restaurants for the sauces, relishes, etc., that give zest and finish to the dishes. The contents of the can, with the minimum of preparation are, as a rule, ready for consumption, but through additional treatment may become more appetizing and inviting.

The brief outline of what are recognized as proper sanitary measures for canneries is incorporated as it will serve as a guide when visiting any food producing establishment.

MANUFACTURING CANNED FOODS

HISTORICAL

Among the military measures enacted by the French government near the end of the eighteenth century, was the offering of a bounty of 12,000 francs for an improved method of preserving foods. The object was to secure better quality and to reduce the loss in waste and spoilage in foods used in military and naval stores. This bounty seemed generous at the time and in fact was sufficient to attract the attention of some capable men. Nicholas Appert, an expert confectioner, brewer, distiller, and chef was among those who began experimenting; he worked from 1795 until 1804 before he attained his first success which consisted in heating the product and then hermetically sealing the container. He continued his efforts, using many different substances, and so perfected the art that in 1810 he published the results. He was awarded the prize and almost universally honored as the discoverer of the art of canning. Appert did his work so thoroughly, and the method was so simple that others began using it as early as 1815, and it was put into commercial practice in 1820. Although conceived primarily as a war measure, the possibilities and advantages of having food preserved in such a wholesome, palatable manner attracted attention immediately to its use in the household. The use of such foods has increased until the value of the product in this country alone amounts to about $250,000,000 annually.

Canning is the art of preserving a food through sterilization by heat, and maintaining it in that condition in a hermetically sealed container. In its highest development it is an attempt to maintain the food in as nearly the natural condition as possible, or in the condition in which

it is usually consumed. Previous to the introduction of this method, resort had to be made to pickling either in salt or vinegar, to drying, to smoking, and to preserving in sugar. Each of these methods was applicable to certain products, but was productive of changes in character, and was attended by so much spoilage in holding, that other methods which would overcome these objections would necessarily meet with success. Canning leaves much to be desired, but is a vast improvement over other methods, besides it is applicable to so many products which can not be conserved in any other manner, and withal is so simple that it can be used in the home as well as in the factory.

According to the account given by Appert, he packed his products in glass bottles, added sufficient water to cover, inserted the corks, and then placed them in the water bath. They were heated very gradually for varying lengths of time, depending upon the character of the food. He obtained a temperature of from 190 to 200° F. (88 to 94° C.) in the center of his bottles, the maximum being 212° F. (100° C.). He used glass exclusively, and achieved results which are difficult to surpass with all our modern equipment.

In 1807, a Mr. Saddington in England described a method of preserving, the essential features of which were that the fruits be placed in glass bottles, loosely corked, put in a water bath at 165° F. (65° C.) for 1 hour, then boiling water added to cover the fruit, the corks driven in, and the bottles laid on their sides to swell the corks. He did not claim to be the originator of the method, and it is believed that the general principles were obtained by him while traveling in France.

Appert did not know why foods kept when treated according to his method, but ascribed it to the exclusion of outside air after applying sufficient heat to the food. He had evidently tried heating the food in a vessel and pouring it into bottles and had unfavorable results, and therefore concluded that it was the effect of the outside air. Those who followed him also laid great stress upon

the effect of the air, and made every effort to secure a high vacuum. When tin cans came into use, they were sometimes vented as many as two or three times in order to secure the desired result.

Science had not progressed sufficiently to determine the real cause for keeping, and, naturally, conclusions were drawn which seemed to coincide with what appeared to be the controlling factors in practice. The French government appointed Guy Lussac, the foremost chemist of the time, to investigate the cause for keeping. He reported that spoiling was a series of oxidation changes, and that by the exclusion of outside air these changes were prevented in bottled or canned foods. This explanation was accepted until the advent of the new science of bacteriology, which brought the true explanation. It is now known that all foods, water, air, and the containers are bearers of bacteria and other micro-organisms; that the effect of the heat is to destroy them, and that the hermetic container merely excludes those from without. This science has also shown that all organisms are not killed at the same temperature; that some spores possess great resistance; and that some products bear types of organisms which are more resistant than others. These facts make it clear why some products, like corn and pumpkin, need a very high temperature and for a very long time, while some others, as raspberries and loganberries, require a relatively low temperature for only a few minutes. The honor for discovering most of the fundamental principles involved also belongs to the French master, Pasteur, though his work was in reality directed along a different line.

