Canning in GLASS JARS

in Community Canning Centers

UNITED STATES DEPARTMENT OF AGRICULTURE
PRODUCTION AND MARKETING ADMINISTRATION
Washington, D. C.
July 1952

AGRICULTURE HANDBOOK NO.44

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Issued July 1952

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C.—Price 20 cents

ACKNOWLEDGMENTS

Acknowledgment for assistance in the preparation of this publication is made to the following:

Dr. John J. Powers, Head, Department of Food Technology, University of Georgia; Dr. William B. Esselen, research professor, Department of Food Technology, University of Massachusetts; Dr. Howard Reynolds, bacteriologist, Food and Nutrition Division, Bureau of Human Nutrition and Home Economics, United States Department of Agriculture; and James M. Reed, National Canners Association Research Laboratories, Washington, D. C., for calculating processing times and for helpful suggestions in adapting home and commercial canning processes to community cannery conditions. Dr. Powers also made available results of studies on processing acid and low-acid foods in glass jars in community-size equipment.

Credit is due Dr. J. Russell Esty and Charles T. Townsend of the National Canners Association Research Laboratories, Berkeley, Calif., for recommendations on which processing times for acid foods were based. R. H. Driftmier, chairman, Division of Agricultural Engineering, Harold D. White, research professor of agricultural engineering, and R. J. McCraney, assistant agricultural engineer, College Experiment Station, University of Georgia Agricultural Experiment Station, for the preparation of drawings and engineering data on the installation of the equipment and for assisting in the preparation of instructions on operation of the equipment; A. O. Duncan, associate professor, Agricultural Education Department, College of Education, University of Georgia, and A. G. Bullard, subject-matter specialist, Department of Agricultural Education, North Carolina State College, for making suggestions on organization and presentation; Karl Ford, Ball Brothers Company, Muncie, Ind., originator of the method described for canning in standard mason jars in community-size equipment, for furnishing photographs and making helpful suggestions; and Dr. M. B. Matlack, food technologist, of the Food Distribution Branch, for technical advice on the text.

In printing the partial list of suppliers of canning equipment on page 6, no guaranty of reliability is implied and no discrimination is intended.

CANNING IN GLASS JARS IN COMMUNITY CANNING CENTERS

By Bertha F. Olsen and Esther H. Scott, *Food Distribution Branch, Production and Marketing Administration*

INTRODUCTION

This publication describes some of the new equipment used in community canning centers to process food in standard mason jars. It gives detailed information on the installation and operation of the retorts for steam-processing and pressure-cooling low-acid foods and on atmospheric cookers for steam-processing acid foods. Included also are processing times that have been calculated expressly for the equipment and procedures described. The publication was designed to provide information on canning in glass jars as a supplement to Miscellaneous Publication 544, Community Canning Centers, which deals with canning in tin containers. Therefore, to avoid repetition, only brief instructions are given here for preparation of foods for canning. For more detailed instructions M.P. 544 may be consulted.

In the preparation of this publication advice and assistance were obtained from leading food technologists and agricultural engineers of the Federal Government, industry, and State universities. Their recommendations, with the most recent published data available on canning in standard mason jars, under the conditions described in the text, provided the basis for the instructions given here

EQUIPMENT FOR CANNING IN GLASS JARS

Retorts

Instructions in this publication are based on the use of vertical single-crate retorts of a certain type and size (fig. 1). Although these retorts are designed primarily for processing low-acid foods in glass jars, they may also be used for processing in tin containers. They will hold 100 quart jars, 195 pint jars, 185 No. 2 cans, 114 No. 3 cans, or 40 No. 10 cans. Except for the way in which the lid is secured to the retort shell, these retorts are similar in construction. Each is equipped as follows:

1. *A thermometer* with a temperature range of 120° to 270° F. to measure the retort temperature during cooling as well as processing. The thermometer, an angle type for easy reading, is installed near the bottom below the retort crate. Installed in this manner, the bulb, which extends into the retort shell, is given the necessary protection and is exposed to the steam or water so as to give good average readings of the retort temperature.

2. *A pressure gage* with a range of from 0 to 30 pounds per square inch specifically designed for steam.

3. *A ¾-inch pop safety valve* set at 15 pounds gage pressure.

4. *Water sprays (4 No. 1 spray nozzles)* on the inside of the retort lid for the initial cooling of the jars at the end of the process (fig. 14).

5. *Water valves, connecting pipes,* and a *one-half inch rubber hose* to bring the water supply to the retort. The hose is made to withstand both heat and pressure. In the pipe connection is a fine strainer.

6. *Air and steam connections* are provided near the top of the retort. The high-pressure steam for venting and the low-pressure steam for processing are brought into the retort through separate connections.

7. *A 1-inch drain* is provided to make sure of rapid venting and for draining the retort of cooling water. Venting is done through the drain at the bottom of the retort when steam is brought in at the top.

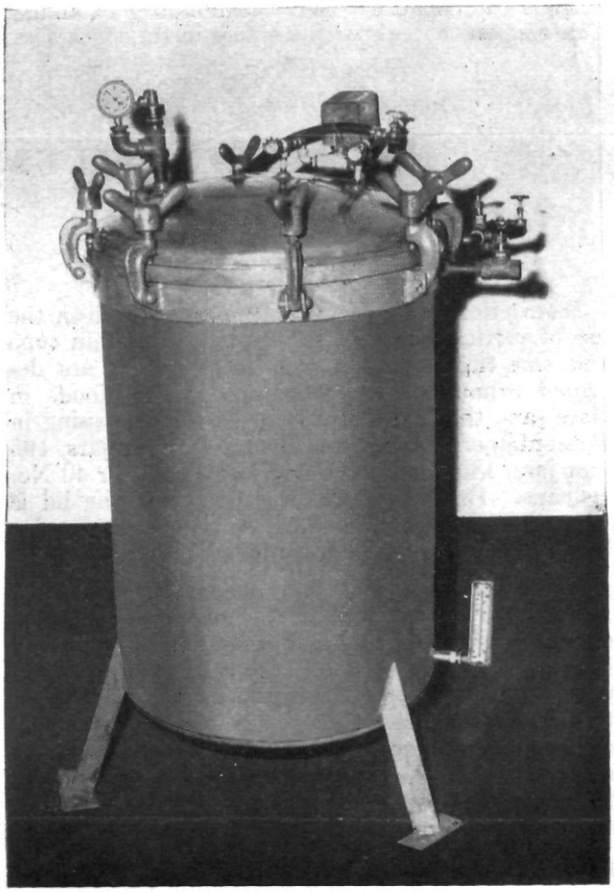


Figure 1.—Retorts equipped for processing glass jars in steam. The retort above has locking arms and a wheel for tightening the lid to the retort shell. The retort at the right has wing nuts.

Retort Crates

Figure 2 shows two types of retort crates that are used for processing in glass jars. The expanded metal crate, designed especially for the purpose, insures good circulation of steam. A slatted metal crate, like those used in community canning centers for processing in tin containers, is also satisfactory if the perforated metal bottom is replaced with expanded metal as shown. The sides of the crate will also need to be lined with expanded metal if the slats are too far apart to support the jars.

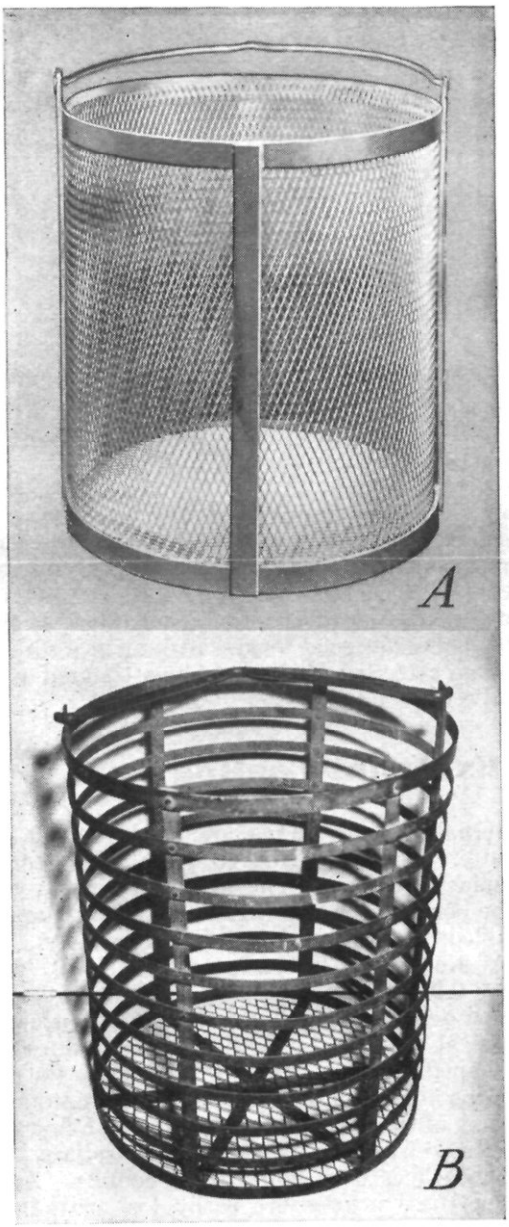


Figure 2.—Retort crates: *A*, Expanded metal; *B*, slatted metal crate with expanded metal bottom.

Air Compressor

Compressed air is used to maintain pressure in the retort at the beginning of the cooling operation. The air is supplied by a heavy-duty type air compressor with a 30-gallon storage tank (fig. 3). The storage tank is constructed in accordance with the code of the American Society of Mechanical Engineers. It is equipped with an automatic pressure switch, a pressure gage, a pressure-relief valve, and a valve for draining the tank. The unit may be bought with or without a motor, but it is desirable to buy it complete with motor. If bought without the motor it is important that the motor used with the compressor be suitable for the purpose. Any compressor similar to the one shown in figure 3, having a capacity of 4 to 5 cubic feet per minute, is adequate for a canning plant with one to six retorts.

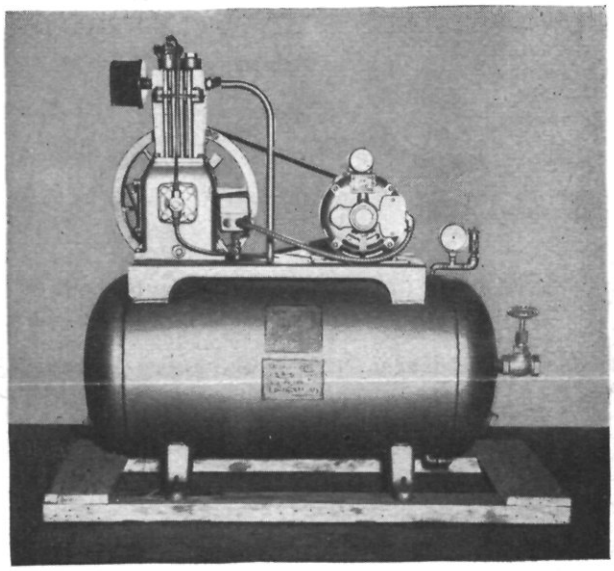
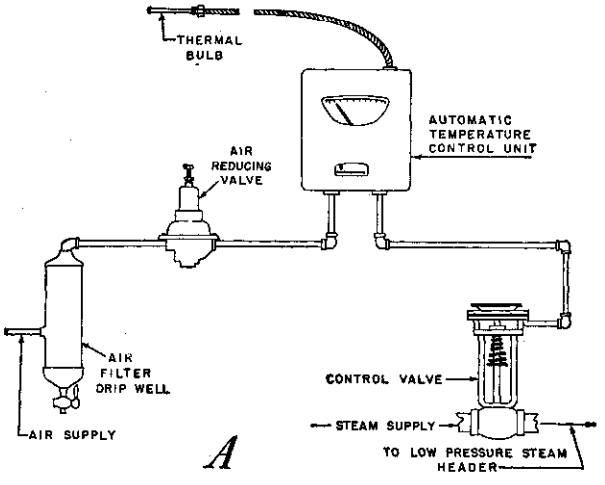


Figure 3.—Air compressor.

Automatic Control Valves

For Steam

An automatic control valve on the steam line is essential for maintaining a constant temperature in the retort during processing. Two of the most



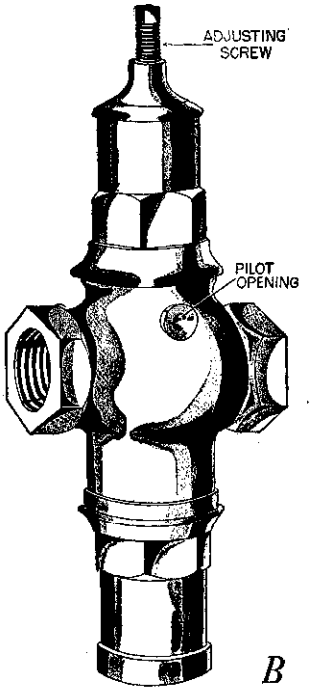


Figure 4.—Automatic control valves: *A*, Air-actuated temperature control; *B*, back-pressure pilot-operated pressure control.

reliable types for the purpose are shown in figure 4. The air-actuated temperature controller (fig. 4*A*) is the preferred type. It is extremely sensitive to temperature changes within the retort or steam header and will give good service over a long period of time. The back-pressure pilot-operated automatic-control valve (fig. 4*B*) is the most satisfactory pressure control valve. Community canneries use this type of valve to a greater extent than the temperature control valve because it is less expensive. Either type of valve is suitable for use on a steam header to a battery of retorts or on a single retort. On a battery set-up, a ¾-inch valve is needed; on a single retort, a ⅜-inch valve.

