SHELLFISH

CLAMS

BUTTER CLAMS OR LITTLE NECK CLAMS

Butter clams (*Saxidomus nuttali*) and little-neck clams (*Tapes staminea*) are found in Oregon, Washington, British Columbia and Alaska, where they are canned in varying quantities, principally in the Puget Sound area.

The clams are found in gravel beaches, between tide lines and are obtained by digging. Both species of clams inhabit the same beds and are usually canned without attempting separation by species. The clams are washed off roughly as they are dug, then packed in burlap bags holding about 100 pounds each. These bags may be brought in from the Puget Sound beaches by boat, but an increasing amount is transported to the cannery by motor truck.

So far as can be determined, the practice of holding the clams for 24 hours in tanks of water in which corn meal has been thrown so that their stomachs will be emptied of waste, reported by Cobb (1919), is no longer followed.

The clams are washed thoroughly on arrival at the cannery and any broken-shelled or dead clams are discarded. They are loaded into "coolers," strap-iron trays used for holding salmon

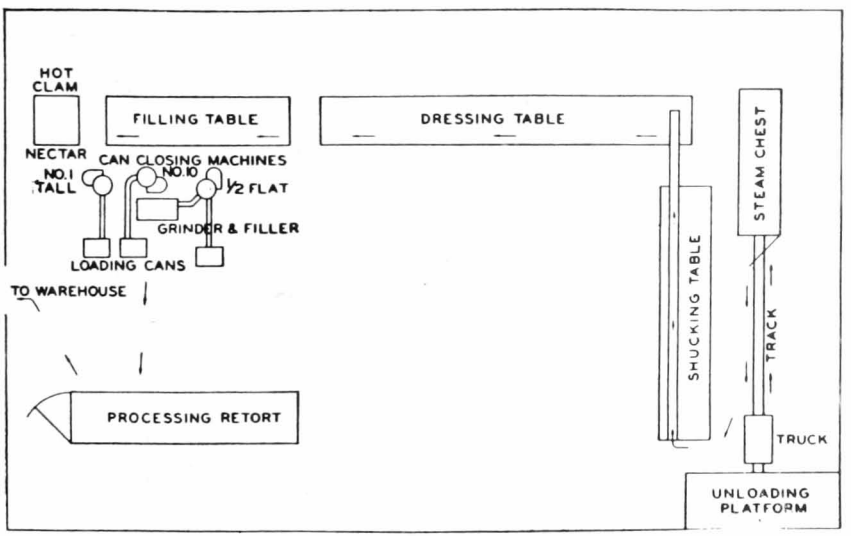

FIGURE 47.—Floor plan showing the equipment layout of a Pacific Coast cannery for butter clams. (From *Pacific Fisherman.*)

NOTE.—[FL–84. Canning clams, oysters, sea mussels, and squid.

cans in processing, which are placed four tiers high on low trucks. The trucks are run into a 4-truck horizontal retort, equipped with drip pans for catching the juice. The clams are steamed in the shell for 15 to 20 minutes at 212° (0 pressure) to 228° F. (5-lb. pressure).

The "coolers" of steamed clams are trucked to the shucking table. In one cannery this is a high table covered with galvanized sheet metal and placed parallel to the track to the steam chest. The table is built with a high back and a metal flume runs to the dressing table. The clam meats are tossed into the flume as they are shucked from the shells, and are carried by the stream of water onto a screen in another trough which runs along the dressing table. Jets of water in the second trough stir the clams and finally carry them to the end of the trough. The flume acts as a conveyor though it is primarily intended to wash the clam meats and free them from sand or other foreign objects.

Women handle the clam meats as rapidly as possible, snipping off the siphon and removing the dark body mass. Waste removed in dressing is dropped in gutters running along the edges of the table which carry the refuse to a drain. As the clams are trimmed and cleaned, they are dropped into quart measuring cups. The meats, if they are to be packed whole, are washed again before they are emptied into a trough on the packing table. They are hand-filled by weight into No. 1 picnic, No. 1 tall, or No. 10 cans. The cut-out (drained) weights required are 5, 8, and 36 ounces respectively.

The containers are filled with hot clam liquor and are sealed immediately. The temperature of the contents averages 160° F. at sealing so there is no need for heat exhaust or vacuum sealing. The process used varies with the packer as in many other products. Typical processes are, for No. 1 picnic cans, 20 minutes at 240° F. (10-lb. pressure); No. 1 tall cans, 70 minutes; and for No. 10 cans, 100 minutes at the same temperature and pressure.