The first application of the science of bacteriology to canning in this country was made by H. L. Russell, of the University of Wisconsin, in 1895. He was followed by Prescott and Underwood, at the Massachusetts Institute of Technology, in 1896. Since that time sufficient work has been done to enable factory superintendents to process all lines of food products with comparative safety.

COMMERCIAL CANNING

The methods described by Appert were so simple that commercial canning on a small scale was begun almost immediately in Europe and started in this country in New York, in 1819, and in Boston, in 1820. Ezra Daggett and Thomas Kensett are credited with having packed some salmon, lobsters, and oysters in New York, and William Underwood and Charles Mitchell with having packed fruits in Boston in these years. These pioneers had learned the methods before emigrating to this country. The firm of Underwood in Boston has been in continuous operation and is the oldest in the United States, the business established by Appert and continued by his descendants being the oldest in Europe. The first cannery in Baltimore was opened in 1840, the sardine industry was started at Eastport, Maine, in 1841, and the first factory in the central states was operated in 1860, on the Pacific coast in 1856, and in Alaska in 1878. It is also of interest to note that nearly all of the pioneer factories started on fish food as the primary pack, and fruits and vegetables as incidental. At the present time there are about 3,000 factories in the United States, having an annual output of 3,000,000,000 cans.

HOME CANNING

There is no essential difference between home and factory canning except that which is made possible through handling materials in large quantity by special machinery, to better grading for size and quality through superior facilities, and to being better able to apply a uniform and proper temperature suited to the product. The home is not ordinarily supplied with the necessary equipment or means of control to get the best results. In many respects a home-canned product stands in the same relation to a factory product as the home-made butter and cheese to that of the creamery

which is equipped with separators, pasteurizer, ripening and chilling tanks, etc. Some persons through the exercise of skill and ingenuity prepare a very superior article of butter or cheese in the home, but the average is not high. The really distinctive feature in home-canning is the use of spices and flavoring, a valuable factor which the commercial packer has neglected. The amount of home-canning probably far exceeds any estimate that may be made, as it is largely done in glass, and the jars used repeatedly. There are thousands among the rural population, and many in the cities, who pride themselves upon their handiwork, and who pack from a dozen to a hundred or more cans each year.

PRINCIPLES IN CANNING

While the fundamental principle in preserving a food product is the administration of heat in due degree and for sufficient time to cause sterilization and to maintain the condition in a closed container, there are other factors of great importance, therefore, a brief discussion of the methods used and principles involved may well precede the general treatise.

Appert used an open water bath for heating his bottles, and this method is the one in common use in the packing of all fruits. In this method a temperature of 212° F. (100° C.) is the maximum attainable, and in practice can not be reached in the center of the can. With fruits, however, this temperature is not necessary, as the more highly acid they are, the more easily they are sterilized. Most of the fruits can be sterilized at 185° F. (85° C.) and in experimental work the results have been quite satisfactory as low as 165° F. (65° C.), at one heating, though continued for a longer period. As far as known to the writer, all fruits may be sterilized in a very short time at or near the boiling point, and as the temperature descends below the boiling point the period must be increased,

but it does not follow in a definite ratio. Vegetables are not so easily sterilized as fruits; for the most part they require a temperature above 212° F. (100° C.), if applied only once. In order to secure the necessary increase in temperature, first salt was added to the bath, and later calcium chloride was used. With the latter, the heat could be made to reach 250° F. (121° C.). Both the salt and the calcium chloride solutions attacked the tin cans and gave them an unattractive appearance. Heavy mineral oil has been used, but it necessitates a thorough scouring or cleansing of the cans after treatment. The most common method now in use is to place the cans in an autoclave or retort and subject them to steam or hot water under pressure. In this manner any desired degree of temperature may be attained. The general practice is to process all vegetables, meat, fish, and milk in this manner, varying the degree and the time to suit the particular product. This method has not been available in the home until quite recently, as small pressure cookers were not built.

A further improvement in the matter of processing has been the development of the agitating cooker. Some products which have a heavy body, require a long time to cook because the heat cannot penetrate rapidly. The time therefore may be greatly reduced by causing the cans to roll or to turn in such a manner that the contents will come to the outside, or that the liquid present will be carried through the mass. It has been found that slow, even agitation will not necessarily break up the fruit or product, but that it will reduce the time by 75 per cent. The special cookers used for this purpose also have the advantage of being continous. In home canning, in lieu of these special devices, resort may be had to the principle of pasteurization, that is, heating the cans for a short period on three or four successive days.