Although the valves shown in figure 4 are the only types which are satisfactory for a header installation, there are other self-operated or spring-type valves that can be used on individual retorts. To make sure of getting the right type of valve when ordering, specify:

1. That it is to be used for steam.
2. Size required.
3. Operating pressures (boiler and retort).
4. Temperature or pressure to be maintained in the retort.
5. Accuracy. (The valve should maintain the desired temperature, within plus or minus 1° F., as long as the minimum steam pressure specified by the manufacturer is maintained in the line.)

For Air

An air-control valve is necessary to maintain the correct air pressure in the retort during the initial cooling period. A ½-inch valve, set about 2 pounds higher than the pressure at which processing is done in the retort, is recommended. Any good-quality valve designed for use with air pressure and having an accuracy of plus or minus 1 pound at any setting is satisfactory.

External Cooling Sprays

External cooling sprays are used to cool glass jars after they are removed from the retort or atmospheric cooker. The external-spray system may be bought as a unit (fig. 16, p. 17) or it may be assembled from parts bought separately. Two nozzles are needed for each unit—a No. 1, which delivers 0.2 gallon of water per minute, and a No. 5, which delivers 0.8 gallon per minute, with water pressure at 30 pounds. Both nozzles produce solid cone-shaped sprays. The No. 1 nozzle is the same size as the nozzles in the retort lid. It is used at the beginning of the cooling operation, when a fine spray is needed to avoid breakage of the glass jars. The No. 5 nozzle is used in the final cooling. As the cores in these nozzles are easily lost or damaged during cleaning, extra ones should always be kept on hand. An average of 1- to 1½-spray units is usually provided per retort or atmospheric cooker.

Atmospheric Cookers

The atmospheric cooker was designed for processing acid foods in glass jars, but it may also be used for processing such products in tin containers. A simple device, it consists of a bell cover with thermometer, a base pan with overflow drain and crate support, and an expanded metal crate for holding the containers. The atmospheric cooker is equipped to process in steam at 212° F. at sea level. The steam is admitted at the top of the cover through a high-pressure steam hose. These cookers come in two sizes—No. 2 and No. 3. The No. 2 cooker shown in figure 5 has an approximate capacity of 36 quart jars, 80 pint jars, 64 No. 2 cans, or 36 No. 3 cans. It is convenient to use since the loaded crate can be placed on the crate support without using a hoist. The No. 3 cooker, comparable in size to the retorts desribed on page 1, requires a hoist to lift both the cover and the loaded crate.

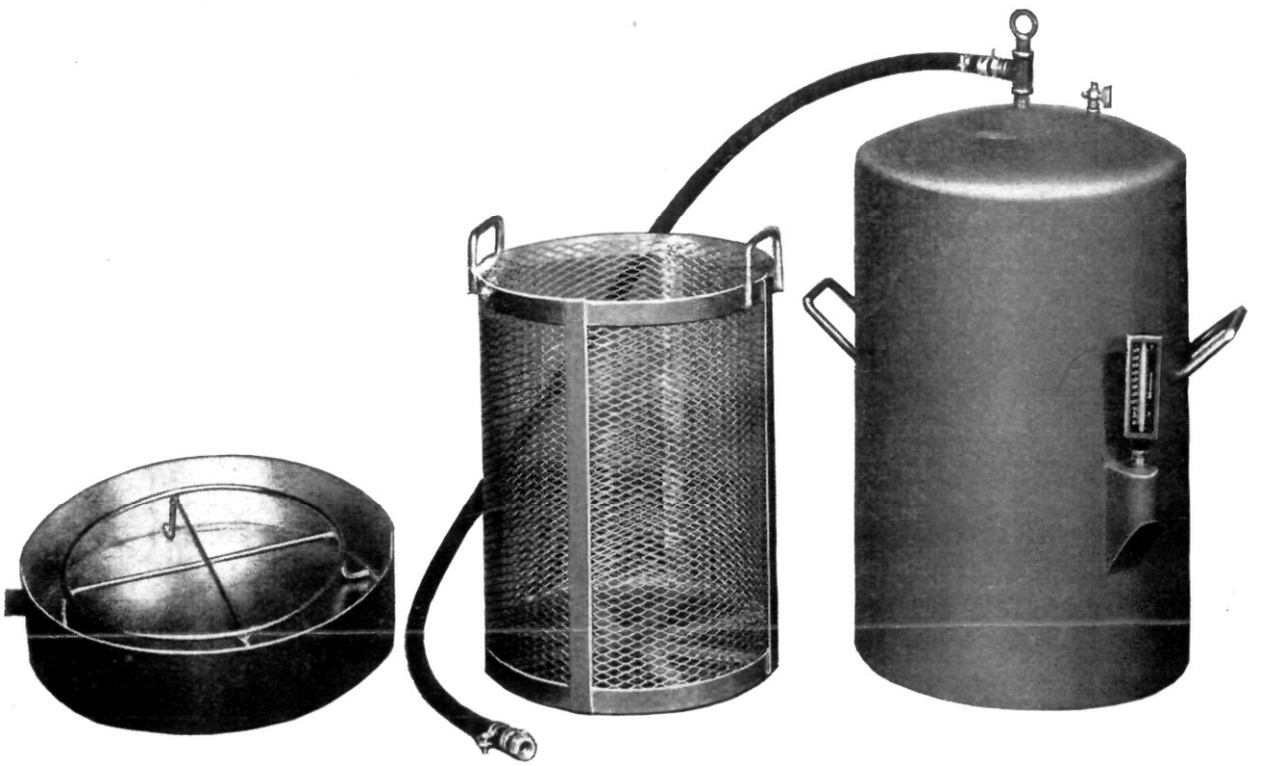


Figure 5.—Base pan, expanded metal crate, and bell cover of No. 2 atmospheric cooker.

Other Equipment and Facilities

Other equipment and facilities needed for handling glass jars include the following:

Jar Trays

A simple tray for handling glass jars at the canning center may be easily constructed (fig. 6). The frame is made of wood with handholes at either end. The bottom is of expanded metal. The tray, measuring 9½ by 15 inches on the inside, is large enough to hold 12 quart jars. Each worker needs two or three trays to hold the jars while filling them, as well as for transferring them from one work area to another. A small truck, with the top at about the same level as the work tables, is handy for transferring trays of filled jars from the filling table to the loading table.

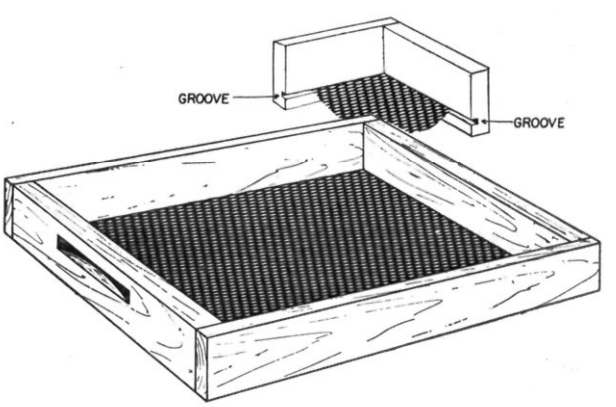


Figure 6.—Jar trays.

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Loading Table

A sturdy table (fig. 7) is needed in the area where the processing crates are loaded with filled jars. A reinforced shelf beneath the table top is convenient for storing empty jar trays.

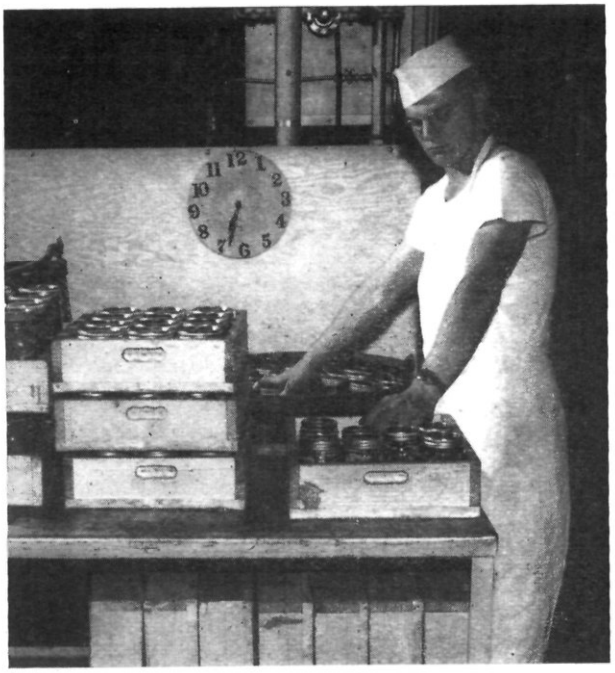

Figure 7.—Loading table.

Storage Shelves

Shelves of the type shown in figure 20, page 21, are needed for the final cooling of the processed food before it is released to the patrons of the canning center. The shelves, slatted to expedite cooling of the jars, are built in sections so that they may be easily removed for cleaning. The retaining strip at the front of the shelves is painted with blackboard paint so that the shelves may be marked to identify each patron's products.

PARTIAL LIST OF SUPPLIERS OF CANNING EQUIPMENT

Canning equipment may be obtained from the following suppliers:

Chisholm-Ryder Co., Inc., 5280 Highland Avenue, Niagara Falls, N. Y.

Dixie Canner Co., Athens, Ga.

Food Machinery Corporation, 101 East Maple Street, Hoopeston, Ill., and San Jose 6, Calif.

F. H. Langsenkamp Co., Harmon and South Streets, Indianapolis 25, Ind.

A. K. Robins & Co., Inc., Baltimore 2, Md.

Retorts

Retorts for processing in glass jars are placed in a regular retort line where an overhead hoist is available for lifting the crates. Retorts of the size described here are spaced on 18-inch centers for convenient operation and maintenance. If space does not permit this arrangement, the retorts may be placed closer, but 42 inches between retort centers is the minimum. After being alined, the retorts are leveled and then bolted securely to the floor to prevent their tipping or moving during loading or unloading and to eliminate the danger of breaking a steam or air line.

On these retorts steam, air, and water are brought in at the top. The high-pressure steam for venting and the low-pressure steam for processing are brought in through separate openings. (High-pressure is a relative term, indicating that the steam pressure in the line is well above the pressure at which processing is done. The actual pressure of the high-pressure steam depends on the State or local requirements for installing pressure vessels. Some States require that it be held at approximately 45 pounds by a pilot-operated pressure-reducing valve in the main steam line. The high-pressure line is, in effect, a bypass around the controller in the low-pressure line.) With steam coming in at the top, venting is done through a 1-inch drain at the bottom. A ¼-inch pet cock is provided on the drain to bleed the retort during processing. These fixtures and others necessary for processing and pressure-cooling glass jars and small-size tin containers (No. 2, No. 2½, and No. 3) are shown in figure 8.

Figure 9 shows the same retort with added facilities for pressure-cooling No. 10 tin containers. Water is brought in at the bottom as well as at the top of the retort to speed the cooling operation.

An overflow pipe is provided to carry off the excess water during the cooling period. A spring relief valve on the overflow assembly is used to prevent the building up of excess pressure in the retort during the cooling operation. This valve is set to operate at a pressure slightly lower than that of the pop safety valve in the retort lid. When the retort is used for processing and cooling glass jars both gate valves in the overflow assembly are closed.

A satisfactory method for installing a battery of retorts is shown in figure 10. It is a practical method for use in community canning centers, as one automatic control valve on a common header regulates the temperature of all of the retorts in the line. The low-pressure steam header must be at least 3 inches in diameter. This size of header will furnish an adequate supply of steam to as many as six retorts. The header is assembled in the desired length with threaded pipe connections (figs. 10 and 11*A*), or it may be made from a single pipe with nipples welded at the take-off points (fig. 11*B*.) To facilitate the removal of condensate, the header is sloped ½ inch per 10 feet toward the steam trap. The pop safety valve, set at 15 pounds pressure, will prevent the building up of excessive pressure in the header. The ¾-inch connecting line between the low-pressure header and the retort is equipped with a gate valve, rather than a globe valve, so as to reduce resistance to the steam flow during processing.

For maximum efficiency use the sizes of pipe indicated for steam, air, and water. Place the header pipes close to the retort line and cover the steam header pipes with asbestos or any suitable insulation. Fit the steam, air, and water lines between the headers and retorts with the proper kind of hand valves specified in figure 10. These valves should be of the right sizes and designed for the purposes intended. Do not use water valves on steam lines or vice versa. All valves used should be constructed of noncorrosive metal, preferably bronze. They should be built to withstand pressure up to 125 pounds per square inch and have replaceable seats, plugs, or discs. If the working parts of the valves are replaceable the cost of maintaining the valves will be greatly reduced.