Some butter clams are canned as minced clams. The dressed and washed meats are ground in a grinder with a ⅛-inch plate. The ground meats are discharged directly into a filler of the type used in packing minced razor clams. The cans are sealed immediately after filling. Other means of obtaining a vacuum are not necessary as the temperature of the contents at time of sealing averages 150° F. Representative processes in packing minced butter or little neck clams are, for ½-pound flats, 60 minutes at 228° F. (5-lb. pressure) or 45 minutes at 236° F. (8-lb. pressure). Minced clams packed in No. 1 picnic cans are given about the same processes.

Minced butter and little neck clams may have an attractive appearance if workmanship in packing is good, although the meat is somewhat darker in color than that of the razor clams. The texture is not as tender as that of minced razor clams, but the product has a strong clam flavor which is relished in clam chowder.

HARD CLAMS

The hard clam or quahog *(Venus mercenaria)* is found from the New England States to the coast of Texas. Hard clams are usually found below the low tide mark and do not burrow deeply into the bottom. They occur abundantly in the southern States where the most productive beds are found on the Gulf coast of Florida, in the vicinity of the Everglades region. The shells of the Florida hard clams are much thicker and heavier. Individual clams in the shell may weigh as much as 2 lb. but the meats are little, if any, larger than in the north. In the Middle Atlantic States hard clams are utilized in the canning industry only as an ingredient in packing "Manhattan Style" clam chowder.

Quahogs are taken by hand tongs and dredges of the same type used in gathering oysters. Hard clams are also gathered by "treading." The clammer wades about in water 3 or 4 feet deep pushing a light skiff. He feels for the clams with his toes, then picks them up by hand or with a short rake. Long-handled, specially designed rakes are used in some sections of the Atlantic Coast and ordinary shovels are also used at times.

Dredged clams are transported to the cannery in the holds of dredge boats. Clams taken by other gear are filled into wooden lug boxes or sacks and brought into the cannery by truck or boat. The distance between the clam beds and the cannery is usually not more than a few miles.

Upon arrival at the cannery, the clams are emptied on a chain-lug type of conveyor which carries them to a drum type rotary washing machine, set in a tank of water. The clams are whirled about and rinsed by water sprays under strong pressure to rid the shells of sand.

From the washer the clams are conveyed to strap-iron cars, such as are used in steaming oysters. The clams may be graded for size while on this conveyor, with those under 3½ inches of shell taken off the conveyor to be canned separately as "little neck" clams.

The cars are run into steam chests, also like those used for steaming oysters except that provision is made for collecting the liquor lost by the meats in steaming open the shells. The liquor is piped from the steam chest to a collecting tank, where it is later

filtered and added to the canned clams. It may be packed separately as "clam juice," "clam broth," or "clam nectar."

The steaming time and temperature used depends on the individual preference of the packer and may vary from 30 minutes at 212° F. to 15 minutes at 240° F. These periods are exclusive of the time required for "coming-up," and in "blowing-down" the steam chest. Steaming times are usually in excess of the minimum required to open the shell in order to obtain as much liquor as possible.

In some canneries the cars are sprayed with cold water as they are taken out of the steam chest in order that the clams may be handled as soon as possible, and to prevent toughening of texture. The clams may be dumped on shucking tables or the openers may work directly from the cars. Payment for shucking is on a piecework basis. One or two cuts of a short-bladed knife separates the base of the adductor muscles from the shell and the meat is dropped into a small bucket by the side of each worker. Usually no attempt is made to remove the dark body mass.

When the buckets are filled they are carried to a checker, where the meats are inspected, and washed in a weak 15° to 20° salinometer brine. A rotary washer may be used or the washer may be of the same type used in an oyster cannery. The washed meats are emptied on a conveyor belt which carries them to a packing table where they are hand filled into No. 1 picnic (Eastern Oyster) or No. 2 cans by weight.

A No. 1 picnic can is required to have a "cut-out" weight of 5 ounces; a No. 2 can, 9 ounces. To allow for the shrinkage in processing it is necessary to fill in an average of 15 percent additional. The packer should cut cans from each day's pack and determine the drained weight in order to vary the "fill-in" weight according to the degree of shrinkage in the meats. When filling, the meats may be graded according to size with small meat packed as "little neck" clams and larger sizes as "steamed clams."