An illustration of the great difficulties which the pioneers had in determining the proper process upon any given article is to be found in the work of Isaac Winslow. He made his first attempts to can corn in 1839, and repeated

his efforts year after year, the experiments mostly proving failures, but always attended with enough success to hold out a ray of hope. He was not reasonably successful until 1852, and was not granted a patent on the process until 1864. At present, one can arrive at a proper process through experiment and by a systematic examination of the product in a reasonably short time.

While sterilization may be accomplished by any of the methods already cited, the difference in the effect upon the product is quite marked. For example, asparagus processed at boiling heat does not have the tenderness nor the flavor that is obtained in that which is processed in the retort. It is decidedly inferior. Most vegetables are improved by heating above the boiling point. With fruits the reverse is true, the conservation of flavor being best at as low temperature as is practicable to be employed in sterilization.

THE CONTAINER

Appert used the glass bottle for his experiments, but the tin can made its advent almost coincident with the art itself. Saddington gave a brief description of the process to the English in 1807, and in 1810, Peter Durand took out a blanket patent on containers of almost every known material, and specifically mentioned tin. He has, therefore, become known as the father of the tin can. There is no such thing as a best container for all products. Some things are better in glass and some in tin. The original long-necked, narrow-mouth bottle gave way to the wide-mouth bottle, and later to the jar with the metal cap and wax top to take the place of the cork. This style of jar may be found in some of the rural communities to this day. Later came the screw cap, and all of the other devices to make a tight closure, the seal being made by a gasket of rubber or fiber. The glass container has its drawbacks because of cost, ease in breaking, increased labor required, added weight, and higher freight. It has had a large usage

in domestic canning, and, through recent improvements, it is gaining as a commercial package. Earthenware jars were introduced as a substitute for glass, but have had only a limited success. In England, all goods packed in glass are referred to as bottled and the process as bottling.

The tin can is preeminently the container of commerce, and, like the glass jar, has gone through many stages in its evolution in arriving at its present state of development. It lacks much of being the ideal container, but it is the most practicable that has been evolved. Tin cans are classed as open top, hole and cap, and wax top, depending upon whether the entire end is to be attached by a process of crimping or double seaming, whether the cap is to be soldered on, or whether wax is used in sealing. The latter type is used exclusively in domestic canning, but is giving way to the solder cap style. Cans are known as key opening if some part of the can has been sufficiently cut to permit opening by stripping a part out of the side or top by means of a key. Some cans are called "enamel" lined when they have been treated with a lacquer on the inside, and these are decidedly advantageous in conserving color in products like berries, beets, etc. In the trade the tendency is to limit the term "canned" to food packed in tin only, and when glass is used to refer to that style of package as fruits, etc., in glass.

METHODS IN COMMERCIAL CANNING

Good commercial canning begins with the production of the material, in the selection of the seed, as for corn and peas; in getting the right variety of fruit; and in supervising the cultivation, harvesting, and delivery of the raw material to the factory. It is imperative that the raw material be of first class quality, uniform, and in the proper stage of development to give the best results. One cannot use mixed varieties of peas, cut at all stages of maturity, and since these and other products must be

furnished by scores of farmers and growers, it is necessary for the canner to have a complete understanding and supervision over the work. This is one of the very important features with which the consumer is not familiar, and accounts in a large measure for "quality."

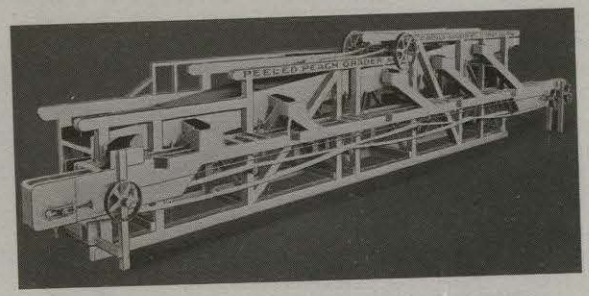
The immediate work in securing products involves rush operations not associated with regular harvesting. Most of the vegetables are green and in a state where they change or spoil rapidly. Asparagus must be cut and packed the same day, and so important is this that the factories have been located near the growing beds. The standing for a day makes a difference in the degree of toughness and flavor. Peas, corn, and green beans are all seriously injured by standing. Berries must be collected in very shallow boxes, and fruits, such as apricots and peaches, picked when just ripe, and handled in shallow lug boxes to prevent bruising. The milk collected for the evaporated product must be fresher and cleaner than that which is generally delivered in the city market.