Y-type strainers are provided on the steam and air lines leading to the automatic control valves to keep scale and trash out of the working parts of the valves. A T-type strainer is provided on the water line near the retort assembly to reduce the possibility of clogging the spray nozzles in the lid of the retort with rust and sediment. This strainer is in addition to the one built into the water line on each retort. A gage is desirable on the water line near the retort assembly in order to know the water pressure in the line. It is essential to have at least 25 pounds gage pressure on the water line at the retort to insure proper operation of the spray nozzles. A gage on the air line near the retort assembly would also be desirable for determining the setting of the air-control valve.

The pressure gage on the low-pressure steam header is needed in order to adjust the pressure control valve and to show whether the pressure on the line is being maintained. For ease of reading, it is desirable to have the pressure gages at eye level.

Retorts installed as shown in figure 10 may be used for processing and pressure cooling glass jars or small-size tin containers. If No. 10 cans are also used it will be necessary to add the extra piping facilities shown in figure 9.

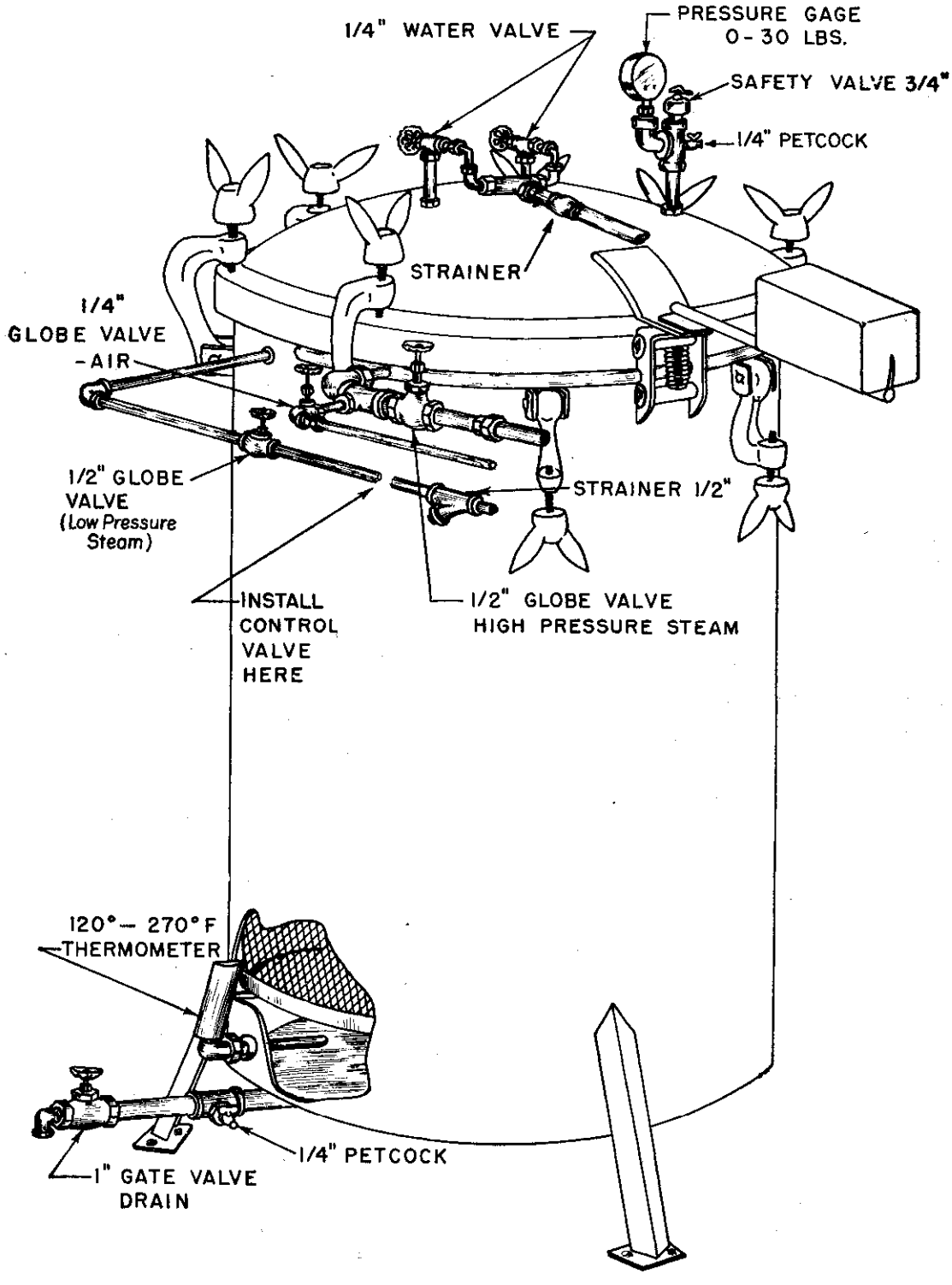

Figure 8.—Retort for glass jars and small tin containers.

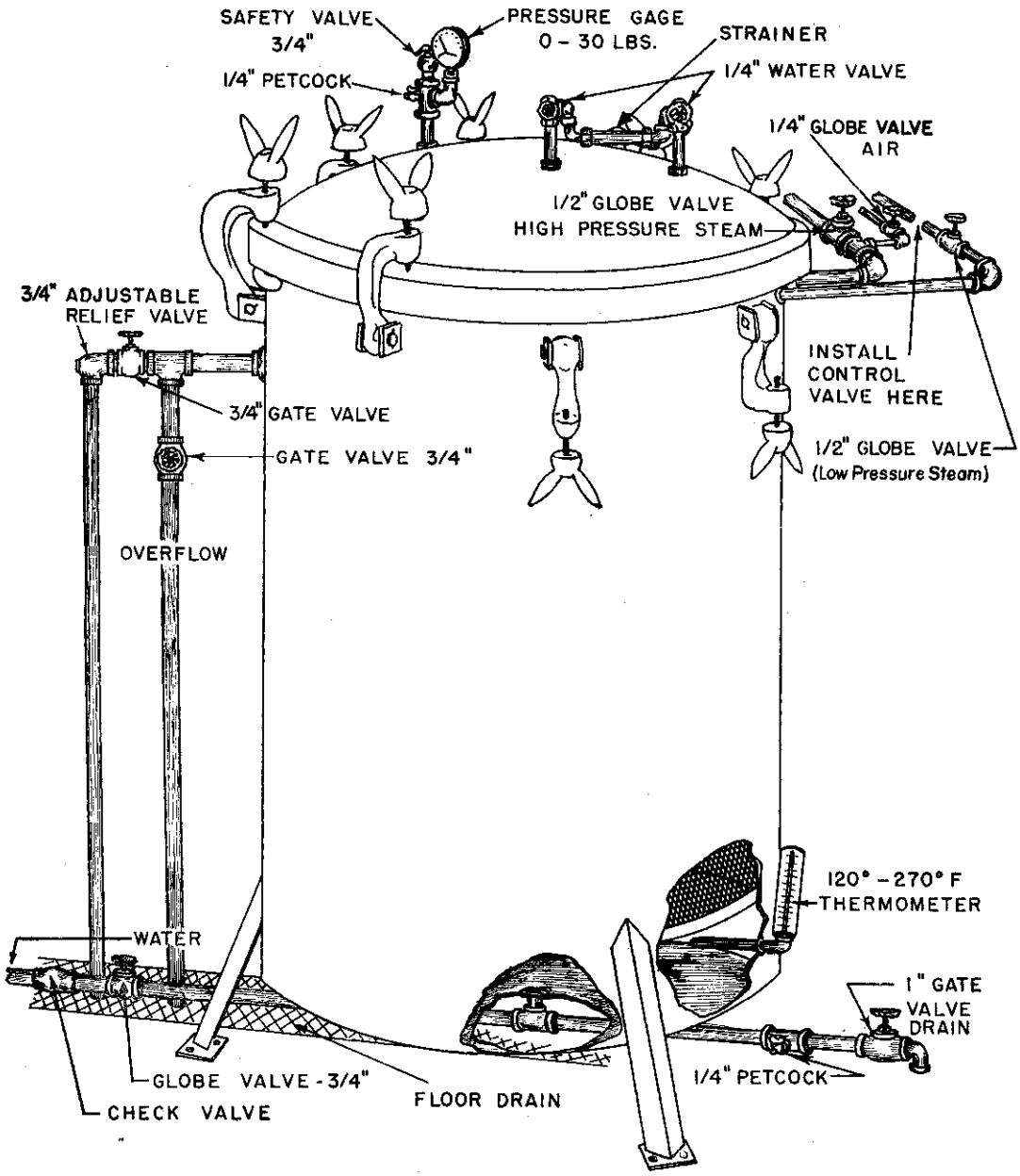

Figure 9.—Retort for glass jars and tin containers of all sizes.

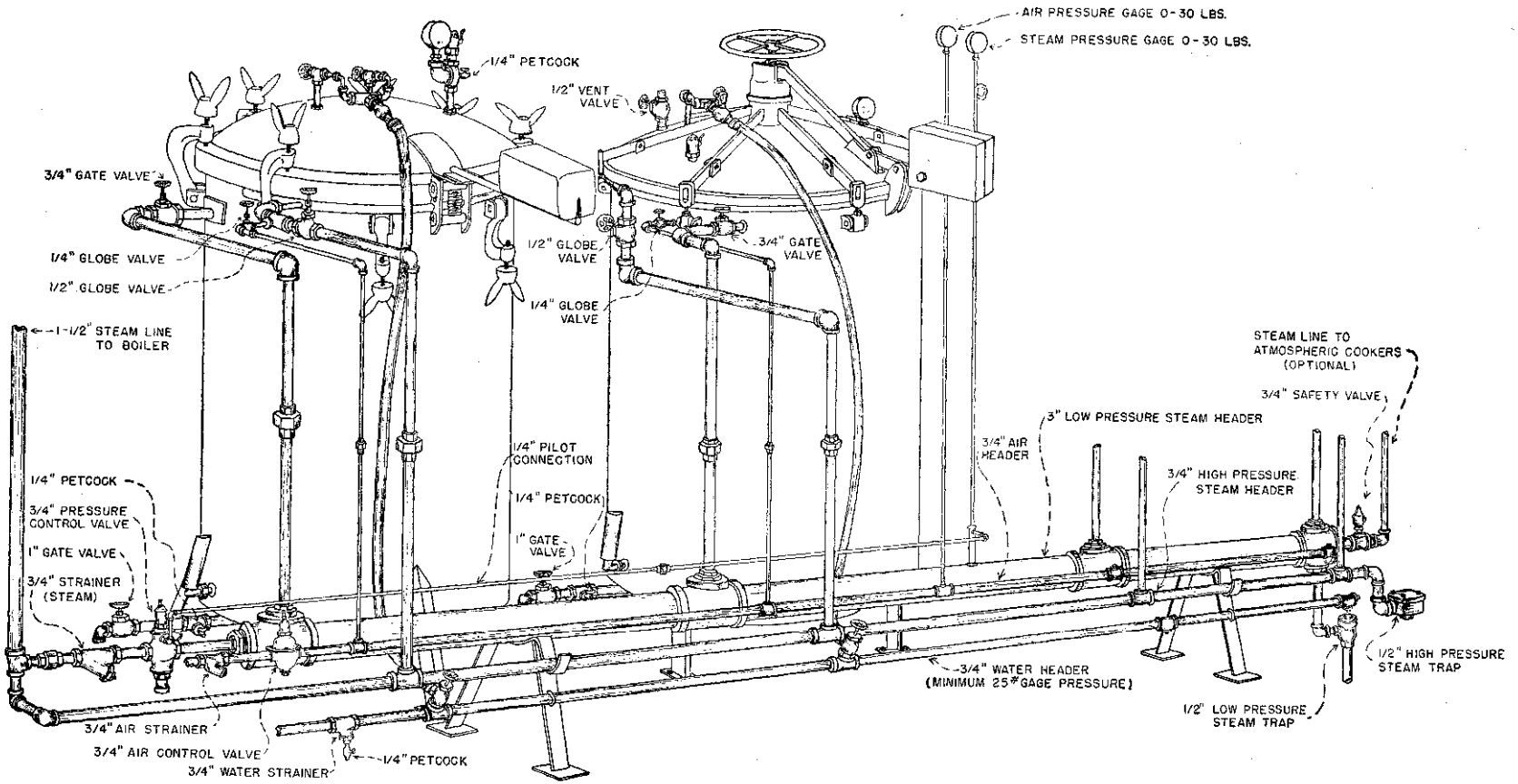

Figure 10.—Piping arrangement to a battery of retorts for processing and pressure-cooling glass jars and small-size tin containers.

Automatic Control Valves

Pressure Control Valve

The proper installation of a back-pressure pilot-operated valve to control the temperature in a battery of retorts is shown in figure 10. The valve is installed on a ¾-inch steam line between the main steam supply line and the 3-inch header. To enable the valve to operate at peak efficiency, the following should be kept in mind: (1) The length of the pipe between the main steam line and the valve, and between the valve and the header, is kept short; (2) a strainer is installed between the main steam line and the valve; (3) the pilot opening on the valve is connected to the header by means of a ¼-inch feeler line to enable the valve to respond quickly to pressure changes in the header; and (4) a steam trap is installed on the high-pressure steam header to remove condensate, thus insuring a good-quality steam.