The cans are filled with hot filtered clam liquor or if there is a good market for canned clam juice, a hot 3-percent salt brine is substituted. The cans are sealed immediately, without exhaust or mechanical vacuum. The process varies with the packer, but typical examples are: No. 1 picnic cans, 30 minutes 240° F. (10-lb. pressure); No. 2 cans, 45 minutes at the same temperature and pressure.

The pack is water-cooled after processing. Canned hard clams or quahogs are often variable in quality. Strong discoloration or "sea-weed" flavor and odor sometimes appear. These defects may be largely overcome by removing the dark body mass when wash-

ing the meat, but as this adds to the cost of packing it is not often done commercially.

RAZOR CLAMS

The razor clam *(Siliqua patula* Dixon) is found only on the Pacific Coast of North America, though related species are native to the Atlantic Coast of North America and northern Europe. The method of canning this clam was originated by P. H. Halferty in 1894. Razor clams are canned only in the Columbia River-Grays Harbor area of the Oregon-Washington coast, in the Queen Charlotte Islands district of British Columbia, in the vicinity of Cordova and at Kukak Bay in Alaska.

The shell of the razor clam is somewhat longer than the shells of the soft clam, quahog or butter clam. It is covered with a closely adhering brown membrane, which becomes darker in color as the clam increases in size, is brittle and has very sharp edges. The "razor-shell" clams of the Atlantic Coast are named for their fancied resemblance to the old fashioned straight razor, but the Pacific razor clam is so-called because the sharp edges are very liable to cut the digger's hands. The average size of the shell is 4½ inches long by 2 inches wide. These clams inhabit only hard sandy ocean beaches near low water mark, and the time in which they can be taken is restricted to a single brief period daily during the extreme low tide run out. The razor clams dig holes several feet deep in the beach sand, using the muscular foot as a digger. They come up near the beach level, with the siphon or "neck" at the top of the sand, so that water may be drawn in over the gills and the minute organisms forming their food may be strained out. When disturbed, the razor clams sink rapidly to the bottom of their holes and dig themselves in even deeper.

The razor clam is taken only by digging and each clam must be dug singly. Skill, strength and rapidity are required in digging, or the clams will escape. A short-handled long-bladed shovel, usually an irrigation ditch shovel with a cut down handle, is used in digging. Each digger drags a netting bag behind him attached by a length of rope. The clams are placed in this bag as they are dug, and are "surf-washed" by being dragged through the surf as the digger goes about his work. Production by the individual digger is small, not more than 2 bushels per day if experienced, the beach undepleted, the weather and tides favorable. Therefore, a large number of diggers are required to supply each cannery with raw material. The largest packer employed 1,800 diggers in 1938. Beaches on the Oregon and Washington coasts are quite long, as much as 18 to 20 miles to an individual beach, and as many as 1,000 diggers may be found working a beach at one

time. In Alaska and British Columbia, the beaches are smaller and the area where clams may be taken is much more restricted.

The digger delivers the clams to a buying station maintained by the packer. Each lot of clams is emptied on an inclined wire screen of the type used by builders in screening gravel. The clams are inspected and graded roughly on this screen. Dead or broken-shelled clams are discarded, and undersized clams must be returned to the water. Regulations specify minimum sizes for razor clams and set penalties for taking under-sized clams. In Oregon and Washington no clam may be taken measuring less than 3½ inches.

After inspection the clams are transferred to wooden lug boxes holding approximately 75 pounds each, in which they are transported to the cannery. In Oregon and Washington the boxes are transported by motor truck. In Alaska and British Columbia clams are delivered at the cannery by boat, usually craft of the salmon cannery tender type. The boxes are piled in the hold of the cannery tender, or if the distance is short, the weather cool and the trip is made at night, they may be loaded on deck. Refrigeration is not used when transporting clams since it has not been found necessary. The distance between the cannery and the beach from which the clams are dug may vary from a minimum of 1 up to a maximum of 100 miles. The clams usually arrive in good condition even from the greatest distance.

In Oregon and Washington the canning season extends from March through May, with the peak of the season in late April. In Alaska packing is most active in late April and early May, although there is an autumn canning season in September and October.