GRADING

The first operation in almost any factory is that of grading. The foreman looks over the loads of peas, corn, tomatoes, or fruit, and sends them to different points to be unloaded according to their condition. This is only a starting point, and it is continued in almost every successive operation throughout the factory. Grading for quality must be done by the eye for the most part, and for size by machinery. It is frequently a question of whether this is not carried to excess, but people eat with their eyes fully as much as with the sense of taste and demand peas that are uniform in size and color, though they are not so good as the mixed, and demand small peas at high cost in preference to the large, though they are not so nutritious nor economical. The extreme to which the work is carried is well illustrated in the offering of fifteen or more grades

of Alaska peas, and an equal number of yellow cling peaches. It is carried to such a point for jobbing purposes that even the packer cannot recognize the difference in his own pack without having two or more grades together.

The machines for sizing are generally built on the principle of a revolving cylinder or of vibrating screens, having holes of standard dimensions to make the necessary separation. The first set of holes are large and all except the largest sized peas will pass through. The next set one size smaller takes out the next grade, and this process is continued to make the number of sizes desired. In the case of fruits,



Machine for grading fruits by means of different size of screens.

tapering rollers may be used so that as the fruit reaches a certain size it will fall through or the rollers may mechanically open and permit the dropping of certain sizes in the proper bins. An ingeniously devised wire belt is also made to open and close a mesh of varying size, and an apple sizer is made to work upon the principle that with a uniform force a light body can be thrown farther than a heavy one.

There is only one important machine used for making the separation for quality, and that is for peas. It is based upon the principle that tender succulent peas are light and that older ones are heavy, and upon this difference an approximate separation can be made by immersing them in a weak brine. The tender ones float and are skimmed

from the top, while those that sink are conveyed from the bottom. The separation of green and soft fruits and those off color must be done by hand.

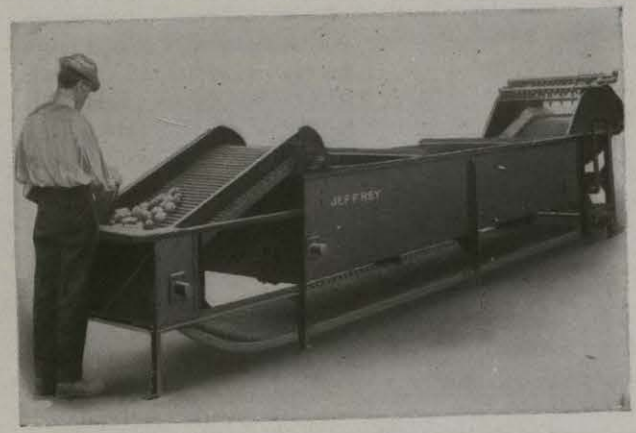
PRELIMINARY PREPARATION

The general preparation will naturally vary widely with the different products. Berries are stemmed and the defective ones picked out; plums are stemmed; cherries are stemmed and may or may not be pitted; apples and pears are peeled and cored; peaches are pitted and peeled; tomatoes peeled and cored; peas are shelled; corn is husked; beans are snipped; and beets, carrots, sweet potatoes, etc., are peeled. Some of these operations require especial and elaborate machinery, while others are dependent upon hand work.

WASHING

The most important operation in canning is that of washing, and for this purpose machines have been invented which are most ingenious in the way and care with which they handle particular products. In some, the product is soaked and then sprayed; in others, it is soaked and agitated to loosen dirt; in another it is sprayed with a large volume of water; and in still another the sprays are small but have a strong pressure. The most common type of washer is known as the squirrel cage. A cylinder is made of woven wire and a perforated pipe runs the full length within, so that peas, beans, or any other product goes through in a single layer, rolls over many times, and is constantly subjected to sprays of water as light or as heavy as desired. Another type of machine passes the product on conveyers under sprays or between sprays. The principle of using sprays is the same as that of washing a floor with a hose with an open end or with a nozzle. The former will use a lot of water and accomplish little, while the latter will use little water and accomplish much if the pressure be