Prior to processing in the retorts, the steam is turned on and the valve is adjusted to operate at a specified pressure. The pressure required to maintain a temperature of 240° F. in the retort will vary with the altitude of the place where the processing is done (table 3, p. 22). To determine the pressure setting of the valve, note the reading of the pressure gage on the steam header. After this control valve has been properly adjusted it will require very little attention from the operator.

The pilot-operated pressure-control valve is as satisfactory on a single retort as on a battery set-up. On a single retort a smaller valve is used. The valve is installed on the ½-inch steam line leading to the retort at the place indicated in figures 8 and 9. The pilot is connected to the retort shell by means of a ¼-inch feeler line.

Temperature-Control Valve

Figure 11 shows two hook-ups for an air-actuated temperature-control valve. The hook-up shown in figure 11*A* is for the same steam header as that shown in figure 10. The hook-up shown in figure 11*B* is an alternate arrangement on a welded steam header. Either hook-up is satisfactory, but in figure 11*A* the thermal bulb is installed in a plate welded in the end of the header rather than in a screwed fitting. This welded installation eliminates the mass of metal which otherwise would surround the bulb and act as a source of heat, thus delaying the response in the controller when the temperature in the header drops.

In both installations (fig. 11*A* and *B*) a pet cock is provided in the bulb end of the header. It is always kept open sufficiently to provide a continuous flow of steam past the bulb. The control valve is installed on a ¾-inch steam line between the main steam supply line and the low-pressure header. It operates automatically in response to temperature changes within the low-pressure steam header.

An air-actuated temperature-control valve is recommended for use on single retorts, as well as on a battery installation. On a single retort a smaller valve is used. It is installed on the ½-inch steam line leading to the retort at the place indicated in figures 8 and 9. The thermal bulb is installed near the thermometer in the retort shell where it is fully exposed to the steam.

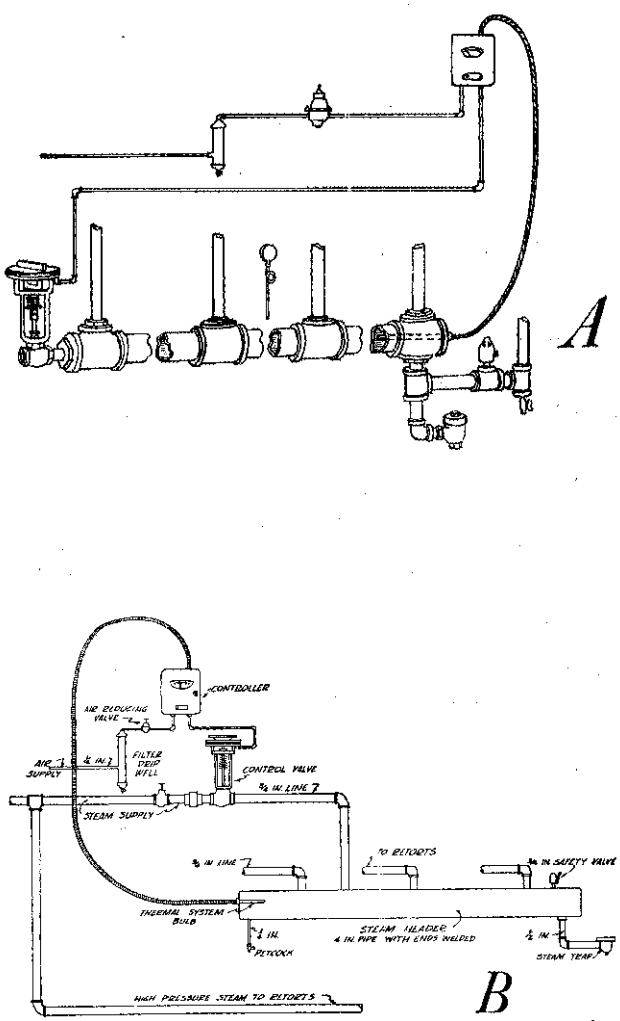

Figure 11.—Temperature-control valve: *A*, On threaded-pipe header; *B*, on welded header.

Air Compressor

For maximum efficiency the air compressor is located as close as practical to the retort line. The compressor may be located in the boiler room or in any convenient place in the canning plant proper but the distance between it and the retorts should not exceed 20 feet. If the compressor is located inside the canning plant, place it above the floor level; out of the way of patrons, and where it will not get wet.

For best results use a ¾-inch air-header pipe between the compressor and the retorts. However, if there is an abundant supply of air a ½-inch pipe will be adequate. Reduce it to ¼ inch before it enters the retort. Install the air-control valve near the retort assembly as shown in figure 10.

Consult a licensed electrician or a local power company representative for information on the size of wire to use for supplying current to the compressor motor. Do not use an ordinary household extension cord. It is not designed to carry enough current to supply a motor of sufficient horsepower to run the compressor.

Atmospheric Cooker

The atmospheric cooker may be operated off of either the high- or low-pressure steam headers. The low-pressure header is preferable because its pressure is uniform and less attention is required by the operator in adjusting the hand valve. Locate the No. 2 cookers close to the regular processing area, if possible, and where there is adequate floor drainage. The No. 3 cookers must be located in the retort line where a hoist is available for lifting the heavy cover and the crate. To provide space for the cover, when the crate is removed, place the cooker at the end of the retort line. To regulate the steam supply to the cooker, install a ½-inch globe valve between the steam-supply pipe and the rubber hose on the cooker as shown in figure 12. Under no circumstances should this valve be installed between the hose and the cooker cover. With such an installation there would be no way of turning off the steam if the hose should break.

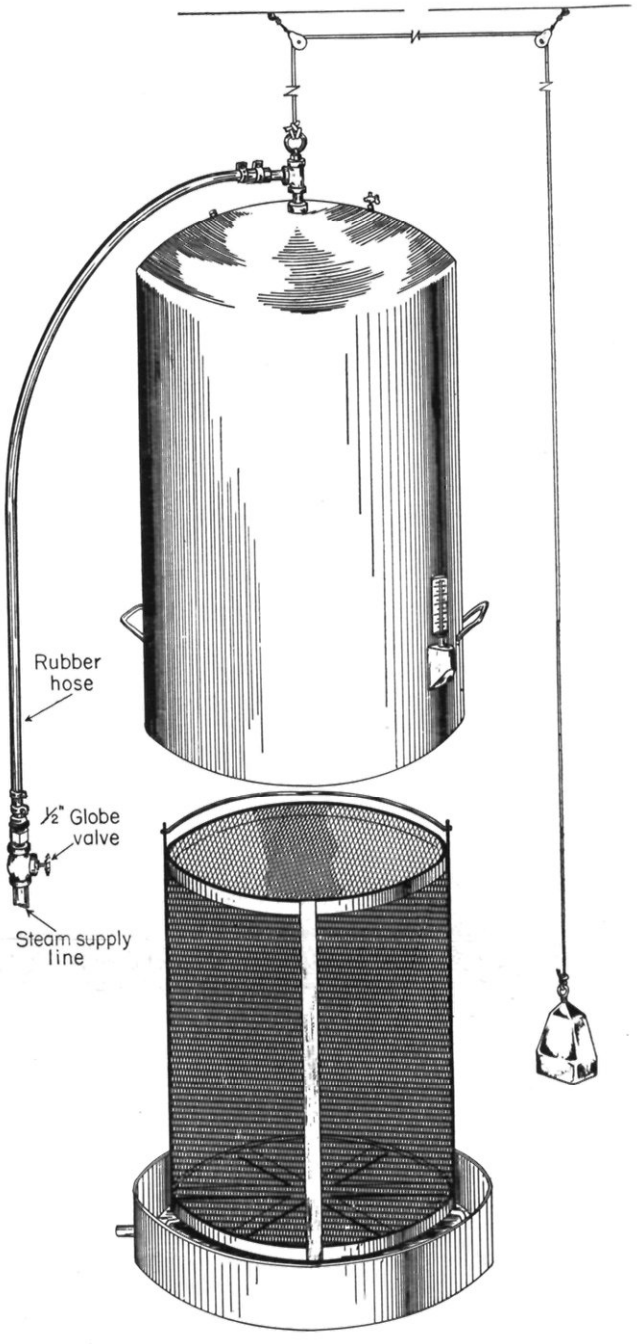

Figure 12.—No. 2 atmospheric cooker installation.

External Cooling Sprays

External cooling sprays used for cooling products processed in a retort are located under the same overhead track as the retorts. Products processed in atmospheric cookers are cooled under the same sprays if the cookers are located in the retort line. If, however, these cookers are placed at some distance from the retort line additional sprays may need to be installed near the cookers.

Regardless of the location of the cooling sprays, the nozzles must be mounted at least 18 inches above the crates so that the jars will get the full benefit of the sprays (fig. 13). Other essential features are: (1) Adequate drainage to carry off the cooling water promptly; (2) slatted wooden platform to keep the crate of jars off of the cold cement floor and to facilitate drainage; (3) baffles to confine the water and prevent splashing. In those canneries where the cooling tank for tin containers must be used for glass jars, a similar platform should be placed in the bottom of the tank and the drain should be kept open to carry off the water promptly. Water should never be allowed to back up on the jars as this may cause them to break.

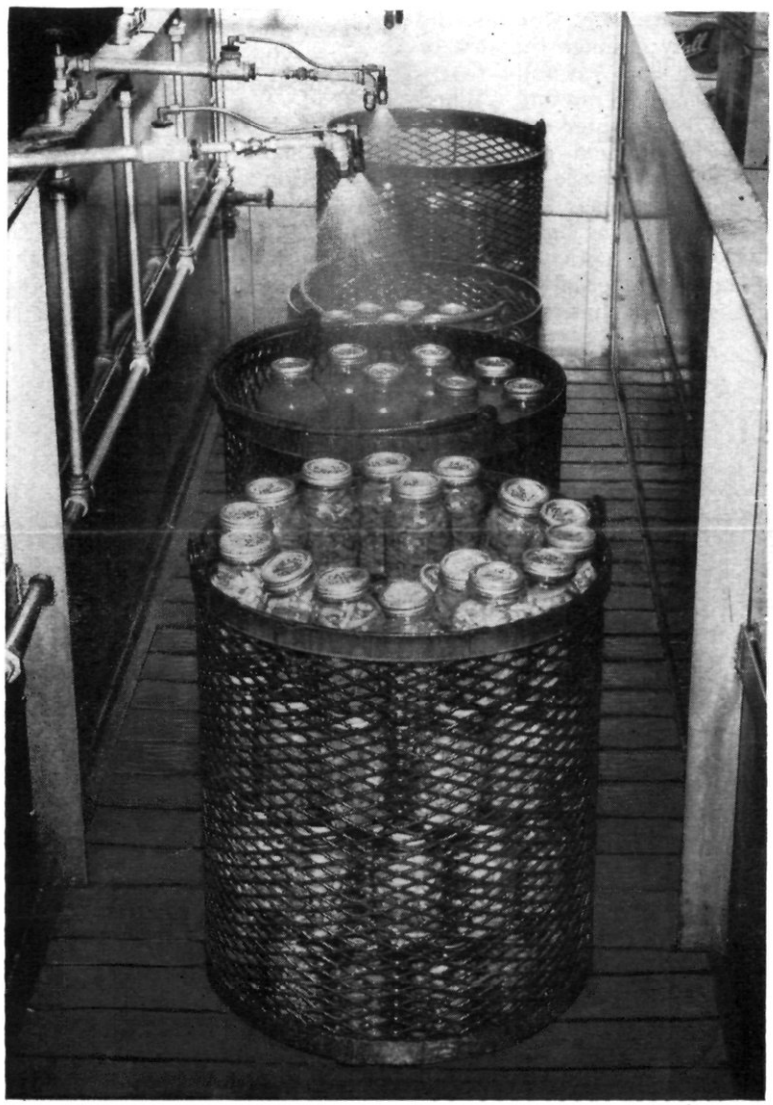

Figure 13.—External cooling sprays being used.

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Spray Nozzles

Spray nozzles in the lid of the retort need to be checked before each cooling operation to see that they are working properly. If the nozzles mounted in the spray ring (fig. 14) get clogged, remove the entire ring before taking the nozzles apart so that they can be worked on conveniently. If the single nozzle in the lid of the retort gets clogged remove the coupling with the nozzle. Otherwise, the core in the nozzle may drop out and get lost. To clean the nozzles, unscrew the end and remove the core with tweezers. Do not attempt to remove the core by pushing a wire or 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 that may be present. When encrusted from the use of hard water remove deposits with dilute hydrochloric acid or radiator cleaner. Wash the end of the nozzle, too, then replace the core in its original position and reassemble the nozzle. After mounting in the lid turn the water on to see that the desired spray pattern is obtained. The nozzles on the external sprays are cleaned in the same manner except that pointed-nose pliers, instead of tweezers, are used to remove the cores from the larger nozzles.

Strainers

The small strainer in the connecting pipe between the water valves and the hose on the retort lid needs to be cleaned at least once a week during the canning season. If difficulty is encountered with rust and sediment in the water supply it may need to be cleaned oftener. To clean the strainer, remove it from the connecting pipe. Wash it under running water or blow the sediment out with compressed air. When all sediment has been removed replace the strainer. The Y-type strainers in the steam and air lines and the T-type strainer in the water line also need to be cleaned occasionally during the canning season.

