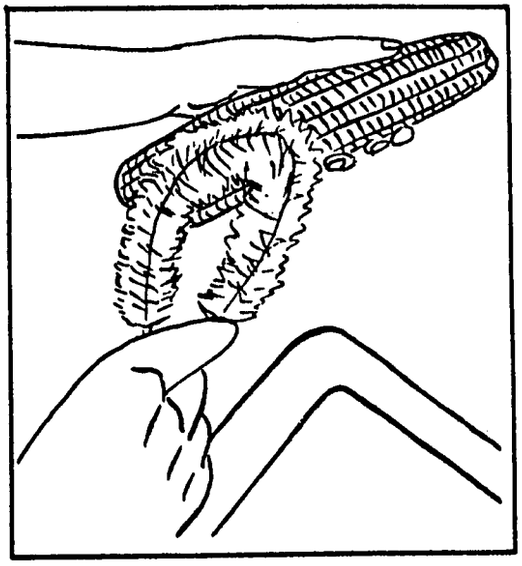
b. Quality of Product. The quality of corn for canning cream-style should be the same as that for whole-grain canning. In general, the corn should be slightly more mature for cream-style corn than for whole-grain corn.

c. Preparation. Husk and silk the corn. Remove as much silk as possible with the husk. Remove the remaining silk with a medium stiff brush. When the silks are removed, trim the ears free of all blemishes and undesirable portions. Wash the ears thoroughly.

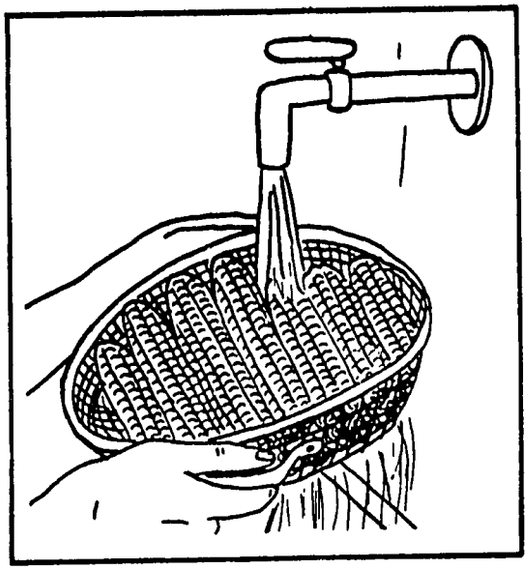
After washing the ears, cut the kernels from the cob. Cream-style corn is usually removed from the ears in two cuts. The first cut removes the major portion of the kernels from the cob; the second cut scrapes off the exposed pulp that remains on the ear. Cut as thin a slice as possible during the first cut. Turn the knife over and use the back to scrape the exposed pulp from the cob. Take care not to scrape too deeply or portions of the cob may be added which would give an undesirable flavor to the finished product. Where rapid hand production is practiced, it is desirable for one person to make the initial cut and another person to scrape the remaining portion from the cob.



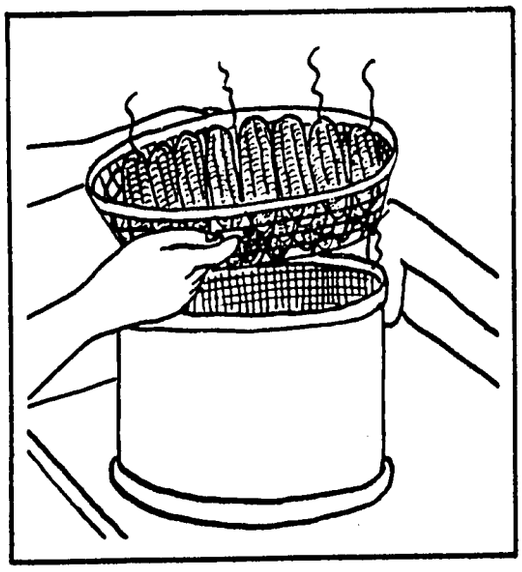
1. REMOVE THE HUSKS AND AS MUCH SILK AS POSSIBLE. DISCARD EARS THAT ARE POORLY DEVELOPED, DISEASED, OR WORM-EATEN.



2. REMOVE REMAINING SILK WITH A MEDIUM STIFF BRUSH.

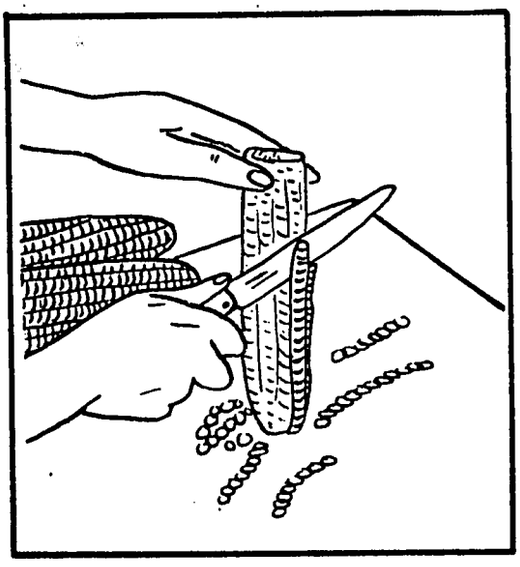


3. WASH THE EARS IN COLD WATER.

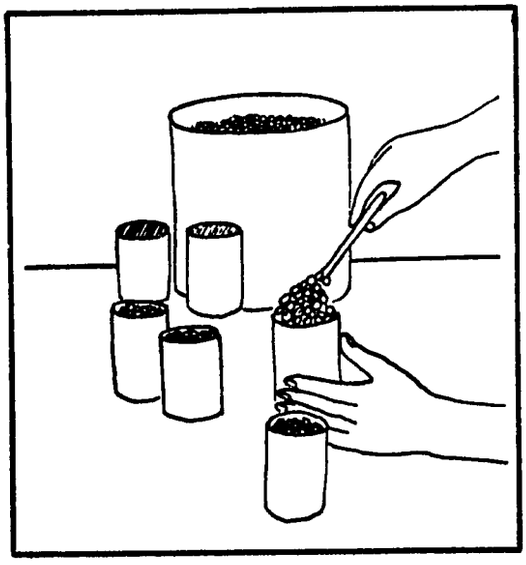


4. PRECOOK EARS OF CORN IN BOILING WATER UNTIL THE MILK IN THE KERNELS SETS (APPROX. 5 MIN.).

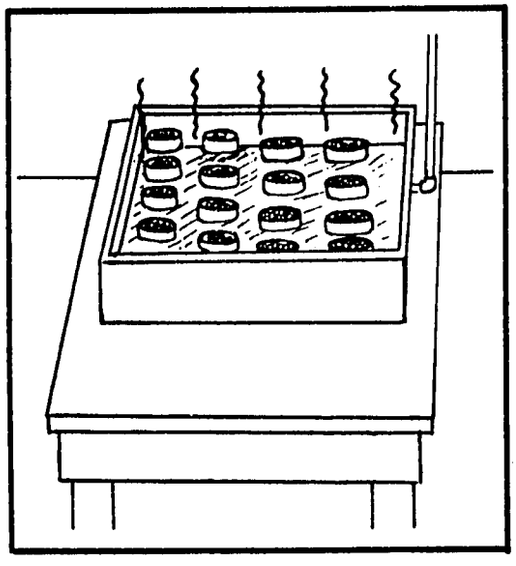
Figures 101-104. Steps in Canning Vegetables in Tin--Corn



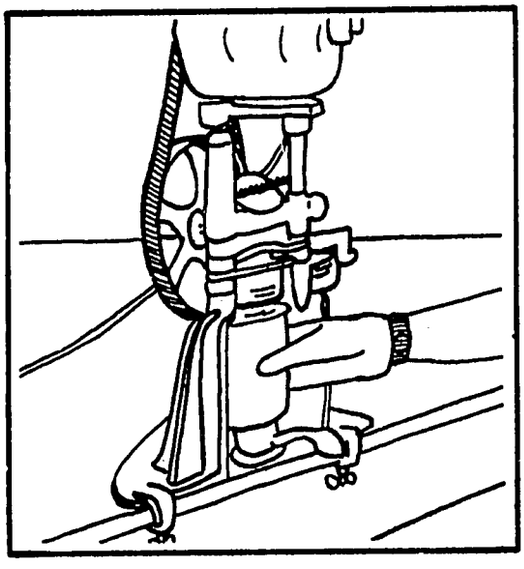
5. WITH A SHARP KNIFE, CUT THE KERNELS FROM THE EAR TO ABOUT TWO-THIRDS OF THE TOTAL DEPTH OF THE KERNELS.



6. ADD PRODUCE TO FILL THE CLEANED CAN WITHIN ONE-HALF INCH OF THE TOP AND ADD CANNING MEDIUM TO FILL CAN COMPLETELY.

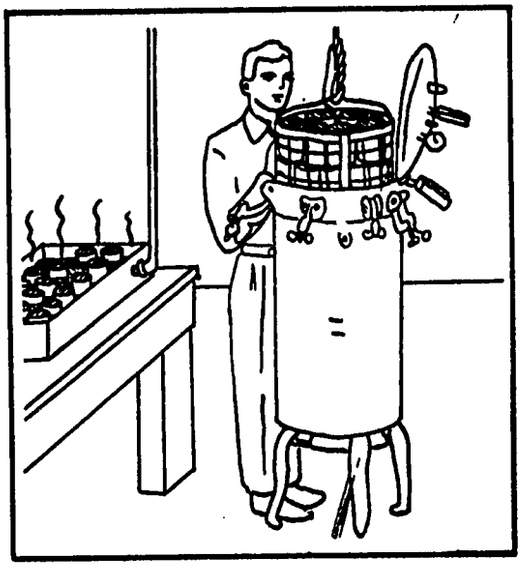


7. EXHAUST TO THE CENTER CAN TEMPERATURE SPECIFIED.

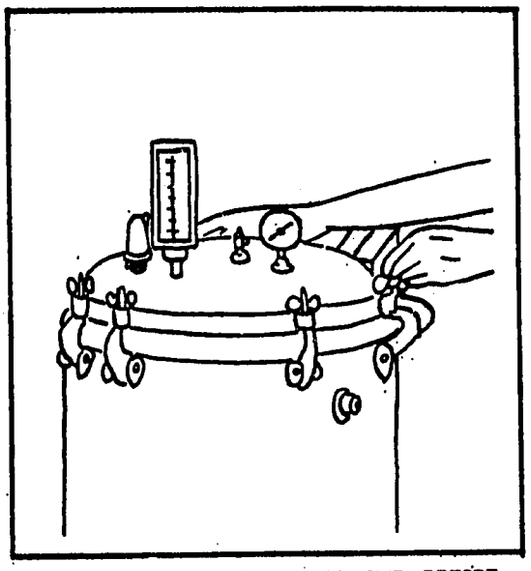


8. SEAL THE CANS IMMEDIATELY AFTER EXHAUSTING.

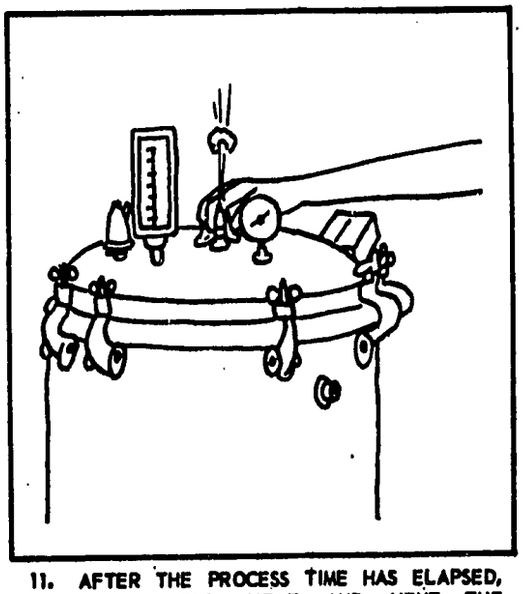
Figures 105-108. Steps in Canning Vegetables in Tin--Corn