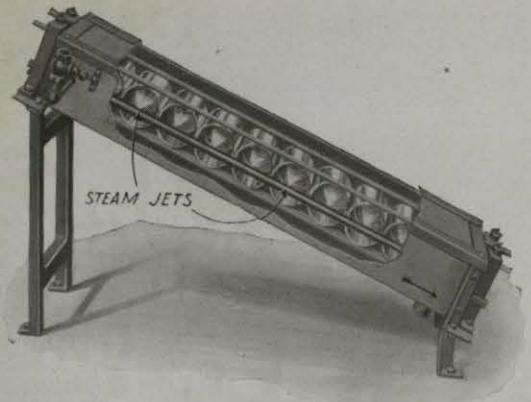
right. Berries need a slight immersion to loosen dust and adherent dirt, and then should be passed under very fine sprays to cause their removal. Pears, apples, and all cut or sliced fruits need to be kept submerged in plenty of fresh water until packed in the cans. Tomatoes need very small but strong jets of water directed upon them. Peas need washing both before and after blanching and probably require more water for their entire preparation than any



Type of washer for fruits and vegetables, which carries them into a tank of water where they are agitated gently but thoroughly to loosen dirt, then sprays them as they emerge.

other product. All the vegetables need to be washed under strong jets of water.

All cans need washing irrespective of their appearance. They collect dust and dirt during manufacture, in shipment and in storage and need to be rinsed just before using. Machines have been devised which do this work very well. The open-top can collects more dust than the hole and cap can, but is much more easily cleaned. The milk can has such a small hole that dirt cannot enter.



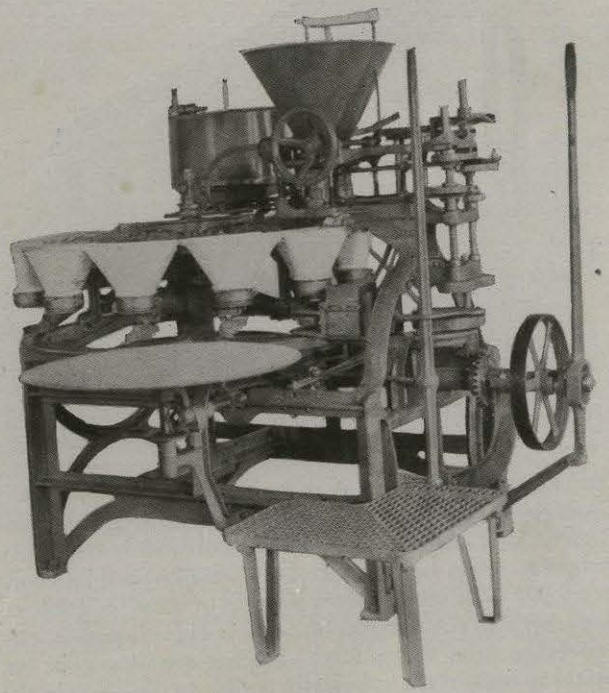
Machine for washing cans effectually by strong jet of steam or water directed on the inside.

BLANCHING

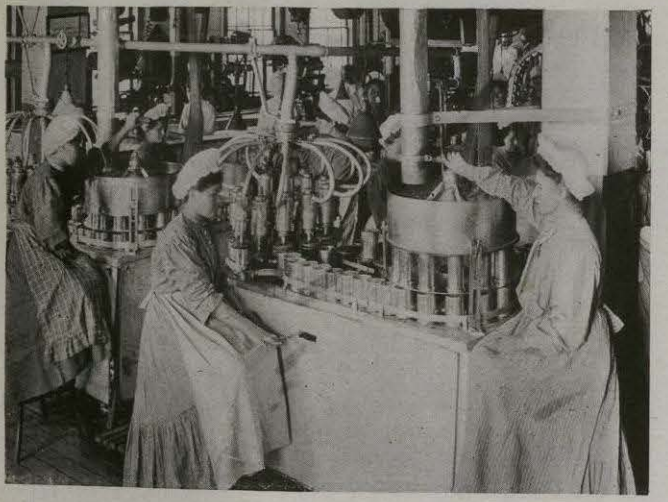
Blanching is a necessary operation with most vegetables, and advantageous with some fruits. The term is derived from the French *blanchir*, used in the culinary sense, meaning to "scald or boil off," and not to whiten as is frequently inferred. Peas, beans, spinach, etc., are dropped into boiling water from one to fifteen minutes to cause their softening, and also the removal of a rather objectionable sticky substance from the surface. Peaches are dipped in hot water to make them sufficiently flexible to pack well in the can, but incidentally the process also serves to obtain a more uniform color. The blanching may be done in steam, but the liquor will not be so clear. This work is accomplished by automatic machinery.