Air Compressor

To keep the air compressor in good working condition clean the air filter once a week. At the same 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 on the compressor follow the manufacturer's instructions.

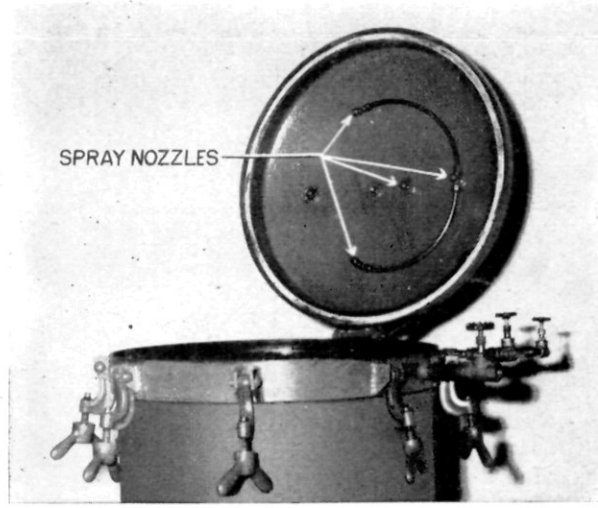

Figure 14.—Location of spray nozzles in retort lid.

PROCEDURE FOR OPERATING THE EQUIPMENT

These procedures for operating retorts, atmospheric cookers, and cooling sprays will assure good results if the basic requirements for installing the equipment have been complied with.

Operating Retort When Processing Under Pressure

Whether processing is to be done in glass jars or in small-size tin containers the procedures for operating the retort are basically the same. Precautions need to be taken, however, when glass jars are used to avoid sudden changes in temperature that might cause breakage. Also to be considered is the possibility of liquid boiling out of the jars because of a sudden drop in pressure. Nevertheless, no difficulty should be encountered with glass jars if the steps given for operating the retort during processing and cooling are carefully followed.

A. Getting retort ready and loading:

1. *Open water valves F and G (fig. 15) to see that nozzles in lid are working properly.*—All nozzles should give off a uniform cone-shaped mistlike spray. If the spray is not uniform the nozzles are clogged and need to be cleaned before processing is started. (For instructions on cleaning nozzles, see p. 14.)

2. *Close water valves F and G after testing sprays.*

3. *Open steam valves A and B to blow out condensate in high- and low-pressure steam lines.*—This should be done for the first load of jars and for subsequent loads if the retort has been allowed to cool. Otherwise the condensate coming in contact with the jars may cause breakage.

4. *As soon as steam flows freely close valves A and B.*

5. *Open wide the drain valve C and pet cock D in drain line.*—It is essential to drain water from retort before loading.

6. *Lift crate of filled jars into retort; close and tighten retort lid.*

7. *Close pet cock or vent valve on lid of retort.*

B. Venting retort and raising temperature:

1. *Check to see that drain valve C and pet cock D in drain line are wide open.*—This is essential for rapid removal of air and condensate during initial venting period.

2. *Open steam valve A to high-pressure line gradually and to the extent necessary to bring retort up to 212° F. in 10 to 15 minutes.* The extent to which the valve is opened will depend on the steam pressure in the line. If the valve is opened too quickly breakage may occur.

3. *When retort thermometer registers 212° F. and steam flows from drain under positive pressure, close drain valve C. Leave pet cock D wide open.*—If there is any obstruction in the pet cock, slightly open drain valve C as some venting from the bottom of the retort is essential throughout the come-up and processing periods. During the come-up period careful attention is required to see that pressure in the retort does not exceed by more than 1 or 2 pounds the pressure at which processing will be done. Otherwise the safety valve may blow.

4. *When the retort temperature reaches that required for processing (240° F.), or 1° or 2° higher, close high-pressure steam valve A, then open quickly and fully the low-pressure steam valve B.*—It is important to operate these valves in prompt sequence to prevent a lag in steam flow and consequent drop in retort temperature. If, however, a pronounced drop should occur, open the high-pressure steam valve A and close the low-pressure steam valve B to bring the temperature up again. This may require from 3 to 5 minutes. When the processing temperature is reached again switch to the low-pressure steam as indicated above. If difficulty is still encountered in maintaining the required processing temperature too much steam may be venting from the bottom of the retort or the installation of the low-pressure steam line may be faulty.

C. Processing at constant temperature:

1. *When the required processing temperature of 240° F. is reached and the temperature and pressure readings are in agreement, start counting the processing time.*

2. *Operate the retort at the required temperature for the full time specified in the processing instructions.*

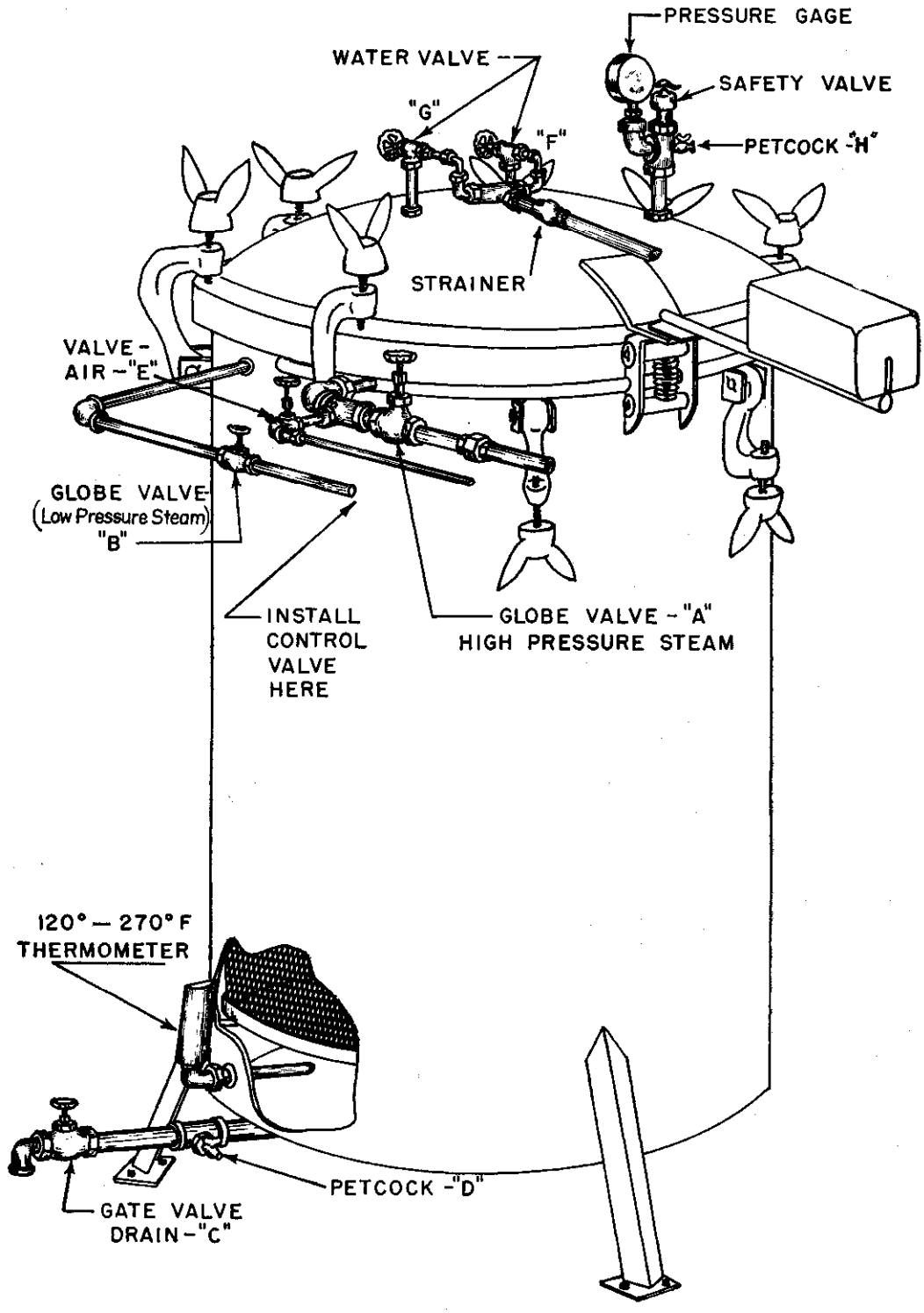

Figure 15.—Retort showing valves used during operation.

Operating Retort When Cooling Under Pressure

A. Maintaining pressure:

1. *As soon as processing is completed close pet cock D in drain line.*

2. *Close low-pressure steam valve B.*

3. *Open air valve E to maintain retort pressure at 1 or 2 pounds above processing pressure.*

NOTE:—In changing from steam to air to maintain pressure in retort, care must be taken to avoid a drop in pressure of more than 2 pounds. Otherwise liquid will boil out of the jars. If the above steps are carried out in prompt sequence, however, there will be no appreciable drop in retort pressure.

B. Bringing temperature down:

1. *Open water valve F to single cooling spray in lid quickly and fully to get a fine mistlike spray.*—If turned on slowly water droplets will be too large and, on contact with hot jars, may cause breakage.

2. *When retort temperature has dropped to 190° F. as indicated by retort thermometer, open water valve G to multiple cooling sprays quickly and fully to speed up cooling.*—Products with a short process time will cool faster than those with a long process time. In any case when the temperature of the retort is 190° F. the jars will be sufficiently cool to withstand the shock of the additional cooling water.

3. *Continue cooling with all sprays wide open in order to reduce the temperature of the jars to a point where they may be safely removed from the retort.*—Fast-cooling products will be cool enough when the retort temperature is down to 140° F. For slow-cooling products such as cream-style corn, pumpkin, spinach, and meats it will be necessary to continue cooling until the retort temperature is down to 120°. Jars not sufficiently cooled as directed sometimes explode on release of retort pressure.

C. Bringing pressure down:

1. *When the required cooling temperature is attained, close air valve E.*

2. *Open pet cock D and drain valve C and allow pressure in retort to drop to 0 pounds.*

3. *Close water valves F and G.*

4. *Open pet cock or vent valve in lid of retort to release any pressure that may be left in the retort and to allow the water to drain out freely.*

D. Unloading retort:

1. *Open retort lid and carefully transfer crate of jars to external cooling sprays.*

Cooling Under External Sprays

When starting to cool jars under external sprays, care will need to be taken to avoid breakage from shock even though the jars are partially cooled in the retort. This is necessary because the heat at the center of the jars will have moved outward and reheated the jar surface. To minimize the change in jar temperature, cooling should be carried out *promptly* as follows:

1. *Open valve to the No. 1 cooling spray quickly and fully to get a fine mistlike spray.* (Fig. 16.)

2. *After 1 minute of cooling under the No. 1 spray open the valve to No. 5 cooling spray.*

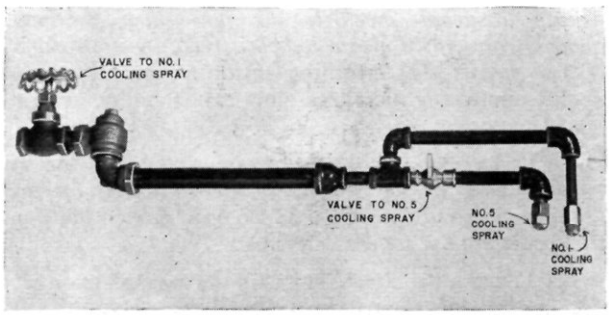

Figure 16.—External cooling sprays.

3. *Continue cooling with both valves wide open until the temperature of the jar contents is about 100° F.* This can be determined by shaking the jar and holding it against the bare arm. It should feel just slightly warm.

4. *When jars have cooled sufficiently place them on storage shelves, as described on page 21, until completely cold.*

Operating Atmospheric Cooker

These procedures for operating the atmospheric cooker (fig. 12, p. 12) are intended for glass jars but they may also be used for tin containers. When processing in tin, the precautions necessary to prevent thermal shock to glass jars need not be taken.

A. Getting cooker ready:

1. *Fill base pan with water.*—This may not be necessary after the first loading of the day as the condensate formed during processing will usually keep water level up to the overflow.

2. *Open steam valve to blow out condensate in steam line.*—This should be done for the first load of jars and for subsequent loads if the cooker is not being used continuously. Otherwise condensate coming in contact with jars may cause breakage.

3. *As soon as steam flows freely, close valve.*

4. *Close pet cock on cover.*

B. Loading cooker:

1. *Place loaded crate of jars on center of support in base pan.*

2. *Lower cover into place over cooker crate with bottom of cover centered on projecting legs of crate support.*—This is important to assure good steam distribution in the cooker and to have as uniform venting as possible around the bottom of the cover.

C. Raising and maintaining temperature:

1. *Open steam valve—slowly for the first half minute to avoid shock to the jars—then continue opening valve until steam bubbles freely through water in base pan.*—This bubbling action at the beginning of the operation indicates that air is being vented from the cooker.

2. *When the required processing temperature is reached (212° F. at sea level), as indicated on the thermometer, and the water in the base pan is boiling, start counting the processing time.*

3. *Throttle the steam so that only a small quantity escapes through the water seal.*—This is important not only to prevent waste of steam after the cooker is up to temperature but to avoid vigorous splattering of hot water from base pan that may cause serious burns.