On arrival at the cannery, the clams are unloaded onto a conveyor, passing through a heavy spray of water at a pressure of about 100 pounds per square inch. This spray washes the shells thoroughly, removing any remaining traces of sand from the shell and other portions of the clam reached by the spray. Carelessness in washing allows sand to get into the canned product, making it unsalable.

The washed clams are transferred to a type of steam chest, or hot water bath in which is placed an inclined screen pitched about 1 foot in 10. The surface, which is divided into a series of sawtooth ridges, is shaken by a cam mechanism. The clams are steamed or blanched for a minimum of 30 seconds to a maximum of 1 minute at a temperature varying from 209 to 212° F. The motion of the screen advances the clams from ridge to ridge and shakes the meats free from the shell after they have been opened by the steaming, or blanching in hot water. The clams must be

cooled by a spray of cold water as rapidly as possible after steaming, otherwise they become quite tough in texture. Workmen standing by the side of the conveyor pick out the meats, freeing any still adhering to the shell. Meats are placed in shallow metal pans while shells continue along the conveyor, which carries them to a waste pile outside the building.

Women using medium-sized sharp-pointed scissors, specially treated to resist corrosion, dress the clams by cutting off the tip of the siphon and open the body from the base of the foot to the tip of the siphon (Fig. 48). The dark body mass or "stomach" is clipped off at the same time. The meats are then put through a washer built like the apparatus used in opening the shells, except that the meats pass through cold water at the end of the rocker where they are admitted.

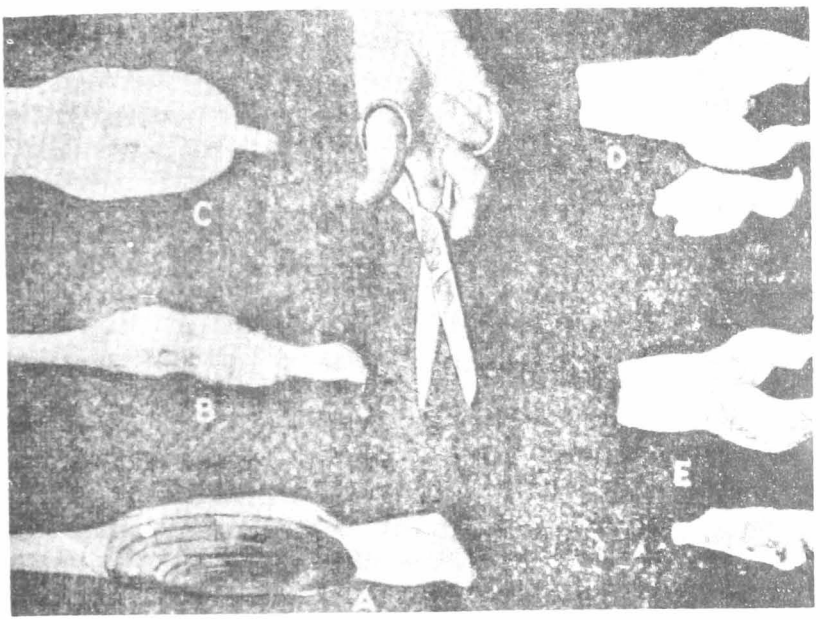

FIGURE 48.—Details of dressing and cleaning razor clams for canning. (A) As received at cannery. (B) Whole shucked clam. (C) After splitting. (D) After cleaning. (E) Ready for grinding. (Courtesy, G. P. Halferty)

After the meats are shaken and washed, a second group of trimmers remove the tough horn-like skin attached to the mantle, open up the foot or "digger," and scrape out the "liver" or other viscera from the body. The meats are given a third washing in the rocker washer and are then drained.

The drained meats are ground in a power-driven grinder with a 1/8 inch plate. Clam juice, obtained in steaming or made by boiling clam siphons and other edible trimmings with water, is

mixed with the meat. The juice should be sufficiently hot so that the temperature of the mixture will be approximately 150° F. when filled into the containers. Empty cans are fed into a specially developed filling machine and filled at the rate of 40 per minute. The mixture in the filler tank is stirred to keep it from separating. Additional juice may be added if the mass is not sufficiently fluid.