FILLING THE CANS

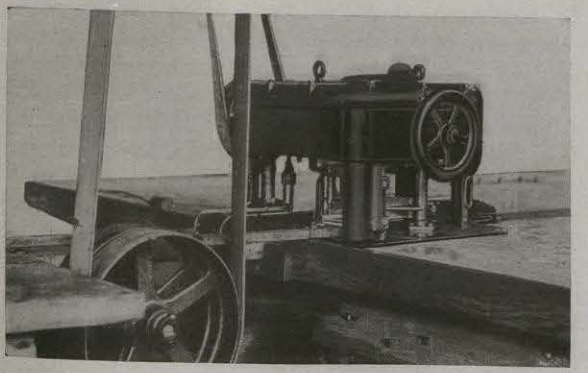
Most vegetables are filled into the cans by automatic machinery. Corn is heated in a tank with the proper amount of water, salt, and sugar, and filled into the cans



A filling machine for delivering a measured amount of a vegetable, like peas, beans, hominy, etc., and then adding the proper quantity of brine. The work is done with more accuracy and with much less injury to the product than if done by hand.



Filling cans by machinery is cleanly as compared with hand work.

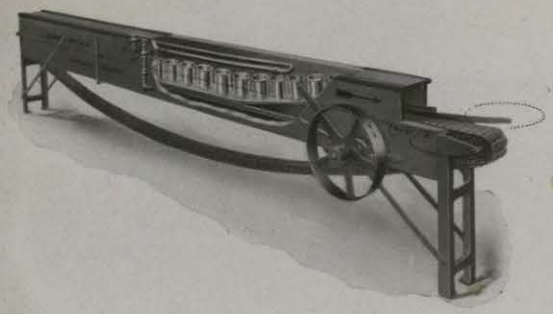


Fish meat and solid products are weighed by automatic machinery to secure the correct fill.

while hot; peas, tomatoes, string beans, soup, milk, fish, and potted meats, each has its special filling machine. The higher grades of fruit require hand-filling to get the proper quantity and to prevent bruising. The practice is to fill the cans as full of the product as possible without injuring in any manner, and then to add water, brine, syrup, or sauce to fill the interspaces. In order to prevent short weight or overweight most hand filling is checked by scales.

EXHAUSTING

After the cans are filled, they are heated slowly until the contents are hot, before capping. The object in heating is to cause the expulsion of air. This has little, if anything, to do with sterilization, but if the air be not driven out, there is not the proper collapse of the can, and it may be difficult to tell when spoilage occurs. A far more important reason is the lessening of the attack of the contents upon the container. The exhausting should be slow, taking from six to ten minutes with products containing more or less liquid and a longer time for those which are almost solid. The temperature should not be less than 130° F. (55° C.), in the center of the can, and it is preferable that it should reach 165° F. (65° C.). Very rapid heating causes the cells to swell and burst, and injures the appearance. A machine has been devised which will exhaust the air mechanically while the can is being sealed and which has some advantages over the heating method. Ordinary cans have a partial vacuum of from 6 to 8 inches, those well exhausted, 10 to 13 inches, and those very well exhausted up to 22 inches. In the factory the exhausting is accomplished by passing the cans on a conveyer through a steam box or a shallow hot water bath. Corn and other products filled into the can while hot are not exhausted. In the home canning the same result is accomplished by setting the glass cans in hot water until the contents are hot before clamping on the lid. The presence of a solder mark on the end or side