4. *Operate the cooker at the required temperature for the time specified in the processing instructions.*

D. Unloading cooker:

1. *As soon as processing is completed close steam valve.*

2. *Open pet cock on cover.*—This will prevent a vacuum from forming in the cooker when the steam is turned off.

3. *Lift cover of cooker and carefully transfer crate of jars to external cooling sprays.*

4. *Cool jars promptly under external sprays in accordance with instructions given on page 17.*

Operating Retort at 212° to 216° F.

The retorts described herein for processing low acid foods at 240° F. may also be used for processing acid foods in steam at 212° to 216° as follows:

A. Getting retort ready and loading:

1. *Open water valves F and G (fig. 15) to see that nozzles in lid are working properly.*—All nozzles should give off a uniform cone-shaped mistlike spray. If the spray is not uniform the nozzles are clogged and need to be cleaned before processing is started. (For instructions on cleaning nozzles, see p. 14.)

2. *Close water valves F and G after testing sprays.*

3. *Open steam valves A and B to blow out condensate in high- and low-pressure steam lines.*—This should be done for the first load of jars and for subsequent loads if the retort has been allowed to cool. Otherwise the condensate, coming in contact with the jars, may cause breakage.

4. *As soon as steam flows freely, close valves A and B.*

5. *Open wide drain valve C and pet cock D in drain line.*

6. *Lift crate of filled jars into retort; close and tighten retort lid.*

7. *Close pet cock or vent valve on lid of retort.*

B. Venting retort and raising temperature:

1. *Open steam valve A on high-pressure steam line.*—Open valve slowly at first to avoid shock to the jars.

2. *When the retort thermometer registers 212° F. and steam flows freely through the drain, open low-pressure steam valve B and close high-pressure steam valve A.*

3. *Partially close drain valve C and adjust steam valve B to maintain a temperature of 212° to 216° F.* The slight pressure required to obtain a temperature of 216°—approximately 2 pounds at sea level—will assure good steam distribution in the retort.

C. Processing at constant temperature:

1. *When retort temperature is at 216° F. start counting the processing time.*

2. *Process for the full time specified for 212° in the processing instructions.*

D. Cooling in retort and unloading:

1. *As soon as processing is completed close steam valve B and open pet cock or vent valve in the lid of retort.*

2. *Open water valve F to single cooling spray in lid, quickly and fully, to get a fine mistlike spray.*—If turned on slowly water droplets will be too large and, on contact with hot jars, may cause breakage.

3. *After 1 minute of cooling under the single spray, open water valve G to multiple cooling sprays, quickly and fully, to speed up cooling.*

4. *Complete cooling in the retort or open retort lid and transfer crate of jars to external cooling sprays for final cooling.* (See instructions given on p. 17.)

Selecting Jars and Closures

Use standard mason jars designed for home canning when processing by the methods described herein. It makes no difference whether they are regular or wide-mouthed but they should be of a type that can be sealed with two-piece metal closures (fig. 17). This is the only type closure that is entirely satisfactory. It permits the jar to vent during the processing period even though the band is screwed down firmly and it is self-sealing. Being of metal the lid helps to absorb the initial shock to the jar when the cold water sprays are turned on for cooling. The lids of the two-piece metal closures must be new. The screw bands may be reused if they will screw down evenly. Carefully examine all jars, whether new or previously used, for defects such as cracks, chips, uneven sealing surfaces, rough edges on rims, or rims that are not perfectly round. Pay particular attention to the tops of the jars. Even the smallest defects that are difficult to see may cause a poor seal. Feel the tops of the jars with the fingers and look through the jars while holding them up to the light.

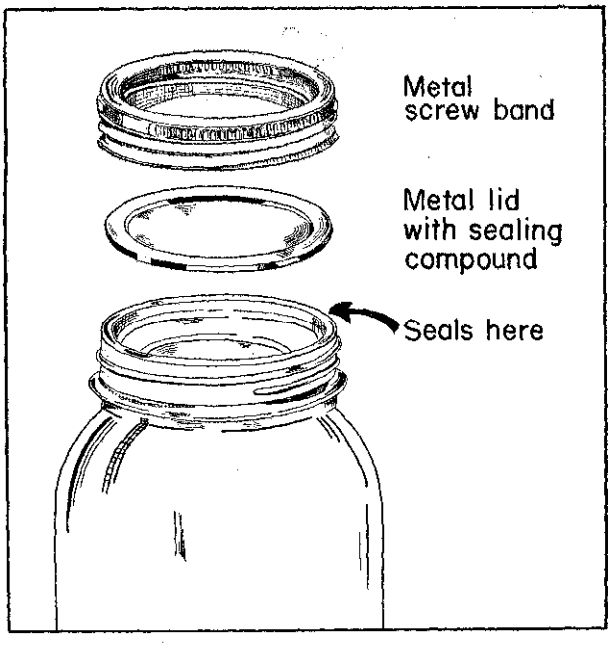

Figure 17.—Standard mason jar with two-piece metal closure.

The size of jars that may be used will vary with the product. Fruits, tomatoes, and other acid foods may be canned in pint, quart, or 2-quart jars. Use only pint and quart sizes, however, for low-acid vegetables and meats. These are the only sizes for which processing times are available. The processing instructions specify the sizes that may be used for each product.

Do not use glass jars that are not intended for canning, such as coffee or mayonnaise jars. These odd jars create problems in stacking and are quite likely to break during processing or cooling. Old style mason jars with flat bottoms and straight sides also create problems. These jars, because of their shape, are known to break readily when used for processing by the methods given herein.

If the proper jars are used and the methods given for handling and processing them are carefully followed, breakage should not exceed 3 jars per thousand.

Estimating Number of Jars Needed

The number of jars needed for canning a given quantity of fruits, vegetables, meats, or poultry may be estimated from tables 1 and 2.

TABLE 1.—*Approximate number of jars required for measured quantities of produce*

Produce	Weight per bushel [1]	Pint jars	Quart jars	2-quart jars
	Pounds	*Number*	*Number*	*Number*
Apples	48	36	18	9
Apricots	48	42	21	10
Asparagus	45	22	11	----------
Beans, green lima (in pods)	32	14	7	----------
Beans, green and wax	30	35	17	----------
Beets (without tops)	52	37	18	----------
Berries	[2] 36	30	15	8
Carrots (without tops)	50	36	18	----------
Cherries	56	53	26	13
Corn, sweet (in husks)	35	17	8	----------
Okra	26	34	17	----------
Peaches	48	44	22	11
Pears	50	45	23	12
Peas, green (in pods)	30	14	7	----------
Plums	56	50	25	13
Spinach	18	15	7	----------
Squash (summer)	40	36	18	----------
Sweetpotatoes	55	40	20	----------
Tomatoes	56	38	19	10

[1] Legal weight of a bushel of produce varies in different States. These are average weights.
[2] 24-quart crate.

TABLE 2.—*Approximate quantities of beef, pork, or chicken required to fill jars of specified sizes*

Meat	Quantity required to fill a—	
	Pint jar	Quart jar
	Pounds	*Pounds*
Beef, round (untrimmed)	1¾ to 2	3 to 3½
Beef, rump (untrimmed)	3 to 3⅓	5 to 5½
Chicken (dressed, undrawn) to be canned with bone	2¾ to 3⅓	4½ to 5½
Chicken (dressed, undrawn) to be canned without bone	4¼ to 4¾	7 to 8
Pork loin (untrimmed)	3 to 3⅓	5 to 5½

Washing and Tempering Jars

To get jars ready for canning, rinse new ones thoroughly in warm water. Wash those that have previously been used, in hot soapy water, then rinse. Wash the screw bands, too, if they have been used.

The metal lids with sealing compound do not need any special preparation. They may be taken directly from the package and placed on the jars at the time of sealing unless the manufacturer's directions specify otherwise.

To avoid breakage when filling jars with hot products, temper them by placing them in a steam box or by dipping them in hot water just before filling. Another method of tempering jars is to start with a small quantity of the hot product and slosh it around in the jars.

Pointers on Filling Jars

For products that are packed in a liquid medium (sirup or water) put from 1½ to 2 inches of liquid in the jar before packing the product. As the product is added, the liquid will rise in the jar and force the air out, thus eliminating the need for bubbling jars. When the product is packed to the head space specified in the processing instructions, add just enough liquid to cover the product. Be sure the liquid is boiling hot. The hotter products are at the time the process is started the better.

With all products some head space should be left in the jars. The head space is the distance between the top of the product and the top of the jar. It will vary from ¼ inch to 1 inch, depending upon the product. The head space is necessary to allow for the expansion of the product and the liquid during processing. If the jars are filled too full, small particles of food may get between the top of the jar and the lid while the jar is venting and prevent a good seal.

Sealing Jars

Seal jars promptly after filling as follows:

1. Check to see that there are no food particles on top to prevent a good seal.

2. Put lid on with sealing compound next to the glass.

3. Screw metal band down so that it is even all the way around. Screw it firmly, using the fingers, not the palm of the hand (fig. 18). Overtightening of the bands may prevent proper venting of the jars during processing.

Warning:—These two-piece closures are self-sealing. Do not tighten them further when removing jars from the processing crate. Any attempt to do so may break the seal.

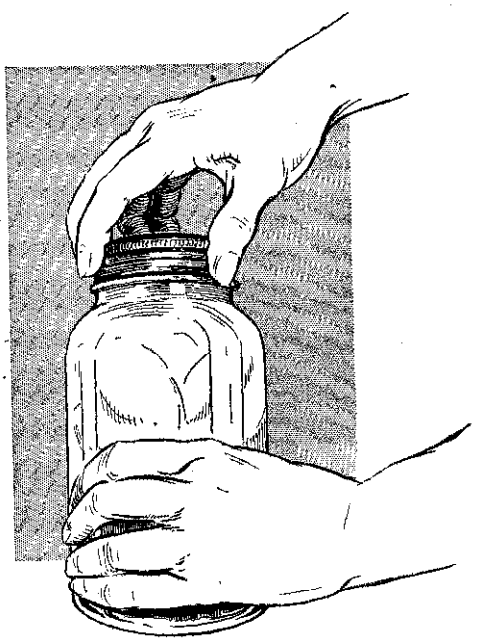

Figure 18.—Tightening screw bands.

Stacking Jars in Processing Crate

To properly load a retort or atmospheric cooker crate, stack the jars upright and stagger them, as shown in figure 19. This arrangement will assure good circulation of steam and increase the efficiency of the cooling process. It will also facilitate the removal of air from the retort or cooker during venting. When processing is to be done in a retort, adjust the load in the crate so that when the lid is closed there will be a space of 6 to 8 inches between the jar tops and the spray nozzles in the retort lid. This is necessary to assure even distribution of the water on the jars during cooling.

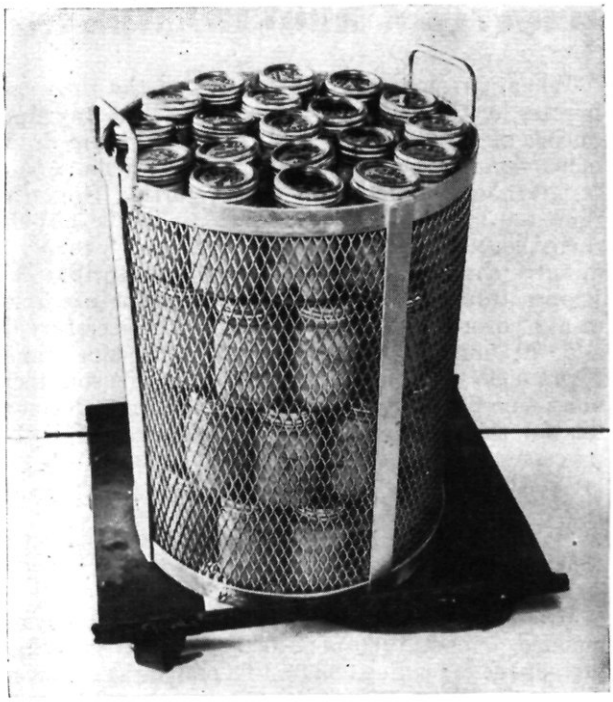

Figure 19.—Jars properly stacked in processing crate.

Air-Cooling Jars on Shelves

After the processed products are spray-cooled, remove the jars from the crate and place them on shelves for further cooling as shown in figure 20. Jars of fruit are placed on their sides to distribute the sirup evenly over the fruit. This helps to prevent fruit from floating. When the jars are completely cool, remove the screw bands so that they will be in good condition for subsequent canning.

Testing Jars for Proper Seal

Check jars to see that they are sealed before releasing them to patrons. A metal lid is sealed 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 with a spoon. A dull note, however, does not always indicate that the jar is not sealed. The vacuum may be too low or the product may be too close to the top of the jar. When in doubt about a seal, turn the jar partly over in the hands to see whether it leaks, or lift the jar with the fingers on the edge of the lid to see whether the seal holds. If the jar is not sealed, the food should be recanned or used immediately. If to be recanned, empty the jar, heat the food, pack, and process as if the product were fresh. Do not use the same jar again unless it is free from defects. If there are no cracks or chips, examine the lid to see whether the impression in the sealing compound is uniform. If not, this would indicate that the sealing surface of the jar was uneven or that the band was not properly applied. In recanning the product, be sure to use a new metal lid and a screw band that fits evenly all the way around.