Filling must be carefully supervised or the drained weight required by the U. S. Food and Drug Administration regulations will not be realized. Insufficient drained weight may be caused by an excess of liquid in filling or excessive shrinkage of the meats in processing. Over-processing increases the amount of shrinkage beyond the normal rate. Shrinkage in processing is believed to average about 25 percent, but varies during the season, becoming greater as the clams approach spawning condition. Variation in shrinkage also depends on the beach area from which the clams are taken. During the day the canner must occasionally cut cans after processing to determine the drained weight in order to make any necessary adjustments in filling. The regulations of the U. S. Food and Drug Administration require a drained weight of 3½ ounces for ½-pound flat cans, 5 ounces for No. 1 picnic, and 8 ounces for No. 1 tall cans.

The net weights usually declared on the labels are: 7 ounces for ½-pound flat; 10 ounces for No. 1 picnic; and 15 ounces for No. 1 tall cans. The difference between the drained weight and net weight is due to the liquid added when filling the cans. This liquid is clam juice, which is not only very palatable but possesses considerable food value.

In a few canneries the filled cans pass along a conveyor to a vacuum closing machine where they are exhausted mechanically and sealed. However, in most canneries the temperature of the can contents is depended upon to produce a partial vacuum and the cans pass directly from filler to double seamer. The sealed cans are stacked in strap iron trays which are loaded on small retort cars holding six trays.

There is no standard process in canning razor clams. Each packer uses processes determined by himself. Representative processes are, for ½-pound flat and No. 1 picnic or regular (Eastern oyster) cans, 70 minutes at 228° F. (5-lb. pressure); and for 1-pound tall cans, 80 minutes at the same temperature and pressure. Processes at high temperatures have been found to cause excessive shrinkage. with discoloration and overcooked flavor in the canned product.

Immediately after cooking, the cans are water-cooled in the retort. If the pack is not cooled rapidly, cooking continues, causing

discoloration and loss of flavor. Packers also believe that slow air cooling causes toughening of the minced clam meat. The yield is given as approximately 20 No. 1 tall, or 40 No. ½ flat, cans per bushel of clams.

Some razor clams are not minced. The dressed and washed meats are filled into cans, so that a drained weight of 4½ ounces will be obtained after processing No. 1 picnic, or 7 ounces in No. 1 tall cans. Sufficient clam juice is added to fill the containers. The cans may be vacuum-sealed or the packer may depend on the hot clam juice to obtain a vacuum. The process given varies with the packer. No. 1 picnic cans may be processed for 45 minutes at 228° F. (5-lb. pressure) or 20 minutes at 240° F. (10-lb. pressure); No. 1 tall cans for 55 minutes at 228° F., or 25 minutes at 240° F. The pack is usually water-cooled after processing. The amount of whole razor clams packed is a small proportion of the total pack.

SOFT CLAMS

The soft clam *(Mya arenaria)*, also known as the long clam, mananose, or squirt clam, is taken commercially from Cape Hatteras northward, but is most abundant on the coasts of Massachusetts and Maine. Soft clams are canned only in these States, since they are not obtainable elsewhere in amounts and at prices at which canning is profitable. The soft clam season in Maine is fixed by law at September 15 to June 1. Canning does not start much before October 15, and is generally finished by January 1. Some canneries also pack in the spring, from late March into April.

The soft clam is found in mud banks and other tide flats covered with water at high tide. The clams have a long siphon or neck which makes it possible to burrow below the surface for a foot or more when the tide-lands are exposed. They vary from 2 to 4 inches in length, with shells which are rather smooth, thin and brittle in comparison with the quahog.

The only means of gathering is hand digging with spading forks, spades and hoes, or rakes of heavy construction equipped with several broad prongs. Dredges have not yet been adapted for harvesting soft clams. The presence of the clams is determined by the small holes in the sand, and the jets of water emitted when they are disturbed. The clams are tossed into buckets or other containers as they are dug or the clams may be dumped into a skiff and taken ashore at high tide. Production is limited since the tide flats may only be worked for a short time each day. A digger will bring in from 1 to 2 bushels of clams on a tide, depending on his skill and the degree of depletion of the digging area.

The clams usually are collected by trucks sent out by the canners. The clams are washed by the diggers and packed in burlap bags. The first operation at the cannery is to wash the clams thoroughly under a series of water sprays at heavy pressure. To remove sand and mud from within the shell it has been recommended that clams be held in tanks of circulating sea water until they have been freed of sand or other debris. This method is not used commercially as far as can be determined. Fresh or salt water may be used in washing, but salt water pumped near the cannery is apt to increase the amount of bacterial contamination.