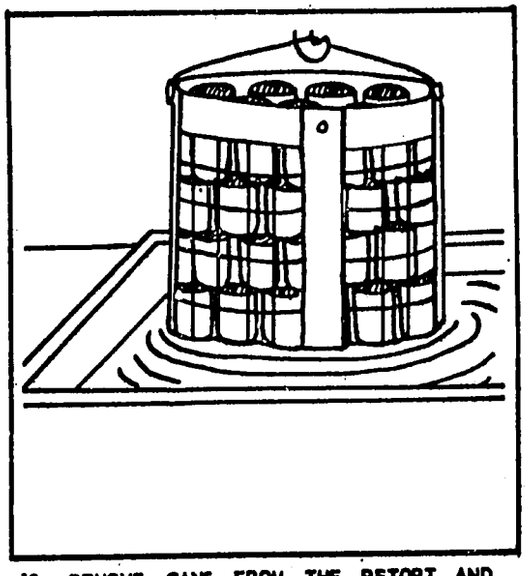
9. PLACE THE CANS IN THE RETORT OR PRESSURE COOKER.



10. FASTEN THE COVER OF THE RETORT. APPLY HEAT WITH PETCOCK OPEN UNTIL PROCESSING TEMPERATURE AND PRESSURE ARE REACHED. CLOSE PETCOCK AND BEGIN TIMING THE PROCESS.



11. AFTER THE PROCESS TIME HAS ELAPSED, REMOVE THE HEAT AND VENT THE RETORT TO ZERO PRESSURE. OPEN THE RETORT.



12. REMOVE CANS FROM THE RETORT AND COOL IN COLD RUNNING WATER TO ABOUT 100° F.

Figures 109-112. Steps in Canning Vegetables in Tin--Corn

Blend cream-style corn thoroughly with the necessary water and seasoning before filling the cans. Salt and sweeten to taste and add water to establish the desired consistency. The following is recommended in order to produce the proper consistency. Add one quart of water to each gallon of cut corn, and add salt and sugar to taste. For larger quantities, one gallon of water is added for each three gallons of cut corn, one cup of sugar and four tablespoons of salt. The quantity of salt and sugar varies with the taste.

Blend the corn in a steam-jacketed kettle or stock pot by bringing the container slowly to between 190° and 200° F. Stir the corn constantly to prevent sticking. Add additional water when necessary. Since cream-style corn thickens during processing, the consistency during blending should not be too great. Pre-prepared syrups may be used in blending corn. Prepare this syrup by adding sugar and salt in the desired proportions to boiling water prior to the time the blending operation is begun. Reduce the time between cutting, blending, and processing to a minimum in order to reduce the tendency of the finished product to spoil.

d. Filling. Add the hot cream-style corn to the containers at the blending temperatures (190° to 200° F.) leaving 1/4-inch head space in tin cans and 1/2-inch head space in glass jars.

e. Exhausting and Sealing. No exhaust is needed when the corn is added to the containers immediately after the blending operation.

Seal tin cans immediately after they are filled with the hot product and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for corn can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

15. Egg Plant

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Egg plant should be fresh and sound for canning. Only freshly cut egg plant should be used.

c. Preparation. Remove green and defective sections of the egg plants. Wash while raw, peel, and can either whole or cubed. Soak the peeled egg plant in a three per cent salt solution for about one hour and then drain.

d. Filling. Pack egg plant to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling brine or water to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for egg plant can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

16. Greens

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Greens for canning should be young and tender. They should be crisp and free from stems of tough woody texture. Tough stems give rise to slow heat penetration, and possible spoilage.

c. Preparation. Green leafy vegetables such as spinach, mustard, beet tops, turnips, kale, collards, and dandelions can be canned. Only the young tender leaves may be picked or the entire plant may be pulled. Trim the roots from the stalks if necessary and remove yellor or discolored leaves and foreign material. This sorting and preparing should be performed before the greens are wet, since wet leaves mat and are not easy to handle. Shake sand and loose dirt from the leaves before wetting them. Wash the greens thoroughly to remove all soil. Usually, several washings are required. Use a large volume of water during the washing process. Wire baskets may be used for washing the greens. Partially fill the basket and dip it up and down in the washing water. Rotary-drum washers or heavy sprays of water are particularly desirable for washing greens. Sprays tend to cut soil from the leaves.

After washing the greens, blanch them in steam or hot water. The blanching operation removes the air from the greens and fixes the color of

the leaf. Care should be taken that the hot water or steam comes in contact with each leaf during the blanching operation. This may require that the greens be blanched in relatively thin layers. Blanch the greens by placing them in blanching baskets about one-third to one-half full and immersing for approximately three minutes in water at a temperature of rolling boil. Blanching time is complete when the leaves and particularly the stems become limber; they should not be blanched so long that the stems become mushy. The leaves will have a bright green color. Drain the greens to remove the excess water before filling the containers. Do not allow the greens to drain for too long a time as they will mat and become difficult to pack.

d. Filling. Pack greens into the containers rather loosely with forks. Thus, they may be handled quite hot. The amount placed in the containers should be regulated in order to insure proper heat penetration during the process. This is normally accomplished by packing to a particular drained weight. Check the weight of the first several filled containers and then check containers often enough to indicate the general average of the fill. Fill pint jars or No. 2 cans to approximately 13 ounces, quart jars to approximately 1 pound 5 ounces and No. 10 cans to approximately 3 and 3/4 pounds. Do not exceed the suggested weights or else the processing will not be complete. After filling the containers with the greens, add boiling water or brine to completely fill tin cans and to fill glass jars to within 1/4 inch of the top. In order to obtain a good fill of brine, agitate the greens or cut them with a sharp stick or knife to permit the hot brine or water to penetrate throughout the containers. Where brine is not used, granulated salt or salt tablets may be placed on top of the contents and covered with boiling water.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for greens can be found in Table XXXIX in the appendix of this manual.

Blanched greens tend to become stratified horizontally in tin cans or glass jars. For this reason, the brine cannot circulate readily unless the cans are on their sides. Processing time is therefore shorter for cans in the horizontal position. The times included in this manual are for processing cans in the horizontal position.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and

wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

17. Hominy

a. Container. Use C-enamel cans or glass jars.

b. Quality of Product. Use flat, fully ripened corn for making hominy.

c. Preparation. Soak shelled corn in a 1-1/2 per cent lye solution and boil rapidly for 25 to 30 minutes. After the corn is boiled in the lye solution, drain it and wash in cold water. The water should run over the lye-treated corn for three to four hours to remove all traces of the lye. After washing, remove the seed coats of the corn kernels by rubbing the corn on a washboard with the hands. Then pick the hulls off by hand. It is also possible to hull the corn with a mechanical hulling machine or a barrel churn.

d. Filling. Pack hominy to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for hominy can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

18. Mushrooms

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Any edible fungus especially *Agaricus campestris* may be canned. Not all mushrooms are edible, however, and some are deadly poisonous. If the wild or uncultivated variety of mushroom is picked for canning, make certain that it belongs to one of the edible varieties. Mushrooms for canning should be fresh.

c. Preparation. Do not remove the stems of small mushrooms. Remove the stems of large mushrooms and can the caps and stems separately. Wash the mushrooms thoroughly and peel the large caps. In order to prevent discoloration after peeling, drop the peeled mushroom into water containing a 1/2 per cent vinegar solution. Blanch or steam the mushrooms for three to four minutes. While blanching, stir them continuously or use containers that will allow them to be completely immersed.

d. Filling. Pack mushrooms to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans and to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for mushrooms can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

19. Okra

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Okra for canning should be tender and about half grown. Harvest the pods every two or three days in order to insure that the product at the canning plant is tender. Old okra is tough and should not be canned.

c. Preparation. Sort the product to remove tough, off-color or damaged pods. Inspect it and trim the stem and tip ends. Do not use iron knives or utensils for trimming okra since these cause it to turn black; stainless steel knives are recommended. Wash the okra thoroughly. Do not allow the okra to stand in the water. After washing the okra, blanch it for three to four minutes in water at 190° F. This time for blanching should produce the bright green color desired for the product. After blanching, dip the okra in cold water to stop the cooking action and to facilitate handling. Drain the blanched and cooled okra. Cut the okra into 1 to 1-1/2-inch pieces or pack whole in separate containers. After cutting the okra, handle it as rapidly as possible in the following operations.

d. Filling. Pack okra to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for okra can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

20. Onions, Scallions, Leeks

Processing onions, scallions, and leeks at the pressure required for adequate sterilization renders them mushy and unacceptable. For this reason, if this product is to be canned it must be processed in an acidified medium in order that it may be processed in boiling water. Since careful supervision of all details are essential when acidification is necessary, a research laboratory associated with the canning industry should be consulted if this product is to be canned.

21. Parsnips

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Parsnips for canning should be fully mature, crisp, and tender. Underdeveloped parsnips lack flavor and those that have developed in dry weather or poor soil are frequently tough and woody and should not be canned.

c. Preparation. Sort the parsnips to remove those of poor quality. Remove the tops of parsnips, but leave 1-1/2 to 2 inches of the stalk to facilitate peeling. Wash thoroughly to remove adhering soil. It is frequently necessary to soak the parsnips before they may be cleaned thoroughly. Scrub the product with a stiff brush until clean. After washing, cut or slice them into sections for canning. The sections are usually about 1-1/2 inches in length.

d. Filling. Pack parsnip to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

When prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for parsnip can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

22. Peas, Field (Blackeyed, Crowder, Etc.)

a. Container. Use C-enamel cans or glass jars.

b. Quality of Product. Peas for canning should be at a stage where the product retains its fresh green flavor, while the hull is sufficiently mature for fairly easy shelling. Although the yield of shelled out peas increases with the maturity and ease of shelling, the flavor and appearance of the product decreases.

c. Preparation. Sort peas in order to separate overmature, bruised, slimy or otherwise undesirable pods. Shell the peas either by hand or with mechanical pea shellers. Where large quantities are to be processed, the mechanical sheller is highly recommended. If these machines are used, the product must be handled rapidly to avoid spoilage. After the peas are shelled, wash them thoroughly. If for any reason they must be held for several hours or more, they should not be washed until just before subsequent operations are undertaken. During the washing, remove faulty peas and foreign materials by hand.