Figure 20.—Shelves for temporary storage of jars.

PROCESSING TIME AND TEMPERATURE REQUIREMENTS

The processing times given in this publication for both acid and low-acid foods, canned in glass jars, take into consideration the fact that the jars are spray-cooled at the end of the process. In general, the processing times are longer than those recommended for products canned in glass jars that are air-cooled. This is because the cooking is stopped promptly at the end of the process by the cold water sprays whereas with air-cooled products cooking continues during the initial cooling period and this cooking is considered part of the process. However, in determining the processing times, other factors than the method of cooling, such as the style of pack and whether the products were packed hot or cold, were also taken into consideration. For this reason the instructions given for each product should be carefully followed.

Requirements for Acid Foods

The processing times for fruits, tomatoes, and other acid foods are based on a temperature of 212° F. —the temperature at which water boils and steam condenses at sea level. This temperature is sufficient to kill all actively growing bacteria and yeasts in the time specified for each product and the acid in the food prevents the growth of any heat-resistant spores that may be present. The times are also based on the assumption that the jars will be spray-cooled at the end of the process, whether processing is done in a boiling water bath, in an atmospheric cooker, or in a retort at 212° to 216° F.

Acid foods processed by any one of these methods may be air-cooled instead of spray-cooled at the end of the process. If this is done, however, the processing times for all products except cold-packed tomatoes and fruit juices should be shortened by 5 minutes. The processing times for cold-packed tomatoes should be shortened 10 minutes, but the time for fruit juices should not be shortened at all.

Requirements for Low-Acid Foods

The processing times given for low-acid vegetables and meats are based on a temperature of 240° F., the minimum temperature necessary for destroying heat-resistant spores of bacteria in a reasonable length of time. To attain this temperature, processing must be done in a pressure vessel such as the retorts described on page 1.

From the time the steam is turned on in the retort until the products are processed and spray-cooled, follow carefully the instructions given for operating the retort. Be sure to vent the retort adequately to remove all air before the process is started. An air-steam mixture in the retort will cause a nonuniform heat distribution resulting in low-temperature regions and possible underprocessing. Timing of the process should not begin even though the proper temperature is indicated until temperature and pressure instruments on the retort give corresponding readings (table 3).

When agreement is reached, record the time and process for the full period required. If at any time during the processing period the temperature drops more than 5° below 240° F. the products should be given a complete new cook, starting from the time the retort is brought back to 240°. Should there be a temperature drop of from 1° to 5°, 2 minutes should be added for each minute that the temperature registered below 240°. For example, in a 4° drop for 10 minutes it would be necessary to add 20 minutes to the normal processing time. If products must be reprocessed for any reason, they must be reprocessed promptly in clean jars with new lids for the full time given for that product in the processing instructions.

Altitude Adjustment

When processing low-acid foods at the recommended temperature of 240° F. the corresponding pressure gage reading will be 10.3 pounds at sea level. To attain this temperature at altitudes above sea level the pressure must be increased approximately ½ pound for each 1,000 feet as shown in table 3.

TABLE 3.—*Gage pressure corresponding to processing temperature of 240° F. at specified altitudes*

Altitude (feet above sea level)	Gage pressure	Altitude (feet above sea level)	Gage pressure
	Pounds		*Pounds*
0	10.3	3,000	11.7
500	10.5	4,000	12.2
1,000	10.8	5,000	12.7
2,000	11.3	6,000	13.1

When processing acid foods at altitudes above sea level the processing times will need to be increased to compensate for the lower temperature at which water boils and steam condenses. For example, at 2,000 feet above sea level the temperature of boiling water or condensing steam is 208° F. instead of the sea level temperature of 212° on which the processing times are based. Therefore, acid foods processed at 208° must be processed for a longer time than that given in the timetable in order to prevent spoilage. For each 1,000 feet above sea level, 1 minute will need to be added to the processing time if the time given for the product is 20 minutes or less and 2 minutes for each 1,000 feet if the processing time is more than 20 minutes. If a retort is used for processing acid foods at 212° to 216° and the pressure is increased sufficiently to maintain the temperature at altitudes above sea level, it will not be necessary to increase the processing times.

PROCEDURE FOR CANNING ACID FOODS

The procedures given for preparing and processing fruits, tomatoes, and other acid foods are briefly outlined in table 4. Some of the products are precooked and packed hot. Others are packed raw and covered with boiling sirup. The method of packing determines, in part, how long the products must be processed. For this reason the instructions should be carefully followed.

TABLE 4.—*Time and temperature for processing fruits, tomatoes, and other acid foods in glass jars that are to be spray-cooled*

Produce	Preparation steps	Time to process at 212° F. at sea level [1]		
		Pint	Quart	2-quart
		Min.	*Min.*	*Min.*
Apple butter	Follow any good formula for making apple butter. Fill boiling hot to within ¼ inch of top of jar. Seal and process immediately.	15	15	15
Apples in sirup	Wash, pare, and core apples. Slice or quarter. Drop into salt water to prevent browning. Drain, then boil 5 minutes in thin sirup or water. Fill boiling hot to within ½ inch of top of jar. Cover with hot sirup or water. Seal and process immediately.	20	25	30
Applesauce	Make applesauce, sweetened or unsweetened. Heat to boiling point, stirring to heat evenly and to prevent sticking. Fill boiling hot to within ¼ inch of top of jar. Seal and process immediately.	15	15	15
Apricots	Wash apricots. Leave skins on or scald, cold dip, and remove skins. Leave apricots whole or cut in half and remove pits. Fill jars to within ½ inch of top. Cover with boiling sirup. Seal and process immediately.	30	35	40
Berries, except strawberries	Wash berries and drain well. Fill jars to within ½ inch of top. Shake while filling for a full pack. Cover with boiling sirup. Seal and process immediately.	15	20	25
Cherries, sour	Wash cherries, chill in ice water, and pit. Fill jars to within ½ inch of top. Shake while filling for a full pack. Cover with boiling sirup or water. Seal and process immediately.	25	30	35
Cherries, sweet	Follow directions for sour cherries. Pits may be left in.	25	30	35
Fruit juices	Wash fruit, remove pits if desired and crush fruit. Heat to simmering. Strain through cloth bag or put through juice extractor. Add sugar, if desired, ½ to 1 cup to 1 gallon of juice. Reheat to to 180° F. Fill to top of jar. Seal and process immediately.	5	5	5
Peaches, in sirup	To can freestone peaches, wash, scald, cold dip, and remove skins. Cut peaches in halves or slices. Remove pits. Drop into salt water to prevent browning. Drain. Fill jars to within ½ inch of top. Cover with boiling sirup. Seal and process immediately. To can clingstones, follow the directions given for freestones but peel peaches by hand or lye peel them.	30	35	40
Peaches, sliced, solid pack	Use soft-ripe peaches. Wash, scald, cold dip, and remove skins. Slice peaches, removing pits. Add ½ cup of sugar per quart of sliced peaches or can them without sugar. Do not add water. Heat peaches slowly to boiling temperature. Stir carefully as needed to heat them evenly. Pack hot into jars to within ½ inch of top. Seal and process immediately.	30	35	40
Pears	To can Bartlett and other mellow pears wash, peel, cut in halves, and core. Drop into salt water to prevent browning. Drain. Fill jars to within ½ inch of top. Cover with boiling sirup. Seal and process immediately. To can sand pears and other varieties that are difficult to mellow follow the directions given for Bartletts but cook them in water or light sirup until tender before filling them into jars, otherwise the processing times will not be adequate.	30	35	40

See footnote at end of table.

TABLE 4.—*Time and temperature for processing fruits, tomatoes, and other acid foods in glass jars that are to be spray-cooled*—Continued

Produce	Preparation steps	Time to process at 212° F. at sea level [1]		
		Pint	Quart	2-quart
		Min.	*Min.*	*Min.*
Plums	Wash plums. Can whole or, if freestone varieties are used, they may be halved and pitted. If whole plums are used press them down closely while packing. Fill jars to within ½ inch of top. Cover with boiling sirup. Seal and process immediately.	25	30	35
Sauerkraut	Heat well-fermented sauerkraut to simmering. Do not boil. Pack hot kraut into jars to within ½ inch of top. Cover with hot kraut juice or weak brine. Seal and process immediately.	20	25	30
Tomatoes, cold pack	Use only perfect, ripe tomatoes. Wash, scald, cold dip, and remove skins. Cut core out. Pack whole or quartered. Press gently to fill space in jars. Fill jars to within ½ inch of top. Add salt, if desired, but do not add water. Seal and process immediately.	45	55	65
Tomatoes, hot pack	Peel, core, and quarter tomatoes as for packing raw. Place in open kettle and bring to boil, cooking the tomatoes until all are hot. Stir frequently so that tomatoes will heat evenly. Fill *boiling hot* to within ¼ inch of top of jar. Add salt, if desired. Seal and process immediately.	15	15	15
Tomato juice	Use ripe, juicy tomatoes. Wash, remove stem ends, cut into pieces. Simmer until softened, stirring often. Put through strainer or juice extractor. Add 1 teaspoon salt to each quart juice. Reheat at once just to boiling. Fill boiling hot juice to within ¼ inch of top of jar. Seal and process immediately.	15	15	15

[1] When using an atmospheric cooker or boiling water-bath, these times will be adequate at sea level only. At altitudes above sea level, add 1 minute for each 1,000 feet when the processing time is 20 minutes or less and 2 minutes for each 1,000 feet when the processing time is longer than 20 minutes. (See statement on altitude adjustment page 22.)

TABLE 5.—*Summary of time and temperature for processing fruits, tomatoes, and other acid foods in glass jars that are to be spray-cooled*

Produce	Time to process at 212° F. at sea level [1]		
	Pint	Quart	2-quart
	Minutes	*Minutes*	*Minutes*
Apple butter	15	15	15
Apples in sirup	20	25	30
Applesauce	15	15	15
Apricots	30	35	40
Berries (except strawberries)	15	20	25
Cherries, sour	25	30	35
Cherries, sweet	25	30	35
Fruit juices	5	5	5
Peaches in sirup	30	35	40
Peaches, sliced, solid pack	30	35	40
Pears	30	35	40
Plums	25	30	35
Sauerkraut	20	25	30
Tomatoes, cold pack	45	55	65
Tomatoes, hot pack	15	15	15
Tomato juice	15	15	15

[1] When using an atmospheric cooker or boiling water bath these times will be adequate at sea level only. At altitudes above sea level, add 1 minute for each 1,000 feet when the processing time is 20 minutes or less, and 2 minutes for each 1,000 feet when the processing time is longer than 20 minutes. (See statement on altitude adjustment page 22.)

PROCEDURE FOR CANNING LOW-ACID VEGETABLES

The procedures for preparing and processing low-acid vegetables are briefly outlined in table 6. If the instructions are carefully followed products packed in liquid will have a closing temperature of at least 140° F. This is the closing temperature on which the processing times are based. It can be readily attained if the blanched or steamed products are not overcooled before filling into the jars and if the water or sirup used to cover the products is at the boiling point. Avoid overfilling the jars as the processing times are based on a fairly loose pack. Spinach and other greens should be filled by weight to avoid overfilling. The processing times for products of heavy consistency such as cream-style corn and strained pumpkin or squash are based on a minimum initial temperature of 160°. The initial temperature is the average temperature of the jar contents at the time the steam is turned on for the process and it is considered part of the process. Therefore, these slow-heating products should not be allowed to cool below a temperature of 160° before processing is started. Otherwise the processing times will not be adequate.

To take the initial temperature of cream-style corn or pumpkin, set aside the first 2 jars that are filled. Place the lids on them but do not screw down the bands. Just before closing the loaded retort and turning on the steam, remove the lids from the jars, stir the contents, and take the temperature. This will give the average temperature of the coldest jars in the retort. If the initial temperature drops below 160° F. it will be necessary to increase the processing time 5 minutes for each 20° below 160°. However, it is preferable to *process a partial load* rather than allow the temperature of the products to drop below that specified.

TABLE 6.—*Time and temperature for processing low-acid vegetables in glass jars that are to be spray-cooled*

Produce	Preparation steps	Time to process at 240° F. (10.3-lb. pressure at sea level)[1]	
		Pint	Quart
		Min.	*Min.*
Asparagus, cuts	Wash asparagus. Cut off tough ends and the leaf scales if they are large and loose or soil is present underneath them. Wash again. Cut into 1-inch pieces. Blanch. Fill hot to within ½ inch of top of jar. Do not pack too firmly. Add salt. Cover with boiling water. Seal and process immediately.	30	35
Asparagus, spears	Follow directions given for preparing asparagus cuts but leave spears whole. Group them and cut to fit pint jars. Do not use larger size jars. Pack into jars, spear ends up, leaving ½ inch space at top of jar. Add salt. Cover with boiling water. Seal and process immediately.	30	--
Beans, green and wax (cut)	Wash beans. Snip ends, cut into 1-inch pieces. Blanch. Fill hot to within ½ inch of top of jar. Add salt. Cover with boiling water. Seal and process immediately.	25	30
Beans, green lima	Can only young tender beans. Shell; wash. Blanch. Pack hot to within 1 inch of top of jars. Add salt. Cover with boiling water. Seal and process immediately.	45	50
Beets, whole, cubed, quartered, or sliced	Sort for size. Cut off beet tops, leaving an inch of stem. Also leave root. Steam beets at 230° F. (6 lb. pressure) until skins slip. Remove skins and trim. Leave baby beets whole and cube, quarter, or slice larger beets. Pack hot to within ½ inch of top of jar. Add salt. Cover with boiling water. Seal and process immediately.	35	40
Carrots, whole, wedged, cubed, or sliced	Wash carrots. Peel by preferred method. Leave small ones whole. Cut larger ones into wedges, cubes, or slices. Blanch. Pack hot into jars to within ½ inch of top. Add salt. Cover with boiling water. Seal and process immediately.	30	35

See footnote at end of table.