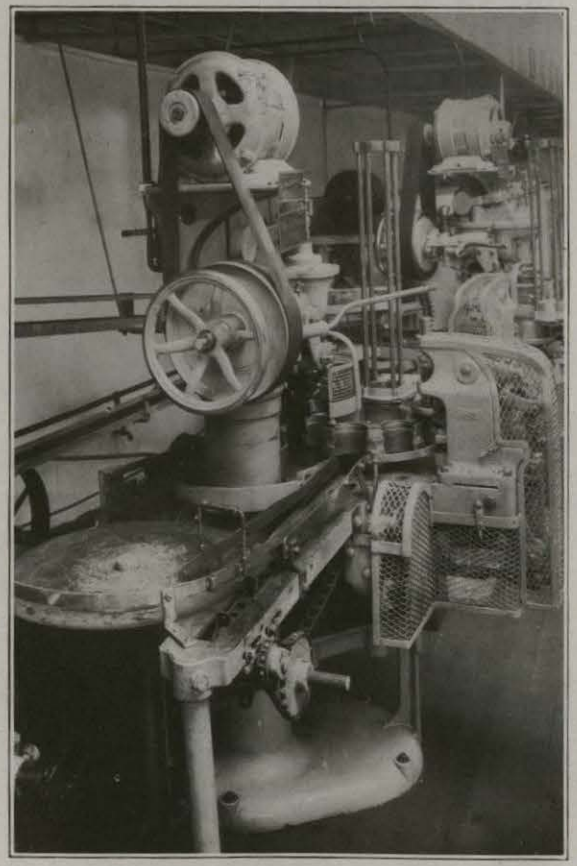


The simplest type of exhaust or pre-heater, conveys the filled cans slowly through hot water, steam, or both and hot to the closing machine.

of a sanitary can usually indicates that the product has been sealed cold, then placed in a retort or a bath for a time, and taken out and vented. This gives a very thorough exhaust and was the method formerly employed on all fish and meats, and to a certain extent on vegetables.

CLOSING THE CAN

Open top cans are closed by a machine known as a double seamer. The edge of the top and the flange on the side are hooked together and turned under with such force that it makes a hermetic closure. This is aided by a very thin layer of cement or a paper gasket. The machines used for this purpose work at speeds varying from thirty to eighty cans per minute. No acid or solder is required. Hole and cap cans are closed by automatic machines which wipe the top, place the caps, apply the flux, solder, and tip the vent at the rate of sixty per minute. The closed cans may be run through a hot bath for inspection for leaks. The presence of a leak is noted by the rise of bubbles. The percentage of leaks is so small that the



Machine for sealing cans without acid or solder.

majority of the factories do not resort to this precaution. Where canning is done on a small scale, the hand-capping steel and copper tipper are used.

PROCESSING

The term processing is applied to the operation of sterilizing. As already indicated, this is accomplished at a temperature and for a time best suited to the product. No rule can be followed, but each product must be treated in the manner found best by experience.

The simplest method of processing is to place the cans in crates or iron baskets and immerse them in a tank containing boiling water. The water is kept hot by turning a jet of steam into it at the bottom. These open baths may be very simple wooden tubs or metal tanks, or very long ones into which the can may enter at one end and travel slowly through and come out at the other. The same kind of apparatus may be used for processing at a lower temperature, or for pasteurizing, by keeping the water at the proper degree of heat. Cans may also be carried into boxes and steamed without pressure. Processing above the boiling point is done in iron boxes or steel cylinders known as retorts. These may be vertical or horizontal and of such size that they will hold from a few hundred to three or four thousand cans. In the vertical retorts steam may be used alone or steam may be introduced in water. In the horizontal retorts steam only is used. The pressure will vary from 5 to 15 pounds, thus giving temperatures from 220° F. (105° C.) to 255° F. (124° C.). The practical agitating cookers have thus far been of the open type, rolling the cans in single file through water or steam.

The proper control of time and temperature is so very important that this is no longer entrusted to the attention and memory of the cook. Temperature controllers and timing devices as well as recording thermometers are installed as a part of the equipment, in order to guard