After the peas are thoroughly washed, blanch or give them a preliminary cook. The time for blanching is dependent upon the maturity of the peas. Where they are fairly mature, a blanch of approximately five minutes in steam or boiling water is necessary. If the peas are picked for flavor and greenness, approximately three minutes is sufficient.

d. Filling. Pack peas to within 1 inch of the top of tin cans or to within 1-1/4 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/2 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for peas can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

23. Peas, Green (Garden)

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Only young tender peas should be canned. They should be canned immediately after harvesting. The small ones are usually preferable because of their high sugar content and deep green color. The larger peas have a high starch content and are less desirable from the standpoint of both the flavor and color.

c. Preparation. Shell peas either by hand or by mechanical shelling machines. Where large quantities are to be processed, the mechanical shellers are recommended. If hand shelling is to be accomplished, it may be quickened by placing the peas in a blanching basket, dipping for a few minutes in boiling water and then plunging quickly into cold water. After shelling, sort the peas to remove broken, overripe or otherwise undesirable peas. Wash the peas thoroughly. If for any reason the product must be held for more than 3 hours, do not wash until just prior to undertaking subsequent operations. Normally, the peas are washed just prior to blanching.

After washing, blanch the peas either in hot water or in steam. Blanching serves to remove the mucilaginous material from the peas as well as fixing the color, improving the flavor, and permitting placing a greater weight of peas in the container. The length of blanching varies with the maturity of the peas and may be as short as 1/2 minute or as long as 30 minutes. The longer blanching times are usually required for large starch peas. Wash or rinse peas thoroughly after blanching in cold water.

d. Filling. Pack peas to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 140° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 140° F., and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F in Chapter III.

f. Processing. Processing instructions for peas can be found in Table XXXIX in the appendix of the manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

24. Peppers, Green

Pressure cooking necessary to safely sterilize green peppers results in an undesirable product. For this reason, acidification is necessary

to permit processing in boiling water. Acidification must be carefully controlled and the prospective canner should consult a research laboratory connected with the canning industry for details of processing.

25. Pimientos

Acidification of pimientos is desirable to prevent spoilage. Since acidification must be carefully controlled, the prospective canner of pimientos should consult a research laboratory connected with the canning industry. For this reason, no further information is included on the processing of pimientos.

26. Potatoes, Sweet

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Freshly cured potatoes should be used for canning. Those that have been allowed to cure become shriveled and are more difficult to peel satisfactorily, but they have more sugar and flavor. Sweet potatoes that have been frosted should not be canned.

c. Preparation. Wash the potatoes thoroughly to remove all dirt. A strong water spray is desirable. Soaking may be necessary to completely remove all adhering soil. After cleaning, peel the potatoes. They may be peeled by hand or more efficiently either by steam or by lye. Before peeling by either of these latter methods, however, grade the potatoes for size to give uniform results in the peeling operation.

If the potatoes are to be steam peeled, place them in retort crates or wire baskets and steam in retorts until the skin may be slipped from the potato by hand. This requires approximately 9 to 12 minutes at 240° F. The time of heating depends on the size and age of the potatoes. After steaming, place the potatoes under sprays or in water vats to cool for handling. It is preferable, however, not to cool the potatoes before peeling, but to handle them with heavy canvas gloves. Cooling before processing must be avoided because the rate of heat penetration with sweet potatoes is so slow that any cooling increases the processing time appreciably.

If the potatoes are to be lye peeled, immerse them in the lye solution and stir slowly. Keep them in a 10 per cent solution of lye for from 4-1/2 to 8-1/2 minutes. Remove them from the lye when the skins begin to come off and wash. Washing is preferably performed under strong cold water sprays. Trim any remaining skin off by hand. Also, remove the stem end or deep pits.

Small potatoes may be canned whole. Cut large potatoes into pieces as desired. In order to prevent discoloration of the cut potatoes, place them in a mild salt or one per cent citric acid solution. Sweet potatoes may also be precooked and canned as mashed potatoes or as puree. Puree is

made by adding enough water to the screened, mashed potatoes to make them soupy.

d. Filling. Pack sweet potatoes as hot as possible to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. The potatoes may be either packed with syrup or packed in the solid pack fashion. For potatoes in syrup, pack the potatoes as closely as possible without mashing them. It is preferable not to pack sliced potatoes together with the whole ones. Add boiling light syrup to completely fill tin cans and to fill glass jars to within 1/2 inch of the top.

For the solid pack potatoes again pack the cut or mashed sweet potatoes as hot as possible into the containers. Mash the cut potatoes into the containers to fill the containers thoroughly or completely. Do not leave air spaces in the contents.

e. Exhausting and Sealing. Exhaust sweet potatoes to a center can temperature of 155° F. for solid pack and of 170° F. for those packed in syrup.

Seal tin cans immediately after they are filled and exhausted and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for sweet potatoes can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

27. Potatoes, White

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Use only small, freshly dug potatoes. Old potatoes and potatoes that have been held in storage are too mealy for processing.

c. Preparation. Wash the potatoes thoroughly and peel. Peeling of potatoes may be accomplished either by hand, by steaming, or with lye (see sweet potatoes). If the potatoes are to be peeled by steaming, immerse them for a short time in boiling water or steam until the skins may be slipped off. After steaming, cool the potatoes to facilitate handling. Do not expose peeled potatoes to the air as they will darken. In order to prevent discoloration, dip the peeled potatoes into a mild salt solution, a one per cent citric acid solution, or cover them with cold water until they are packed.

d. Filling. Pack potatoes to within 1/4 inch of the top of tin cans or to within 1/4 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to completely cover the potatoes in glass jars.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 160° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 160° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for potatoes can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

28. Pumpkin

a. Container. Use R-enamel tin cans or glass jars.

b. Quality of Product. Use pumpkin varieties which are hard and sweet and evenly ripened. The flesh should be of good texture but not watery. Do not use frosted pumpkin.

c. Preparation. Wash pumpkin thoroughly, cut open and remove seeds and fiber. Discard pumpkin which show evidence of rot. Cut the pumpkin into pieces approximately one inch in size. Steam the pieces at 240° F. for approximately 20 minutes. (If steam is not available, the pieces may be cooked in boiling water until tender.) Separate the pulp from the skin and tough fiber with a pulper or siever. Drain off excess water. Evaporate the product further by placing the pulp in a steam-jacketed kettle or stock pot and heat at about 212° F.

d. Filling. Pack pumpkin to within 1/2 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. The pumpkin should be filled as rapidly as possible to conserve heat.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 185° F. and seal them immediately. Where exhaust

facilities are not available, precook the food, add it to the cans at 185° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the hot product is added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for pumpkin can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

29. Squash, Summer

a. Container. Use R-enamel tin cans or glass jars.

b. Quality of Product. Only young, tender squash should be used.

c. Preparation. Wash the squash thoroughly, remove the stems and cut into slices approximately 1/2- to 3/4-inch thick.

d. Filling. Pack squash to within 1/2 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for squash can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

30. Squash, Winter

For canning winter squash the instructions and processing data used for pumpkin may be used.

31. Mixed Vegetables and Soup Mixtures

In general, mixtures vary in composition and in canning procedure. For this reason it is considered advisable to consult with a research laboratory connected with the canning industry when mixtures other than green beans, cut asparagus, cut celery, lima beans, peas, and carrots are to be canned. The vegetables can be canned in any desired combination.

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. The same quality is required for canning mixed vegetables that is required in canning the vegetables separately. Defective and otherwise undesirable vegetables should not be canned.

c. Preparation. Prepare each vegetable as if for canning alone. Mix the vegetables in the desired proportions.

d. Filling. Pack vegetable and soup mixtures to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling water or brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

Where prepared brine is not utilized, salt in granulated or tablet form is placed on top of the product after it is added to the container. Boiling water is used as the canning medium.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 150° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 150° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for mixed vegetables and soup mixtures can be found in Table XXXIX in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

D. Juices

The canning or preservation of fresh juices is frequently desirable. When properly canned, the juices provide a tasty and high-vitamin addition to the diet. However, the juices of many fruits and vegetables are not satisfactory for canning. The canned juice must retain its fresh flavor and color throughout its shelf life. With some juices freezing is the only commercial method of preservation capable of keeping the quality of the juice comparable with the fresh food.

The juices normally prepared and canned are of sufficient acidity that they may be processed at or below the temperature of boiling water. In order to prevent producing a product that has a cooked or burned flavor, the temperature of processing is usually less than that of boiling water. Flash pasteurization is highly recommended for sterilizing juices such as apple and citrus juices. This method of processing renders the juice safe for consumption in a minimum of time. The equipment needed for flash pasteurization is comparatively complex and expensive. Consequently it will not be discussed in this manual. However, research laboratories associated with the canning industries should be consulted regarding flash pasteurization and other information if relatively large scale juice preservation is to be undertaken.

In preparing juices for canning, the same general procedures hold that apply to the canning of fruits and vegetables. The same precautions regarding cleanliness and care in performing the various operations should be observed. In particular, the preparation steps must be carried out as rapidly as possible. Juices are particularly susceptible to oxidation with resultant discoloration and change in flavor and taste. Citrus juices, for example, lose flavor and color very rapidly due to oxidation, and at the same time they lose their food value.

Certain metal utensils and containers should not be used in preparing products for making juices. Copper, iron, or steel implements are likely to cause darkening of some juices whereas some metals impart an unfavorable flavor to the juice. For example, zinc or galvanized containers render certain juices poisonous. Glass, agate ware, tin coated, aluminum, or stainless steel utensils and containers are recommended for use in the preparation of the various fruit or highly acid juices.

The flavor of all juices is retained for a longer period of time if the juices are deaerated immediately after preparing and before filling the containers. However, the use of deaerating equipment will not be discussed in this manual. It will be considered that deaeration need not be performed if the juice is flash pasteurized. If the prospective canning plant operator intends to can relatively large amounts of juices that require deaerating, he should consult with laboratories associated with the canning industry for use of such equipment.

1. Apple Juice

a. Container. Use plain tin cans or glass containers.

b. Quality of Product. Apples that are fully ripe, quite acid, and of good quality may be used for making apple juice. The apples should be free from rot and fermentation.

c. Preparation. Wash the apples thoroughly and remove all undesirable fruit. Soak apples in tanks and wash under heavy sprays of water in order to free them from dirt and spray residue most efficiently. Crush the apples and press the juice from the pulp. Heat the juice to 170° F. and strain. Do not heat to boiling.

d. Filling. Pour the hot juice into the containers to fill them as completely as possible.

e. Sealing. Seal tin cans and apply crown-type caps to small-mouth glass jars immediately; adjust the lids of regular glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for apple juice can be found in Table XL in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. Berry Juices

a. Container. Use R-enamel tin cans or glass containers.

b. Quality of Product. Any good-flavored variety of berry such as blackberry, raspberry, strawberry, may be used in preparing juices provided they are not underripe and are free from rot and fermentation.

c. Preparation. Wash the berries thoroughly and remove all underripe, bruised, and overripe fruit. Heat the berries in boiling water, drain, and press to extract the juice. Strain the juice to remove the pulp and add sugar if desired. Reheat the juice to simmering.

d. Filling. Pour the hot berry juice into the containers. Fill the containers as completely as possible.

e. Sealing. Seal tin cans and apply crown-type caps to small-mouth glass jars immediately after the hot juice has been added. Adjust the lids of regular glass jars as described in Section I, F of Chapter III.

f. Processing. Processing instructions for berry juice can be found in Table XL in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

3. Grape Juice

a. Container. Use R-enamel tin cans or glass container.

b. Quality of Product. Any good-flavored juicy grape or muscadine that is free from rot may be used in preparing juice.

c. Preparation. Wash and stem the grapes. Crush them and heat to between 140° and 145° F. and press while hot to extract the juice. Strain the juice and add sugar if desired. Pasteurize the grape juice in one- or two-gallon containers at 165° F. for 40 minutes. Seal the containers and allow them to stand for three to six months to allow the undesirable cream of tartar to separate. After this time, the juice can be used or canned in smaller containers.

d. Filling. Heat the juice to simmering and pour into the containers to fill them as completely as possible.

e. Sealing. Seal tin cans and apply crown-type caps to small-mouth glass jars immediately after the hot product has been added. Adjust the lids of regular glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for grape juice can be found in Table XL in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

4. Grapefruit Juice

a. Container. Use plain tin cans or glass container.

b. Quality of Product. The grapefruit for producing juice for canning should be well ripened yet free from spoilage.

c. Preparation. Wash the grapefruit thoroughly. Cut the fruit in half and ream the fruit juice from the halves by hand or by machine. Filter or strain the juice to remove seeds and pulp. Heat the juice to simmering.

d. Filling. Fill containers as completely as possible with the hot juice.

e. Sealing. Seal tin cans and apply crown-type caps to small-mouth glass jars immediately after the hot juice has been added. Adjust the lids of regular glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for grapefruit juice can be found in Table XL in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. Orange Juice

Since a successful method has not been developed for processing orange juice other than flash pasteurization, it is recommended that this juice not be canned unless it is mixed with higher acid juices such as grapefruit juice. If such a mixture is made, the juice will retain its flavor for a longer period of time than pure orange juice. The pasteurizing times for such mixtures are dependent upon the acidity and upon the size of the containers. Research laboratories connected with the canning industry should be contacted for specific instructions if orange juice is to be canned.