TABLE 6—*Time and temperature for processing low-acid vegetables in glass jars that are to be spray-cooled*—Continued

Produce	Preparation steps	Time to process at 240° F. (10.3-lb. pressure at sea level)[1]	
		Pint	Quart
		Min.	*Min.*
Corn, cream style	Husk corn and remove silk. Wash. Cut corn from cob at about center of kernel and scrape cob. Blend corn with boiling water, using about half as much water as corn. Sugar and salt may be added to taste. Heat to boiling. Pack boiling hot into pint jars to within 1 inch of top. Do not use larger size jars. Seal and process *immediately*. The processing times for cream style corn are based on a minimum initial temperature of 160° F. (See page 25 for statement on initial temperature.)	105	--
Corn, whole kernel	Husk corn, remove silk. Wash. Blanch on the cob in boiling water or steam for 3 to 5 minutes. Cool in cold water and drain. Cut corn from cob at about ⅔ depth of kernel. Do not scrape cob. Wash cut corn on screen to remove small particles of kernels. (Processes for whole-kernel corn may not be adequate if small particles are not removed.) Pack corn *loosely* into jars to within 1 inch of top. Add salt. Cover with boiling water. Seal and process immediately.	60	70
Greens, spinach and others	Pick over and wash greens thoroughly to remove all sand and dirt. Remove tough stems and midribs. Blanch in steam or water until well wilted. Pack hot greens *loosely* to within ½ inch of top of jar. (Maximum drained weight for pints should be 13 oz.; for quarts, 23 oz.) Add salt. Cover with boiling water. Seal and process immediately.	85	105
Mixed vegetables	Combine tender, young vegetables such as cut green or waxed beans, cut asparagus, cut celery, baby lima beans, peas, and carrots. Do not use starchy vegetables such as potatoes or corn as the processing time will not be adequate. Prepare vegetables as for canning separately. Mix in desired proportions. Cover with water and bring to boil. Pack hot into jars to within ½ inch of top. Add salt. Cover with cooking liquid. Seal and process immediately.	45	50
Okra	Can only tender pods. Wash; trim. Cook for 1 minute in boiling water. Cut into 1-inch lengths or leave pods whole. Pack hot to within ½ inch of top of jar. Add salt. Cover with boiling water. Seal and process immediately.	30	35
Peas, green	Shell and wash peas. Blanch. Pack hot to within 1 inch of top of jar. Add salt. Cover with boiling water. Seal and process immediately.	45	50
Pumpkin or squash (strained)	Wash pumpkin or squash. Cut open and remove seeds and fiber. Cut into sections, peel, and steam in a retort at 220° F. (2½ pounds pressure at sea level) until soft. Or steam sections with rind on and scoop out meat. Put through pulper. Heat pulp to boiling, stirring to prevent sticking. Pack hot to within ½ inch of top of jar. Add no liquid or salt. Seal and process *immediately*. The processing time given for pumpkin and squash is based on a minimum initial temperature of 160°. (See page 25 for statement on initial temperature.)	85	125
Summer squash	Wash. Do not peel. Trim ends. Cut squash into ½ inch slices; halve or quarter to make pieces of uniform size. Blanch. Fill hot to within ½ inch of top of jar. Add salt. Cover with boiling water. Seal and process immediately.	35	45
Sweetpotatoes in sirup, whole or cut	Wash sweetpotatoes. Sort for size. Steam in retort at 240° F. (10.3 lb. pressure at sea level) for minimum time necessary to make skins slip, or lye peel them. Can small sweetpotatoes whole. Quarter larger ones. Pack to within 1 inch of top of jar. Guard against packing steamed sweetpotatoes too tightly. Cover with boiling sirup (medium light). Seal and process immediately. WARNING—The processing times given here are not adequate for solid-pack sweetpotatoes.	55	65

[1] At altitides above sea level it takes more than 10.3-pound pressure to attain a temperature of 240° F. (See table 3 for gage pressure readings corresponding to 240° at various altitudes.)

TABLE 7.—*Summary of time and temperature for processing low-acid vegetables in glass jars that are to be spray-cooled*

Produce	Time to process at 240° F. (10.3-lb. pressure at sea level) [1]	
	Pint	Quart
	Minutes	*Minutes*
Asparagus, cuts	30	35
Asparagus, spears	30	
Beans, green and wax, cut	25	30
Beans, green lima	45	50
Beets, whole, cubed, quartered, or sliced	35	40
Carrots, whole, wedged, cubed, or sliced	30	35
Corn, cream style (initial temperature 160° F.)	105	
Corn, whole kernel	60	70
Greens, spinach and others (maximum drained weight pints 13 oz.; quarts, 23 oz.)	85	105
Mixed vegetables (kinds specified on p. 26)	45	50
Okra	30	35
Peas, green	45	50
Pumpkin or squash, strained (initial temperature 160° F.)	85	125
Summer squash	35	45
Sweetpotatoes in sirup, whole or cut	55	65

[1] At altitudes above sea level it takes more than 10.3-pound pressure to attain a temperature of 240° F. (See table 3 for gage pressure readings corresponding to 240° at various altitudes.)

PROCEDURE FOR CANNING MEAT AND POULTRY

The procedures for preparing and processing meats and poultry are briefly outlined in table 8.

The instructions given for roasts, steaks, stew meat, and ground meat may be used for beef, veal, mutton, lamb, pork, and large game animals. Similarly, the instructions given for chicken may be used for duck, goose, guinea, squab, turkey, or small game animals such as rabbit.

Can the meaty pieces of chicken or other poultry, with or without the bone. Use the bony pieces for soup stock. Giblets may be canned also but because of their flavor, should be canned separately.

When canning meat, bone out the carcass and separate the tender from the less tender cuts. Trim the meat to remove tough connective tissue, blood clots, and most of the fat. Cut the large tender pieces to fit into pint or quart jars, with the grain of the meat running lengthwise. Use the less tender cuts and good quality trimmings for stew meat and ground meat. Do not use meat of doubtful freshness or lumps of fat. Use the bones for making soup stock.

Meat and poultry may be canned with or without salt. If they are canned with salt, use a good-grade canners' salt and put it in the jar before packing the meat. For ground meat, however, add the salt to the meat and mix well before grinding.

Roasts, steaks, stew meat, and chicken may be precooked and packed hot or be packed raw and exhausted to 170° F. before sealing. Other meats and soup stock are packed hot. Follow carefully the instructions given for preparing each product. Work fast. Seal and process the jars before they cool to any extent. Otherwise, the processing times will not be adequate.

TABLE 8.—*Time and temperature for processing meats and poultry in glass jars that are to be spray-cooled*

Meats	Preparation steps	Time to process at 240° F. (10.3-lb. pressure at sea level) [1]	
		Pint	Quart
		Min.	*Min.*
Roasts, steaks, and stew meat	*Hot Pack*—Precook meat slowly in just enough water to prevent sticking. Cook until medium done or until meat has a pink, rather than red, color at center. Pack hot into jars to within 1 inch of top. Cover with hot meat juice or broth leaving 1-inch head space in jars. Seal and process immediately.	90	105
	Raw Pack—Pack pieces of raw meat firmly into jars to within 1 inch of top. Do not add liquid. Exhaust for 75 minutes or until center-jar temperature is 170° F. Press meat down into jars and add boiling broth, if needed, to cover the meat, leaving 1 inch head space. Seal and process immediately.	90	105
Ground meat, cakes	Form ground meat into fairly thin cakes to fit glass jars. Precook cakes until red color at center is almost gone. Pack hot into jars to within 1 inch of top. Add hot broth or meat drippings from which fat has been removed to completely cover the meat. Shake jars to distribute liquid. Add more liquid, if necessary, leaving 1 inch head space in top of jars. Seal and process immediately. WARNING—These processing times will not be adequate for raw, solid-pack ground meat.	90	105
Sausage, cakes or links.	Use any tested sausage recipe but omit sage and go easy with other spices, onion, and garlic because flavors change with processing and storing. Shape sausage meat into cakes or fill into sausage casings and tie in links to fit the length of jar, allowing about 1 inch head space. Precook cakes or links until pink color at center is almost gone. Pack hot into jars to within 1 inch of top—cakes in layers; links on end. Cover with boiling water or drippings from which fat has been removed. Shake jars to distribute the liquid. Add more liquid if necessary, leaving 1-inch head space in top of jar. Seal and process immediately.	90	105
Heart and tongue	Prepare heart and tongue separately for canning. To prepare heart, wash thoroughly. Remove thick connective tissues and cut into pieces. Simmer until medium done in just enough water to cover. Pack hot into jars to within 1 inch of top. Cover with boiling broth leaving 1-inch head space. Seal and process immediately. To prepare tongue, wash thoroughly. Cover with boiling water and simmer until skin can be removed. Then cut into pieces and proceed as for heart.	90	105
Corned beef	Wash corned beef. Cut into pieces suitable for packing in jars. Cover meat with cold water and bring to a boil. If broth tastes very salty, drain and cover with fresh water and parboil again. Pack hot meat into jars to within 1 inch of top. Cover with hot broth leaving 1 inch head space. Seal jars and process immediately.	90	105
Chicken with bone	*Hot Pack*—Use meaty pieces. Bone breast, saw drumsticks off short, if desired. Leave bone in second joint. Precook chicken until medium done in just enough water to cover meat. Pack hot into jars to within 1 inch of top. Pack second joints and drumsticks so that skin is next to glass. Fit breasts and smaller pieces into center. Cover with boiling broth skimmed of fat, leaving 1-inch head space. Seal jars and process immediately.	80	90
	Raw Pack—Pack pieces of raw chicken firmly into jars to within 1 inch of top. Pack second joints and drumsticks so that skin is next to glass. Fit breasts and smaller pieces into center. Do not add liquids. Exhaust for 75 minutes or until center-jar temperature is 170° F. Press chicken down into jars. Add boiling broth, skimmed of fat, if needed to cover the meat, leaving 1 inch head space. Seal jars and process immediately.	80	90
Chicken without bone	Remove bone from meaty pieces of chicken either while raw or after precooking. Then follow directions given for canning chicken with bone by hot pack or raw pack method but process for the longer time required. Chicken without bone is more solidly packed than chicken with bone and therefore must be processed longer.	90	105

See footnote at end of table.

TABLE 8—*Time and temperature for processing meats and poultry in glass jars that are to be spray-cooled*—Continued

Meats	Preparation steps	Time to process at 240° F. (10.3-lb. pressure at sea level) [1]	
		Pint	Quart
		Min.	*Min.*
Chicken giblets	Because of their flavor it is best to can livers alone. Gizzards and hearts may be canned together. Cook the giblets in broth made from bony pieces of chicken or in water until medium done. Pack hot into jars to within 1 inch of top. Cover with hot broth skimmed of fat leaving 1 inch head space. Seal jars and process immediately.	90	105
Soup stock	Use bony pieces of chicken or other bony pieces of meat. Saw large bones, such as beef bones, in suitable lengths to fit into steam-jacketed kettle or stock pot. Partially cover with lightly salted water and cook until meat is tender. Remove pieces of bone and trim off meat. Skim fat off broth. Add meat to broth and heat mixture to boiling. Fill hot into jars to within 1 inch of top, stirring the mixture each time a jar is filled. Seal jars and process immediately.	45	50

[1] At altitudes above sea level it takes more than 10.3-pound pressure to attain a temperature of 240° F. (See table 3 for gage pressure readings corresponding to 240° at various altitudes.)

TABLE 9.—*Summary of time and temperature for processing meats and poultry in glass jars that are to be spray-cooled*

Meats	Time to process at 240° F. (10.3-lb. pressure at sea level) [1]	
	Pint	Quart
	Minutes	*Minutes*
Roasts, steaks, and stew meat:		
Hot pack	90	105
Raw pack (exhaust to 170° F.)	90	105
Ground meat, cakes	90	105
Sausage, cakes or links	90	105
Heart and tongue	90	105
Corned beef	90	105
Chicken with bone:		
Hot pack	80	90
Raw pack (exhaust to 170° F.)	80	90
Chicken without bone:		
Hot pack	90	105
Raw pack (exhaust to 170° F.)	90	105
Chicken giblets	90	105
Soup stock	45	50

[1] At altitudes above sea level it takes more than 10.3-pound pressure to attain a temperature of 240° F. (See table 3 for gage pressure readings corresponding to 240° at various altitudes.)

☆U. S. GOVERNMENT PRINTING OFFICE: 1952—212370