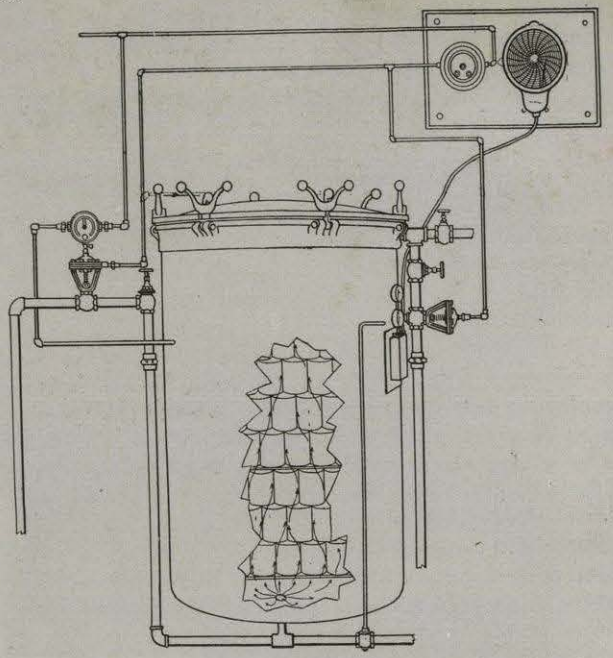


Diagram of a retort, 6 feet in height, nearly 4 feet in diameter, and holds from 600 to 1,500 cans. Steam enters at the bottom and heats water or surrounds the cans.

against mistakes. These have been perfected to such a degree that in processing in a retort the chef can turn on the steam, turn the key on the controllers, and know that the temperature will be maintained, that the steam will be cut off at the right time, and that the air and water will be admitted to properly cool the cans.

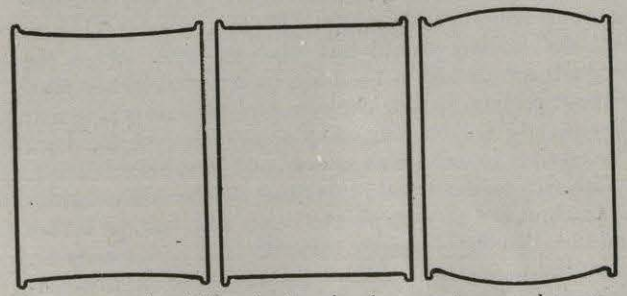
HOME EQUIPMENT

The simplest equipment for home canning is a heavy pan somewhat deeper than the height of the cans. A wash

boiler answers very well. A wooden false bottom is desirable when using either glass or tin, though not absolutely necessary for the latter. The tin cans are set in sufficient water to exhaust them, and when processing, they may be completely submerged. When packing in glass, jars are usually not more than half submerged, or they may be set above the water and a tight cover be placed over the cooker and dependence placed upon the steaming to give the proper temperature. A small pressure cooker suitable for many purposes in the kitchen may be used for processing a few cans at a time at any desired temperature. (A simple pressure cooker is illustrated.)

COOLING

The process should be carried to the point of sterilization and then should cease, as retention of heat for a longer time only tends to cause injury. For this reason it is important that cooling should take place at once. When the products are packed in the store room and ricked or piled without cooling, no one can say what process was given; they may be hot for hours, and some cans even for days. The result is invariably an uneven and an inferior product. Under extreme conditions, tomatoes may become as brown as a walnut and acquire a bitter taste, peas become mushy and taste scorched, and the majority of the cans show an unnatural darkening. One of the anomalies of this condition is that in peas and corn particularly, souring may take place, due to bacteria which can withstand a high temperature.



Testing cans for defects by tapping for sound; normal, overfilled or warm, and a swell.

Cooling is accomplished by immersing the cans in tanks of water, by turning cold water into the kettles, or by spraying the cans in the air. Where water is scarce, the practice is to stack the cans in an open shed for a day or two.

LABELING AND BOXING

After the cans are cool, the ends should be well drawn in, and the cans bright and clean and free from rust. When canning is done near the sea, or where there is much dampness, it is a common practice to lacquer the cans. This is done as soon as possible to prevent rusting, and not later to cover up rust. The cans are then labeled and boxed. The nailed box is the one generally used, though the wire-bound is coming into use on account of the saving on lumber and freight. The fiber-board container is also gaining recognition, especially for small-sized cans. Whatever style of box is used, it should be neat, clean, and of sufficient strength to stand shipment to the consumer.

FOOD FACTORY SANITATION

Modern food manufacture means in reality a high-class community kitchen for the preparation of food for many consumers. Therefore it becomes a matter of public interest that the sanitary condition be of a high order. A description of the proper requirements for a cannery may serve to indicate, in a general way, what should be expected of all food manufacturers.

The location of the plant should be away from lines of business which may be objectionable, as tanning, hide-dressing, soap-making, fertilizer-grinding, or any other manufactory in which disagreeable odors are given off, or in which decomposition and putrefactive processes are associated. The site should have proper drainage, an ample