6. Pineapple Juice

a. Container. Use plain tin cans or glass container.

b. Quality of Product. Field ripened pineapple should be used in preparing pineapple juice. Pineapple juice is usually a by-product from a canning plant, after the choice sections have been canned.

c. Preparation. Wash the pineapple thoroughly. Peel, slice, core, and grind the pineapple to a pulp. Press the pulp to extract the juice. Strain the juice and heat to simmering.

d. Filling. Fill the containers as completely as possible with the hot juice.

e. Sealing. Seal tin cans and apply crown-type caps to small-mouth glass jars immediately and adjust the lids of regular glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions for pineapple juice can be found in Table XL in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. Prune Juice

a. Container. Use R-enamel tin cans or glass containers.

b. Preparation. Soak dried prunes in hot water for one to four hours at 200° F. to remove the soluble substances. The length of soaking time depends on the toughness of the prunes. Repeat the soakings to fully extract the soluble substances. Filter the juice and bring to the desired concentration by boiling or by diluting with water.

c. Filling. Pour the hot juice into the containers to fill them as completely as possible.

d. Sealing. Seal tin cans and apply crown-type caps to small-mouth glass jars immediately after the hot juice has been added. Adjust the lids of regular glass jars as described in section I, F of Chapter III.

e. Processing. Processing instructions for prune juice can be found in Table XL in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

8. Tomato Juice

a. Container. Use plain tin cans or glass jars.

b. Quality of Product. Use tomatoes which were harvested when fully ripe. The tomatoes should have developed full color and flavor.

c. Preparation. Sort tomatoes in order to remove green, over-ripe, or otherwise undesirable product. Wash the tomatoes thoroughly to remove dirt, mold, or rot. Cut up the tomatoes and place in steam-jacketed kettles or in stock pots and heat in their own juice at 140° F. (They may also be treated in the steam blancher for two to three minutes.) Take care to prevent excess aeration during these operations.

After preheating the tomatoes, extract the juice. This may be done in one of several ways. The hot pulp may be passed through the juicer puree attachment of the meat grinder. The tomatoes may also be run through a juice extractor or pulper. Heat the extracted juice to between 180° and 185° F.

d. Filling. The containers should be filled immediately with the hot juice. Fill tin cans as full as possible. Glass jars should be filled to within 1/4 inch of the top. Salt may be added at this time if desired.

e. Sealing. Seal tin cans immediately after the hot juice has been added. Adjust the lids of glass jars as described in section I, F of Chapter III.

f. Processing. Processing instructions of tomato juice can be found in Table XL in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

E. Meats, Poultry, Fish

While meats may be canned throughout the year, certain animals are generally slaughtered at the end of the grass growing season. If this time occurs after the fruit and vegetable season is past, an efficient canning schedule can be employed. Canning in this way prolongs the operating season of the canning plant.

Meats for canning should be from healthy animals of good quality that have been slaughtered and prepared for canning in a sanitary manner. After animals such as cattle and sheep have been slaughtered and dressed, the meat should be allowed to age and become tender. Aging is normally carried out at about 36° F. for 7 to 20 days depending on the quality of the animal. Meats such as pork and poulty and fish should not be aged but should be prepared and processed or frozen immediately. If the meat such as beef cannot be canned immediately after aging, refrigeration facilities should be available for storing the meat. If it is necessary to hold the meat for two or three days, it should be kept at 40° F. or colder; for long-time storage, it should be frozen until canned. If the meat is frozen, keep it so until canning time since alternate freezing and thawing spoils the meat.

All meats are nonacid products and as such must be processed at a minimum of 240° F. in order to kill the harmful microorganisms. Thus, the processing of meat must take place under pressure.

The processing instructions for heavy meats such as beef, veal, lamb, mutton, pork, venison, and the meat of other large animals are the same. The processing instructions for poultry such as chicken, duck, and turkey, and small game such as rabbits are also the same. Canning instructions for fish and shell fish vary with the type of product being prepared. In general, the canning of mixtures of meats and vegetables is not recommended unless the processing instructions and data are obtained from a research laboratory associated with the canning industry.

1. Roast, Steaks, Stew Meats (Beef, Veal, Pork, Lamb, Mutton, Venison)

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. For canning in large pieces, use loin, round, chuck, shoulder, or other cuts suitable for roasts, steaks, or chops. Use the trimmings and the less tender cuts such as brisket, neck, and shanks for canning as stew meat.

c. Preparation. Remove the bone and most of the fat. Too much fat makes the meat difficult to process. Save the bones to make th broth with which the cans are filled. Cut roasts across the grain of the meat in lengths that will come approximately 1/4 inch above the top of the container. Cut steaks and chops as for serving fresh and pack in layers to fit the container. Use the meat cut and trimmed from the larger pieces as stew meat, and handle it in the same way as the larger pieces.

d. Precooking and Filling. Roasts, steaks, and stews may be either precooked and packed hot into the containers or packed raw and exhausted in the containers. The method utilized is dependent upon facilities available and the canning schedule. In either case, the meat shrinks during the precooking or exhausting sufficiently to prevent excessive shrinking during processing. This preshrinkage assures a full pack and expels air from the product.

If the meat is to be packed hot, place pieces of meat in large shallow pans, add a small amount of water and heat the pieces to 240° F. for about 25 to 30 minutes. The time for this preheating should be sufficient to assure that the meat has a pink rather than red color at the center. Heat stew meats in steam-jacketed kettles and allow to simmer from 25 to 40 minutes.

Fill the containers with the hot precooked meat to within 1/4 inch of the top of tin cans and to within one inch of the top of glass jars. Add salt before the meat is placed in the containers. Fill tin cans completely with boiling broth which has been prepared from scraps of meat and bone, and fill glass jars to within 1/4 inch of the top.

If the meat is to be packed raw, fit the pieces tightly into the containers to fill them completely. Add salt by placing it in the containers before the meat is added. Exhaust the cans containing the raw meat to a center can temperature of 170° F. Exhausting normally requires about 50 minutes. When the proper temperature has been reached, press the meat into the containers to obtain the proper head space. Fill with broth if needed as was done in the hot-pack method.

e. Sealing. Before the meat can cool appreciably, seal tin cans and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the containers to cool before processing.

f. Processing. Processing instructions for roast, steaks, and stew meats can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

2. Ground Meat

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. The quality of meat required for ground meat must be essentially the same as that of meat canned in whole sections. In general, however, the meat may be somewhat coarser or fatter than meat canned whole.

c. Preparation. Grind the meat for hamburger in a meat chopper or grinder. Add one cup of salt for each 25 pounds of meat and mix well. Add additional seasoning if desired. If spices are added, it should be noted that their flavor changes during storage.

d. Precooking and Filling. Ground meat may be packed into the containers raw or as cakes or links which have been precooked. The method utilized is dependent upon the equipment available and the canning schedule. When packing the meat raw, fill the containers about 3/4 inch above the top. The meat can be packed in bulk or link form.

Exhaust to a center can temperature of 170° F. Exhausting requires approximately 75 minutes. Once the meat has been exhausted to the proper center can temperature, press it down into the containers. Leave not more than 1/2 inch of space at the top of tin cans and 1 inch at the top of glass jars. The liquid from the meat should fill the tin cans completely and fill glass jars to within 1/4 inch of the top. Add additional medium if necessary.

If precooked, pack ground meat as either cakes or links to within 1/2 inch of the top and in glass jars to within 1 inch of the top. Completely fill tin cans with hot broth and fill glass jars to within 1/4 inch of the top.

e. Sealing. Before the meat can cool appreciably, seal tin cans and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for ground meat can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and

wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

3. Tongue and Heart (Beef)

a. Container. Use C-enamel tin cans or glass jars.

b. Preparation. Wash the heart thoroughly. Remove the thick connective tissue and cut it into pieces. Place the pieces in a steam-jacketed kettle or stock pot, partially cover with water, and simmer for 25 to 40 minutes or until the pieces show only a slight pink at the center. Wash tongue thoroughly, place it in a steam-jacketed kettle or stock pot and cover with boiling water. Simmer for about 45 minutes or until the skin can be removed. Remove the skin and cut the tongue into pieces.

c. Filling. Add seasoning to the containers before they are filled. Pack heart and tongue separately. Pack the hot meat into the containers to within 1/2 inch of the top of tin cans and to within 1 inch of the top of glass jars. Fill tin cans as completely as possible with boiling broth and fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust, if necessary, to a center can temperature of 170° F.

Before the product can cool appreciably, seal tin cans and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for tongue and heart can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

4. Corned Beef

a. Container. Use C-enamel tin cans or glass jars.

b. Preparation. Wash the corned beef and cut it into pieces suitable for packing. Remove excess fat from the meat. Cut the meat into large pieces to fit the containers with the grain of the meat running lengthwise. Place the cut pieces in a steam-jacketed kettle or stock pot and cover with cold water. Bring the meat to a boil.

c. Filling. Pack the hot meat into containers to within 1/2 inch of the top of tin cans and to within 1 inch of the top of glass jars. Fill tin cans completely and glass jars to within 1/4 inch of the top with boiling water.

d. Exhausting and Sealing. Exhaust, if necessary, to a center can temperature of 170° F.

Seal tin cans immediately after the hot product has been added or immediately after the containers are exhausted and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

e. Processing. Processing instructions for corned beef can be found in Table XLI in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

5. Poultry and Small Game (Boned)

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Plump fowl or animals should be used for canning boned style. If young birds are canned, the texture and flavor of the meat is not as good as that from more mature birds.

c. Preparation. Dress the bird or animal for cooking. Take care not to break the gall bladder of poultry since this spoils the meat. Cut the bird or animal into pieces such as breast, thighs, legs, back, neck, etc. and separate the giblets, such as heart, liver, etc. If giblets are kept, they should be canned separately. Remove lumps of fat. Cover the meat with lightly salted cold water and simmer until the meat is tender. Keep the broth for use as a canning medium. Strip the meat from the bones.

d. Filling. Pack the meat into tin cans to within 1/4 inch of the top of cans and to within 1/4 inch of the top of glass jars. Add boiling broth to completely fill tin cans and to fill glass jars to within 1/4 inch of the top. Add salt as desired.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for poultry and small game can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

6. Poultry and Small Game (Not Boned)

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. The quality of the bird or animal for canning on the bone should be as good as that for canning in the boned style. Only the meaty pieces of the bird or animal should be canned by this method.

c. Preparation. Dress the bird or animal as for cooking. Cut into pieces such as breast, thighs, legs, etc. Do not utilize bony pieces such as back, wings, neck, etc. Trim fat from the meat.

d. Precooking and Filling. The meat may then either be precooked before packing or packed raw and exhausted. The method utilized is dependent upon equipment available and the canning schedule.

If the bird or animal is to be precooked and packed hot, place the meaty portions in a steam-jacketed kettle or stock pot and cover with hot water. Precook until the meat is medium done or until it shows a pink color at the center of the pieces.

Pack the hot precooked meat to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars.

If meat is to be packed raw, pack to within 1/4 inch of the top of tin cans and to within 1/2 inch of the top of glass jars. Exhaust the containers packed with raw meat to a center can temperature of 170° F.

e. Sealing. Before the contents can cool appreciably, seal tin cans and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for poultry and small game can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

7. Haddock, Halibut, Cod, or Pickerel

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Fish should be fresh for canning. If the fish is frozen, do not thaw it until just prior to canning.

c. Preparation. Remove scales, fins, tail, and head and the entrails. Scrape the fish until it is free from slime and blood. Remove the blood from the fish by soaking it up to 60 minutes in a 5 per cent brine. Drain and cut the fish into container-length pieces. Precook the fish for about 20 minutes or exhaust it in the container.

d. Filling. Pack fish to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling 2 per cent brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the hot product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for haddock, halibut, cod, and pickerel can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

8. Herring or Alewives

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Fish should be fresh for canning. If the fish is frozen, do not thaw it until just prior to canning.

c. Preparation. Wash the fish, remove fins and scales. Remove head and entrails. Wash and clean the body cavity and rinse off any blood. Soak the fish in brine for about six hours. If the skin wrinkles or changes color, the brine is too strong and the fish should be taken out at once. Cut the fish into container-length pieces and wrap each piece in vegetable parchment paper.

d. Filling. Pack the wrapped pieces of fish into the container. Alternate heads and tails in order to get a uniform, full pack. Fill tin cans completely with a 2 per cent brine solution and fill glass jars to within 1/4 inch of the top with this solution.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature at 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F., and seal the cans immediately. Do not allow the contents to cool before processing.

After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for river herring and alewives can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

9. Mackerel and Trout

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Fish should be fresh for canning. If the fish is frozen, do not thaw it until just prior to canning.

c. Preparation. Clean the fish, removing heads, fins, and other waste parts. Split the fish, leaving the backbone in the fish. Trim off the belly strips and cut the fish into container-length pieces. Wash the fish well, drain, and soak for one hour in a 2 per cent brine. If the fish is to be precooked and packed hot, cook for approximately 20 minutes at a pressure of 3 pounds per square inch.

d. Filling. Pack the fish into clean containers flush with the rims. Alternate heads and tails to get a full pack.

e. Exhausting and Sealing. If the fish is packed raw, exhaust to a center can temperature of 170° F.

Before the exhausted or precooked fish can cool appreciably, seal tin cans and adjust the lids of glass jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

f. Processing. Processing instructions for mackerel and trout can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

10. Salmon and Barracuda

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Fish should be fresh for canning. If the fish is frozen, do not thaw it until just prior to canning.

c. Preparation. Remove the scales, fins, and head. Clean and wash the fish thoroughly, leaving the backbone. Cut the fish into container-length pieces. Soak the fish in a 6 per cent brine for approximately 1 hour and drain thoroughly. Prepare the brine by adding 1/2 pound of salt to 1 gallon of water.

d. Filling. Pack salmon and barracuda to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling 2 per cent brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F., and seal the cans immediately. Do not allow the contents to cool before processing. After the raw product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for salmon and barracuda can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

11. Tuna or King Mackerel

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Fish for canning must be fresh. If the fish is frozen do not thaw it until just prior to canning.

c. Preparation. Dress the fish by removing the head, fins, tail, and entrails, and wash carefully. Cut away thin belly strips. Precook the fish at 10 pounds pressure for 1-1/2 hours. Cool the fish thoroughly and scrape off skin, remove backbone and cut out dark pieces of meat. Cut the meat into pieces 3/4 inch less than the depth of the container.

d. Filling. Add salt and a small amount of olive oil or cottonseed oil to each container. Pack the meat solidly into the containers filling up spaces with small flakes.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F., and seal the cans immediately. Do not allow the contents to cool before processing.

After the precooked product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for tuna or king mackerel can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

12. Clams

a. Container. Use C-enamel tin cans or glass jars.

b. Preparation. Soak the clams in a 10 per cent brine for 12 to 24 hours. After soaking, wash the clams free of adhering mud and sand. Place them in boiling water for 10 to 20 minutes or steam at 212° F. for the same length of time. Collect the juice from the clams. Cool the clams and remove the meat from the open shells. Discard the mantles or dark membranes that surround the meat. Wash the meat thoroughly. Strain the juice from the clams and concentrate it to about two-thirds its original volume by boiling.

c. Filling. Pack clams to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling hot brine or clam broth to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, precook the food, add it to the cans at 170° F. and seal the cans immediately. Do not allow the contents to cool before processing.

After the precooked product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

e. Processing. Processing instructions for clams can be found in Table XLI in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and

wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

13. Lobster

a. Container. Use C-enamel tin cans or glass jars.

b. Preparation. Place live lobsters in a boiling 5 per cent brine and cook for 15 to 30 minutes. Remove the lobsters from the boiling brine and cool in cold brine. Break open the shells and pick the meat from them. Wash the meat in cold fresh water. Remove any particles of the shell that remain. Drain the meat thoroughly.

c. Filling. Pack lobster to within 1/4 inch of the top of tin cans or to within 1/2 inch of the top of glass jars. Add boiling 2 per cent brine to completely fill tin cans or to fill glass jars to within 1/4 inch of the top.

d. Exhausting and Sealing. When using tin cans, exhaust the filled cans to obtain a center can temperature of 170° F. and seal them immediately. When using glass jars, adjust the lids of the filled jars as described in section I, F of Chapter III. Do not allow the contents to cool before processing.

e. Processing. Processing instructions for lobster can be found in Table XLI in the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

14. Shrimp

a. Container. Use C-enamel tin cans or glass jars.

b. Quality of Product. Shrimp should be fresh for canning. If the shrimp is frozen, do not thaw it until just prior to canning.

c. Preparation. Head the shrimp as soon as they are removed from the water. Remove the vein or black streak if it does not come off with the head. Wash the shrimp thoroughly, sort for freshness and peel. The shrimp may be peeled relatively easily if they are packed in fine ice as soon as they are headed. Discard strong smelling, bloody,and flat colored shrimp. Soak the shrimp in a cold 2 per cent brine solution for 20 to 30 minutes depending on the size. Drain the meat and precook it in boiling brine of same concentration for 6 to 8 minutes. Discard the brine entirely after each 5 batches. Allow the shrimp to cool and dry before packing.

d. Filling. Shrimp are usually canned only in commercial canning plants, and the containers are normally filled by weight. Six ounces of shrimp are added to No. 1 cans or half-pint jars, and 12 ounces are added to No. 2 cans or pint jars. Fill the containers with a scalding 2 per cent brine.

e. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Where exhaust facilities are not available, preheat the food, add it to the cans at 170° F., and seal the can immediately. Do not allow the contents to cool before processing.

After the precooked product and boiling medium are added to glass jars adjust the lids as described in section I, F of Chapter III.

f. Processing. Processing instructions for shrimp can be found in Table XLI in the appendix of this manual.

g. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans rapidly to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

15. Crab

a. Container. Use C-enamel tin cans or glass jars.

b. Preparation. Place live crabs in boiling water and boil for 20 to 25 minutes. The length of time is determined by the size of the crabs. Remove from the water and extract meat. Wash for 5 to 10 minutes in a salt solution of 2 to 3 per cent. Do not use more than 4 pounds of meat to a gallon of the salt solution. Spread the meat on a screen and allow to drain.

Dip the crab meat in a one per cent citric acid solution to prevent discoloration. Squeeze out excess liquid from the meat before canning.

Where exhaust facilities are not available, precook the crab meat.

c. Filling. In either glass or tin cans, fill the containers as full as possible. Add salt as desired. If the meat is precooked it should be at a temperature of 160° F. when filled.

d. Exhausting and Sealing. Exhaust the filled tin cans to a center can temperature of 170° F. and seal them immediately. Do not allow the contents to cool before processing.

When canning precooked crab meat seal tin cans before the meat can cool appreciably and adjust the lids of glass jars as described in section I, F of Chapter III.

e. Processing. Processing instructions for crab meat may be found in Table XLI of the appendix of this manual.

f. Cooling. Begin the cooling operation immediately after the processing time has elapsed. Cool tin cans as rapidly as possible to 100° F. Drain and wipe excess water from the containers. Do not stack or store the containers until they are completely cool and dry.

APPENDIX A GLOSSARY

Aging. The process by which meats such as beef and mutton are allowed to become tender immediately after killing. This requires storage for approximately 5 to 10 days.

Bacterial Load. The microorganisms associated with a quantity of foodstuff that must be removed or rendered harmless during the canning operation.

Botulinus. See page 158.

Brine. A solution of salt in water which is used as the canning medium for some foods. See page 134.

Buckling. The permanent bulging out of tin cans due to excessive internal pressure. The defect frequently occurs during cooling of large cans. The can does not cool so rapidly as the cooker and may remain at the processing pressure for a time sufficient to deform the can. See page 150.

Can Flanger. See page 72.

Canning Medium. The liquid such as brine, syrup, or oil used to improve the flavor of canned products and to fill the air spaces reducing discoloration and improving heat penetration. See page 134.

Can Reformer. See page 71.

Collapsed Container. See page 103.

Corn Cutter. See page 79.

Corn Silker. See page 81.

Crates. A basket or container into which tin cans and glass jars are stacked for placement in the cooker. See page 153. Also, boxes or cases made of slats of wood in which harvested produce is stored and transported.

C-Enamel. See page 106.

Direct Fired. Heated by direct contact with a flame.

Direct Labor. Labor involved in the actual canning operations as opposed to supervision personnel and office workers.

Double Seamer. See page 72.

Exhauster. See page 81.

Flange Reformer. See page 72.

Flat-sour. See page 157.

Flippers. See page 157.

Free-stone Peaches. Peaches such as the Elberta variety in which the pit does not cling to the pulp of the ripened fruit.

Headspace. See page 133.

Heavy Syrup. See Table XLV.

Hot-Lift Tongs. See page 81.

Hydrogen Swell. See page 158.

Indirect Fired. Heated indirectly as by steam from a boiler.

Indirect Labor. Labor not involved in the actual canning operations. Indirect labor includes supervisory personnel and office workers.

Light Syrup. See Table XLV.

Medium Syrup. See Table XLV.

Open Kettle Method. A cooking operation performed in an open vessel at atmospheric pressure.

Pack. The food product that has been placed in the container.

Panelling. Panelling is a permanent inward distortion of tin cans caused by excessive external pressure. This defect is found most frequently in large size cans with excessive vacuum.

Pea and Bean Huller. See page 76.

Perforation. A pinholing found in tin containers caused by the action of oxygen.

Preformed. See page 103.

Quonset Hut. A prefabricated shelter usually made of corrugated metal, shaped like the longitudinal half of a cylinder resting on its flat surface.

R-enamel. See page 106.

Respiratory Gases. Gases evolved from fruits and vegetables especially during storage.

Retort. See page 85.

Sanitary-Enamel. See page 106.

Sealer. See page 85.

Simmering. A condition where water is just below the boiling point or is gently boiling with a low murmuring sound.

Springers. See page 157.

Stack-burn. The softening and darkening of canned foodstuff that results from placing uncooled containers in stacks on shelves or in shipping containers.

Stock Pot. See page 81.

Syrup. A sugar and water canning medium used for most fruits. See page 134.

Tote Boxes. A box or basket used for carrying containers.

APPENDIX B

TABLES XXXVIII through XLII

TABLE XXXVIII

PROCESSING INSTRUCTIONS FOR ACID PRODUCTS
(See P.147 for operating instructions.)

			Time to Process in Boiling Water at 212° F.						
						Glass Jars			
			Cans			Spray Cooled		Air Cooled	
		Closing	Minutes			Minutes		Minutes	
Product	Type of Pack	Temperature (°F.)	No.2	No 2-1/2	No.10	Pint	Quart	Pint	Quart
1. Apples		190	20	25	35	20	25	15	20
2. Apple sauce	Hot	190	15	20	30	15	20	10	15
3. Apricots		160	25	35	45	30	35	25	35
4. Berries		170	15	20	30	15	20	10	15
5. Cherries		170	15	20	30	25	30	20	25
6. Cranberries	Hot	200	10	10	25	15	20	10	15
7. Figs	With lemon juice	200	10	25	75	15	20	10	15
	Hot precooked 1 hour	180	10	10	10	10	10	10	10
			Pasteurize at not greater than 180° F.						
8. Grapefruit		160	40/180	40/180	60/180	40/180	40/180	40/180	40/180
9. Grapes		170	15	15	20	15	15	15	15
10. Guava	Hot	190	20	20	25	20	20	15	20
11. Guava sauce	Hot	200	10	10	20	10	10	10	10
12. Loquat	Hot	190	15	20	25	15	20	15	20
13. Mango		170	15	20	30	15	20	15	20
14. Mayhaw sauce	Hot	180	10	10	20	10	10	10	10
15. Orange	Hot	180	Pasteurize 10 mins at 185° F.						
16. Papaya	Hot	170	15	20	30	15	20	15	15
17. Peaches		160	25	35	45	30	35	25	30

(Continued)

TABLE XXXVIII (Continued)

PROCESSING INSTRUCTIONS FOR ACID PRODUCTS
(See P.147 for operating instructions)

			Time to Process in Boiling Water at 212° F.						
						Glass Jars			
			Cans			Spray Cooled		Air Cooled	
		Closing	Minutes			Minutes		Minutes	
Product	Type of Pack	Temperature (°F.)	No.2	No.2-1/2	No.10	Pint	Quart	Pint	Quart
18. Pears		160	20	30	45	30	35	25	30
19. Pineapple		160	20	30	45	30	35	25	30
20. Plums		180	15	20	35	25	30	20	25
21. Quince	Hot		18	20		20	25		
22. Rhubarb	Hot	190	14	14	20	14	14	10	12
23. Roselle	Hot	170	8	12	20	8	12	8	12
24. Sauerkraut	Hot	160	20	25	40	20	25	20	25
25. Strawberries		170	8	8	10	10	10	5	5
26. Tomatoes	Cold (Raw)	140	45	55	90	45	55	35	45

TABLE XXXIX

PROCESSING INSTRUCTIONS FOR NONACID PRODUCTS
(See page 148 for operating instructions)

			Time to Process at 240° F. (10.3 psi at Sea Level) Minutes							Time to Process at 250° F. (15.1 psi at Sea Level) Minutes						
			Cans			Glass Jars				Cans			Glass Jars			
						Spray		Air					Spray		Air	
Product	Type of Pack	Initial Temp.°F.	No.2	No. 2-1/2	No.10	Pint	Quart	Pint	Quart	No.2	No. 2-1/2	No.10	Pint	Quart	Pint	Quart
1. Asparagus																
Cuts		170	25	25	35	30	35	25	30	15	20	25	15	30	15	20
Spears	(Containers upright)	170	27	27	(not pack)	32	37	27	32	17	20	(not pack)	17	30	15	30
2. Beans, Baked		150	95	115	220	110	120	100	110	75	95	180	85	100	80	95
3. Beans, Snap		165	20	25	35	25	30	20	25	20	20	30	20	25	15	25
4. Beans, Green Lima		140	35	40	55	45	50	40	45	18	25	30	25	30	20	25
5. Beets		160	30	30	40	35	40	30	35	20	25	30	20	25	15	25
6. Broccoli		150	30	30	40	35	40	30	35	25	25	30	20	25	15	25
7. Brussels Sprouts		150	40	45	60	35	40	30	35	25	30	35	25	30	20	25
8. Cabbage		150	40	45	60	35	40	30	35	25	30	35	25	30	20	25
9. Carrots		150	30	30	40	35	40	30	35	20	20	30	20	25	15	25
10. Cauliflower		150	20	20	40	35	40	30	35	20	20	30	20	25	15	25
11. Celery		150	25	30	40	30	35	25	35	20	20	30	20	30	20	30
12. Corn																
Whole-Grain		180	50	65	80	60	70	55	65	25	35	40	30	35	30	35
Cream		185	95	130	185	105				75	110	160	80			

(Continued)

TABLE XXXIX (Continued)

PROCESSING INSTRUCTIONS FOR NONACID PRODUCTS
(See page 148 for operating instructions)

				Time to Process at 240° F. (10.3 psi at Sea Level) Minutes							Time to Process at 250° F. (15.1 psi at Sea Level) Minutes						
				Cans			Glass Jars				Cans			Glass Jars			
							Spray		Air					Spray		Air	
	Product	Type of Pack	Initial Temp.°F.	No.2	No. 2-1/2	No.10	Pint	Quart	Pint	Quart	No.2	No. 2-1/2	No.10	Pint	Quart	Pint	Quart
13.	Egg Plant		160	35	40	60	35	40	30	35	25	30	45	20	25	20	25
14.	Greens	Horizontal position Observe Maximum Filling weight	170	75	75	100	85	105	80	100	45	50	75	55	65	50	60
15.	Hominy		160	75	90	120	75	90	70	85	30	35	50	35	40	30	35
16.	Mushrooms		150								25	30	50	30	35	25	30
17.	Okra		170	30	35	45	30	35	25	35	20	25	35	20	25	15	20
18.	Parsnips		150	30	30	40	35	40	30	40	20	25	30	20	25	15	20
19.	Peas, Field		160	45	50	70	45	50	40	45	20	25	40	25	30	20	25
20.	Peas, Green		140	35	40	55	45	50	35	40	15	20	25	25	30	20	25
21.	Potatoes, Sweet	Syrup pack	170	55	60	75	55	65	45	55	40	45	60	40	50	35	45
		Solid pack	155	95	115	225	95	125	75	105	75	95	200	80	110	75	105
22.	Potatoes, White		160	35	40	50	40	45	35	40	25	30	40	30	40	25	35
23.	Pumpkin	Solid pack	185	75	95	190	85	125	65	105	60	75	165	80	120	60	100
24.	Squash, Summer		150	35	45		35	45	30	40	25	30		30	40	25	35
25.	Squash, Winter		185	75	95	190	85	125	65	105	60	75	165	80	120	60	100
26.	Mixed Vegetables		150	35	45	90	45	50	35	40	25	35	80	30	35	25	30

TABLE XL

PROCESSING INSTRUCTIONS FOR JUICES

Product	Closing Temperature (°F.)	Water Bath Temperature (°F.)	Pasteurizing Time Minutes: Tin Cans No. No.2	Tin Cans No. 2-1/2	Tin Cans No. No.10	Glass Jars Pint	Glass Jars Quart
1. Apple Juice	170	212	5	10	30	5	10
2. Berry Juices	170	212	5	10	30	5	10
3. Grape Juice	190	212	5	10	20	5	10
4. Grapefruit Juice	190	212	5	10	20	5	10
5. Pineapple Juice	190	212	5	10	20	5	10
6. Prune Juice	180	190	20	35	60	25	35
7. Tomato Juice	180	212	40	45	80	40	45

TABLE XLI

PROCESSING INSTRUCTIONS FOR MEATS
(See page 148 for operating instructions)

Product	Type of Pack	Initial Temp. °F.	Time to Process at 240° F. (10 psi at Sea Level) Minutes				Time to Process at 250° F. (15 psi at Sea Level) Minutes			
			Cans		Glass Jars Spray		Cans		Glass Jars Spray	
			No.2	No. 2-2/2	Pint	Quart	No.2	No. 2-1/2	Pint	Quart
1. Roast, steaks, stew meats (Beef, veal, pork, lamb, mutton venison)		170	75	100	90	105	55	80	55	80
2. Ground Meat	Cakes-Hot	170	75	100	90	105	55	80	55	80
	Solid-Raw	170	100	135	100	135	75	110	75	110
3. Tongue, Heart (Beef)		170	75	100	90	105	55	80	55	80
4. Corned Beef		170	75	100	90	105	55	80	55	80
5. Poultry, Small Game, (Boned)		170	90	105	90	105	55	80	55	80
6. Poultry, Small Game, (Not Boned)		170	65	85	80	90	50	70	50	70
7. Fish of Halibut, Haddock, Cod, or Pickerel Type		170	90	105	90	105	55	80	55	80
8. Fish of Herring or Alewives Type		170	90	105	90	105	55	80	55	80

9.	Fish of Mackerel and Trout Type	170	90	105	90	105	55	80	55	80
10.	Fish of Salmon and Barracuda Type	170	100	115	100	115	85	100	85	100
11.	Tuna and King Mackerel	See Table XLII								
12.	Clams, Whole	170	60	80	70	90	40	60	50	70
13.	Lobster	See Table XLII								
14.	Shrimp	170	30	40	40	55	20	30	25	35
15.	Crab	See Table XLII								

TABLE XLII

PROCESSING INSTRUCTIONS FOR SEAFOODS IN SPECIAL CONTAINERS
(See pages 148-149 for operating instructions)

Product	Initial Temp. °F.	Time to Process at 240°F. (10 psi) Minutes		Time to Process at 250°F. (15 psi) Minutes	
		1/2 Flat Cans	1/2 Pint Jars	1/2 Flat Cans	1/2 Pint Jars
1. Crab	170	55	65	40	50
2. Lobster	170	60	70	45	55
3. Tuna and King Mackerel	150	80	90	60	70

APPENDIX C

TABLES XLIII THROUGH L

TABLE XLIII

PRODUCT IDENTIFICATION BY LATIN NOMENCLATURE AND SUITABILITY FOR CANNING

Product	Latin Nomenclature	Suitability For Canning	Suitability For Juices
Apple	Pyrus malus	Good	Excellent
Apricot	Prunus armeniaca	Excellent	
Asparagus	Asparagus officinalis	Excellent	
Bean, Snap	Phaseolus Vulgaris	Good	
Bean, Lima	Phaseolus lunatus	Excellent	
Beets	Beta Vulgaris	Good	
Blackberry	Rubus villosus	Excellent	Excellent
Broccoli		Good	
Brussels Sprouts	Brassica oleracea gemmifera	Good	
Cabbage	Brassica oleracea capitata	Good	
Carrots	Daucus carota	Good	
Cauliflower	Brassica oleracea botrytis	Good	
Celery	Apium gravedens	Fair	
Cherry	Prunus {Cerasus avium}	Excellent	
Corn	Zea Mays	Excellent	
Cranberry	Oxycoccus {palustris macrocarpus}	Good	
Egg Plant	Solanum melongena	Fair	
Fig	Ficus carica	Excellent	
Grape	Vitis {labrusca vinifera vulpina Muscadinia rotundifolia}	Fair	Excellent
Grapefruit	Citrus grandis	Fair	Fair
Guava	Psidium {quajava cattleyanum}	Good	
Loquat	Eriobotrya japonica	Good	
Mango	Mangifera indica	Fair	

(Continued)

TABLE XLIII (Continued)

PRODUCT IDENTIFICATION BY LATIN NOMENCLATURE AND SUITABILITY FOR CANNING

Product	Latin Nomenclature	Suitability For Canning	Suitability For Juices
Mayhaw	Crataegus aestivalis	Poor	
Mushroom	Any edible fungus of orders Agaricales, Lycoperdales, especially Agaricus campestris	Excellent	
Okra	Abelmoschus esculentus	Fair	
Orange	Citrus {sinensis, aurantium, bergamia}	Fair	Fair
Papaya	Carica papaya	Fair	
Parsnip	Pastinaca sativa	Good	
Peach	Amygdalus persica	Excellent	
Pear	Pyrus {serotina, communis}	Excellent	
Pea, Field	Pisum arvense	Excellent	
Pea, Green	Pisum sativum	Excellent	
Pineapple	Ananas sativa	Excellent	Excellent
Plum	Prunus {munsoniana, domestica, americana}	Good	
Potato, White	Solanum tuberosum	Good	
Potato, Sweet	Ipomoea batatas	Excellent	
Pumpkin	Cucurbita pepo	Good	
Quince	Cydonia oblonga	Poor	
Raspberry	Rubus strigosus	Excellent	
Rhubarb	Rheum rhaponticum	Good	
Roselle	Hibiscus sabdariffa	Fair	
Spinach	Spinacea oleracea	Good	
Squash, Summer	Cucurbita pepo	Good	

(Continued)

TABLE XLIII (Continued)

PRODUCT IDENTIFICATION BY LATIN NOMENCLATURE
AND SUITABILITY FOR CANNING

Product	Latin Nomenclature	Suitability for	
		Canning	Juices
Squash, Winter	Cucurbita {maxima, moschata}	Good	
Strawberry	Fragaria Virginiana	Poor	
Tomato	Lycopersicum esculentum	Excellent	Excellent

TABLE XLIV

YIELD OF CANNED PRODUCTS PER BUSHEL OF RAW MATERIAL

Product	Weight Per Bushels (Pounds)	No. 2 Cans	Pints	Quarts	No. 10 Cans
Apples	48	28	36	18	6
Apricots	48	--	42	20	--
Asparagus	45	12	22	11	--
Beans, Green and Wax	30	28	35	18	6
Beans, Lima (in pods)	32	11	14	7	2
Beets (without tops)	52	29	37	18	6
Berries	24 Quart Crates	24	30	15	5
Carrots (without tops)	50	29	36	18	6
Cherries	56	36	53	26	7
Corn (in husks)	35	15	17	8	2
Egg Plant	12 medium	10	14	7	--
Figs	14	12	18	9	--
Grapefruit	--	10	16	8	--
Grapes	--	30	36	18	--
Greens	18	12	15	7	2
Guavas	--	--	32	16	--
Loquats	--	--	34	17	--
Mangos	--	--	32	16	--
Okra	26	27	34	17	5
Peaches	48	35	44	22	7
Pears	50	36	45	22	7
Peas, Field (in pod)	30	10	13	6	2
Peas, Green (in pod)	30	11	14	7	2
Plums	56	35	50	25	7
Pumpkin	28	28	35	17	5
Rhubarb	10	12	16	8	--

(Continued)

TABLE XLIV (Continued)

YIELD OF CANNED PRODUCTS PER BUSHEL OF RAW MATERIAL

Product	Weight Per Bushels (Pounds)	No. 2 Cans	Pints	Quarts	No. 10 Cans
Squash, Summer	40	29	36	18	6
Sweet Potatoes	55	32	40	20	6
Tomatoes	56	29	38	19	6

TABLE XLV

INSTRUCTIONS FOR PREPARING SYRUP

	Water (Parts by Volume)	Sugar (Parts by Volume)
Light	3	1
Medium	2	1
Heavy	1	1

TABLE XLVI

AMOUNT OF SALT REQUIRED FOR CANNING VARIOUS VEGETABLES

Product	Grams of Salt Added		
	Can sizes		
	No. 2	No. 2-1/2	No. 10
	(303x406)		
	(307x409)	(401x411)	(603x700)
Asparagus	3.9-5.8	6.5-9.8	29
Beans, Green	3.3-4.9	4.9-5.8	16.2-19.4
Beans, Lima	3.3-4.9	4.9-5.8	16.2-19.4
Beets	3.3-4.9	4.9-5.8	16.2-19.4
Carrots	3.3-4.9	4.9-5.8	16.2-19.4
Corn	3.3-4.9	---	---
Greens	3.9-5.8	6.5-9.8	29
Okra	3.3-4.9	---	---
Peas	3.3-4.9	4.9-5.8	16.2-19.4
Squash, Summer	3.3-4.9	---	---

Note: 1 gram = 15.43 grains

1 gram = 0.035 ounces (Avoir.)

CAN DIMENSIONS

The can sizes are given in the nomenclature usually employed in the industry, which avoids the confusion incident to conflicting local names of cans.

In this system the cans are identified by a statement of their dimensions (over-all diameter and over-all height). Each dimension is expressed as a number of three digits. The left-hand digit gives the number of whole inches, while the two right-hand digits give the additional fraction of the dimension expressed as sixteenths of an inch.

The first number given in the size of each can is the diameter, and the second number is the height. For example, a No. 303 can, designated as 303 x 406, is 3 3/16 inches in diameter and 4 6/16 inches high, that is within manufacturing tolerances.

The dimensions are "over-all," the diameter being measured to the outside of the double seam, and the length including the entire seam at each end of the can.

TABLE XLVII

AMOUNT OF MATERIAL TO ADD TO WATER TO OBTAIN A SPECIFIED CONCENTRATION

Per Cent Desired	Ounces (Avoir.) per U. S. Gallon	Grams per Liter
1	1.33	10.0
1-1/4	1.67	12.5
1-1/2	2.00	15.0
1-3/4	2.34	17.5
2	2.67	20.0
2-1/4	3.00	22.5
2-1/2	3.34	25.0
2-3/4	3.67	27.5
3	4.00	30.0
3-1/4	4.33	32.5
3-1/2	4.67	35.0
3-1/4	5.00	37.5
4	5.34	40.0
4-1/4	5.67	42.5
4-1/2	6.00	45.0
4-3/4	6.34	47.5
5	6.67	50.0
6	8.00	60.0
8	10.7	80.0
10	13.3	100.0
12	16.0	120.0

TABLE XLVIII

RELATIONSHIP BETWEEN GAUGE PRESSURES IN POUNDS PER SQUARE INCH AND TEMPERATURES AT VARIOUS ALTITUDES

Temperature	Elevation above Sea Level (Feet)								
(Degrees F.)	0	500	1000	2000	3000	4000	5000	6000	Temp. Deg. C.
200	—	—	—	—	—	—	—	—	93.3
205	—	—	—	—	—	—	0.5	0.9	96.1
210	—	—	—	0.4	0.9	1.4	1.8	2.3	98.9
212	0.0	0.2	0.5	1.0	1.5	2.0	2.4	2.9	100.0
215	0.9	1.1	1.4	1.9	2.4	2.9	3.3	3.8	101.7
220	2.5	2.7	3.0	3.4	3.9	4.4	4.9	5.3	104.4
225	4.2	4.5	4.7	5.2	5.7	6.2	6.6	7.1	107.2
230	6.1	6.3	6.6	7.1	7.6	8.0	8.5	9.0	110.0
235	8.1	8.3	8.6	9.1	9.6	10.0	10.5	11.0	112.8
240	10.3	10.5	10.8	11.3	11.7	12.2	12.7	13.1	115.6
242	11.2	11.4	11.7	12.2	12.7	13.1	13.6	14.1	116.7
245	12.6	12.9	13.1	13.6	14.1	14.6	15.0	15.5	118.3
248	14.1	14.3	14.6	15.1	15.6	16.0	16.5	17.0	120.0
250	15.1	15.4	15.6	16.1	16.6	17.1	17.5	18.0	121.1
252	16.2	16.4	16.7	17.2	17.7	18.1	18.6	19.1	122.2
255	17.8	18.1	18.3	18.8	19.3	19.8	20.2	20.7	123.9
260	20.7	21.0	21.2	21.7	22.2	22.7	23.1	23.6	126.7

TABLE XLIX

EQUIVALENTS OF HOUSEHOLD FOOD MEASURES

Quarts	Pints	Standard Cups	Fluid Ounces	Tablespoonfuls	Teaspoonfuls	Milliliters
1.0	2.0	4.0	32.0	64.0	192.0	946.4
0.5	1.0	2.0	16.0	32.0	96.0	473.2
0.25	0.5	1.0	8.0	16.0	48.0	236.6
0.125	0.25	0.5	4.0	8.0	24.0	118.3
	0.125	0.25	2.0	4.0	12.0	59.2
		0.125	1.0	2.0	6.0	29.6
			0.5	1.0	3.0	14.8
				0.33	1.0	4.9
					0.2	1.0

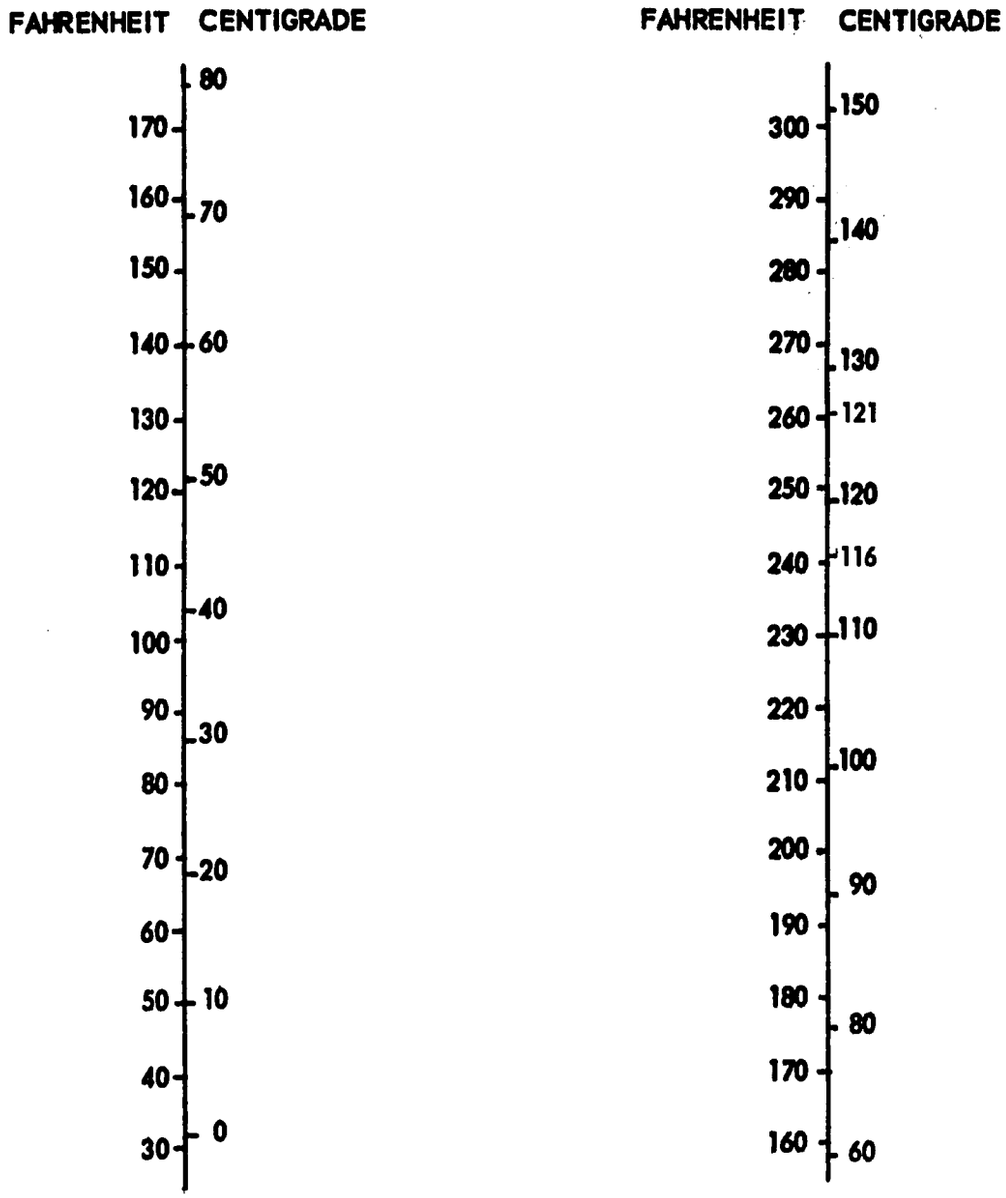


Figure 113. Temperature Conversion--Fahrenheit and Centigrade Scales

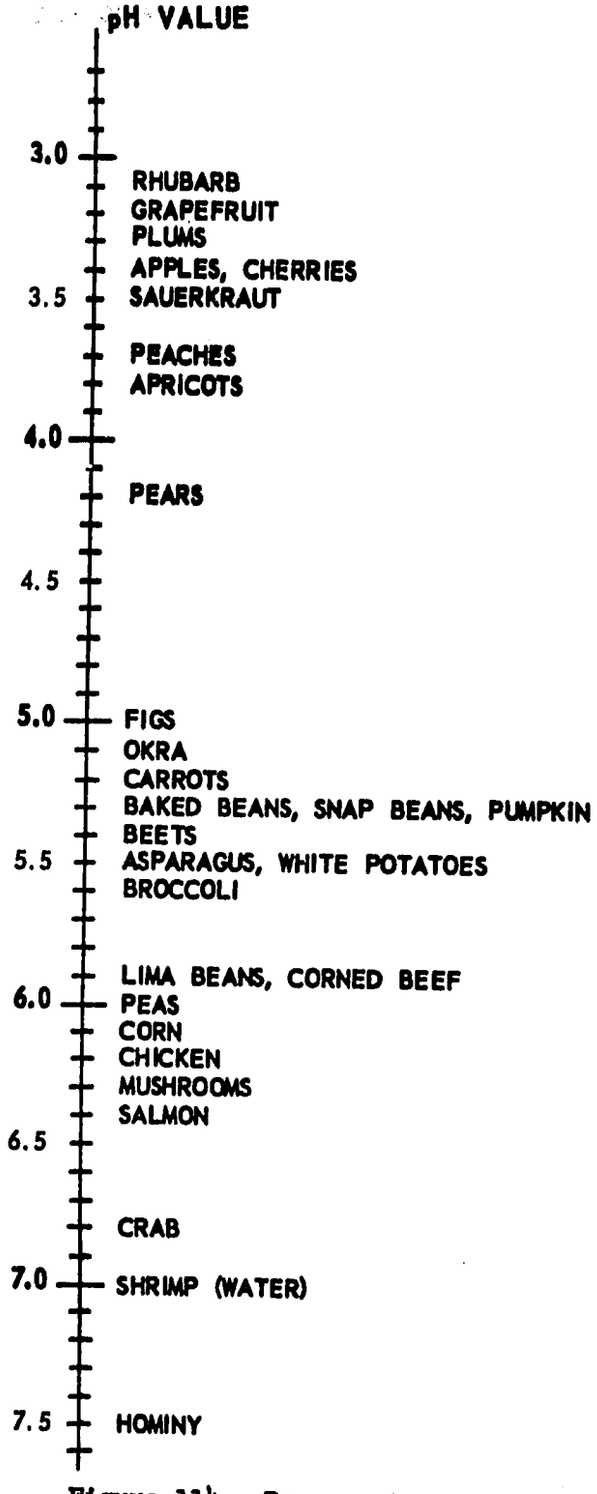


Figure 114. Representative pH Values

APPENDIX D

EQUIPMENT SUPPLIERS

Equipment Suppliers

For convenience, the equipment discussed in this manual has been classified in the following categories:

A. Food preparation equipment

1. hand-operated
2. power-operated

B. Exhausters

1. batch
2. continuous

C. Sealers

1. hand-operated
2. power-operated

D. Kettles, cookers, and retorts

E. Materials handling equipment

F. Instruments

G. Steam boilers

H. Labeling equipment

I. Can manufacturing equipment

J. Can reforming equipment

K. Cans

L. Glass jars

An alphabetized list of distributors of canning equipment and the specialized items they handle, as indicated in the above classification, is given in Table L. Mention of the name of these firms is not to be construed as a recommendation or endorsement but merely as a citation that is typical in its field. Commercial directories generally list names of additional companies.

New equipment is constantly being developed in the canning machinery industry. Hence, this listing cannot be considered complete or up to date after the lapse of even a few months.

TABLE L

DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
1. Aluminum Goods Manufacturing Company Manitowoc, Wisconsin	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
2. American Can Company 100 Park Avenue New York, New York 10017	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
3. Angelus Sanitary Can Machine Company 4900 Pacific Boulevard Los Angeles, California 90058	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
4. Athens Boiler & Machine Works, Inc. Athens, Georgia	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-
5. Berlin Chapman Div. of Perfex Corp. Berlin, Wisconsin 54923	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
6. E. W. Bliss Company 1004 East State St. Hastings, Michigan 49058	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
7. Burpee Can Sealer Company 128 West Liberty Street Barrington, Illinois 60010	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
8. Burt Machine Company 401 East Oliver St. Baltimore, Maryland 21202	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-

	Distributor	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
9.	Callahan-Max Ams Can Machine Company 61 Main Street Proctor, Vermont 05765	-	-	-	-	x	x	-	-	-	-	-	x	-	-	-
10.	Chisholm-Ryder Company, Inc. College & Highland Avenues Niagara Falls, New York 14305	x	x	-	-	-	-	x	x	x	-	x	-	-	-	-
11.	Continental Can Company, Inc. 633 Third Avenue New York, New York 10017	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-
12.	Crosby Steam Gage & Valve Company Wrenthan, Massachusetts	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
13.	Dewey & Almy Chemical Division W. R. Grace & Co. 62 Whittemore Avenue Cambridge, Massachusetts 02140	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
14.	Dixie Canner Equipment Company P. O. Box 1348 Athens, Georgia 30601	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-
15.	Federal Enameling & Stamping Company Box 626 Pittsburgh 30, Pennsylvania	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
16.	First Machinery Corporation, Falcon Mfg. Div. 209 Tenth Street Brooklyn, New York 11215	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
17.	FMC Corporation Canning Machinery Div. 103 East Maple Street Hoopeston, Illinois 60942	x	x	-	x	-	x	x	x	-	-	-	-	-	-	-

(Continued)

TABLE L (Continued)
DISTRIBUTIRS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
18. Hamburg Boiler Works, Inc. Hamburg, Pennsylvania	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
19. Hamilton Kettles Div. of Brighton Corporation 11861 Mosteller Road Cincinnati, Ohio 45241	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
20. Hazel-Atlas Glass Division, Continental Can Co. Inc. Wheeling, West Virginia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
21. Kewanee-Ross Corporation Kewanee, Illinois	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
22. Lakeside Aluminum Company 2633 Southeast Fourth Street Minneapolis, Minnesota	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
23. F. H. Langsenkamp Company 229 East South Street Indianapolis, Indiana 46225	x	x	-	x	x	x	x	x	x	-	x	-	-	-	-
24. Lee Metal Products Company, Inc. 432 Pine Street Philipsburg, Pennsylvania 16866	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
25. Legion Utensils Company 40th Avenue & 21st Street Long Island City 1, New York	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
26. Lookout Boiler & Manufacturing Company Chattanooga, Tennessee	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-

	Distributor	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
27.	Manning, Maxwell & Moore, Inc. Stratford, Connecticut	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
28.	Moeller Instrument Company 132nd Street and 89th Avenue Richmond Hill 18 New York, New York	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
29.	National Aluminum Manufacturing Company Peoria, Illinois	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
30.	National Pressure Cooker Company Eau Claire, Wisconsin	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-
31.	Orr & Sembower, Inc. P.O. Box 1138 Reading, Pennsylvania 19603	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
32.	Palmer Instruments, Inc. 2515 Norwood Avenue Cincinnati, Ohio 45212	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
33.	Pressure Cooker Company 388 Broadway Denver, Colorado	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
34.	Rietz Manufacturing Company 150 Todd Road Santa Rosa, California 95401	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
35.	A.K. Robins and Company, Inc. 713 East Lombard Street Baltimore, Maryland 21202	x	x	-	x	-	x	x	x	-	-	-	-	-	-	-

(Continued)

TABLE L (Continued)

DISTRIBUTORS OF CANNING EQUIPMENT

Distributor	Equipment Category														
	A-1	A-2	B-1	B-2	C-1	C-2	D	E	F	G	H	I	J	K	L
36. R. & S. Machinery Company 19 Howard Street New York 13, New York	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
37. Ross Machine Works, Inc. 30 Main Street Brooklyn 1, New York	-	-	-	-	-	x	-	-	-	-	-	x	-	-	-
38. Sinclair-Scott Company 6245 State Road Philadelphia, Pennsylvania 19135	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
39. Taylor Instrument Companies 95 Ames Street Rochester, New York 14601	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
40. Vischer Products Company 2815 West Roscoe Street Chicago 18, Illinois	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
41. Vulcan Hart Manufacturing Company 3600 North Point Boulevard Baltimore 22, Maryland	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
42. Wisconsin Aluminum Foundry Company, Inc. 16th Street at Franklin Manitowoc, Wisconsin	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-