The clams are graded after washing and any dead or broken specimens are culled. Little attention is paid to size and undersized clams are not returned to the beach. Clams fit for canning are placed in metal baskets and taken to a steamer. Steamers may vary from tanks equipped with a steam coil on the bottom and a rather loosely fitting lid, to processing retorts. In tanks the clams are steamed from 10 to 20 minutes. If retorts are used the pressure varies from atmospheric pressure to five pounds pressure. The time is not fixed but if the clams are used for bouillon as well as for meats, the steaming is heavier. A better plan is to turn on the steam for about two minutes which is sufficient to open the shells. The juice which has accumulated during this period is discarded since it consists of water held inside the shell and steam condensate. The juice collected from subsequent steaming contains a considerable quantity of extractives and after filtering is generally saved, to be used with the meats or for making bouillon or broth (Cobb, 1919).

When the clams have been sufficiently steamed the baskets are wheeled to the packing room and are piled on tables or benches, where workers remove the meats and prepare them for canning. The removal of meats is known as "snapping." The body muscles are cut from the shell and the dark body membrane is stripped away in one operation, after which the meats are rinsed. In order to remove the dark body mass the bodies are squeezed by thumb and forefinger. The siphons or necks are snipped off with scissors. The meats are again rinsed and dropped into pans. This work is generally performed by women and girls, on a piecework basis.

Some diggers steam open the clams as soon as they are dug. The equipment generally consists of an iron drum set over an open fire. The clams are removed after a few minutes heating, when the shells have opened. The digger and his family then remove the meats from the shells, and clean them in preparation for canning. The clam meats are then packed in slip cover tin cans of various sizes and held until the arrival of the cannery truck.

Several days may elapse between shucking and canning when this practice is followed. The quality of the canned product is adversely affected, and the bacterial contamination greatly increased, making it more difficult to secure a sufficient process. None of the larger packers or the more progressive of the smaller packers will accept clams shucked previous to delivery for this reason.

The pans of meats are taken to filling tables where packers fill the clams into the cans by hand, weighing the cans, or using scoops gauged to hold an amount sufficient to give the necessary drained weight. There is an estimated loss of about 15 percent in cooking or processing so that allowance must be made when filling the cans. The loss of weight in processing will vary with the degree of steaming before shucking, the shorter the period, the greater the loss, and to some extent with locality and season of the year at which the pack is made. It is estimated that 6 ounces of meats will be required for a 5-ounce "cut-out." The average yield of shucked clam meats, after removing "necks" (siphons) and "stomachs" (dark body mass), is estimated at 2 gallons per bushel. A gallon of clam meats should fill 24 No. 1 Eastern oyster cans, with a "cut-out" weight of 5 ounces each.

The cans are then placed on a conveyor belt which carries them under a perforated pipe which fills the containers with hot 3-percent salt brine. Some packers filter the liquor obtained from the clams in steaming, and add this to obtain a more pronounced clam flavor in the product. When brine is used as the filling liquid it is claimed that the appearance of the product is superior, with less trouble from darkening in the container.

Soft clams are packed in No. 1 Picnic, No. 1 Tall, No. 2 Short or special, and No. 2 Regular size cans. The No. 1 Picnic can is used more than all other sizes. The same process is generally given for all sizes; namely, 20 minutes at a 10-pound pressure (240° F.), but some packers process No. 2 cans for an additional 5 minutes. The cans are water-cooled immediately after processing.

The principal difficulty in the canning of soft clams is discoloration after canning. That this discoloration is not entirely due to the formation of iron sulfide is demonstrated by the fact that "C" enamel-lined cans tend to reduce but not to eliminate darkening. Unpublished data of experimental work conducted by the U. S. Fish and Wildlife Service indicate that blanching the clams for 1 minute in a 1.5 percent solution of citric acid at 180° F., and the addition of 0.5 percent of citric acid to the brine filled into the cans in packing, will inhibit darkening in soft clams without affecting the flavor of the product.

CLAM JUICE, BROTH OR NECTAR

In the process of opening all species of clams large amounts of liquid are extracted which contain varying amounts of soluble proteins and other food materials. Clam liquid is canned by methods which are usually quite primitive, although a few packers follow carefully developed canning formulae.

There is confusion as to nomenclature. Canning technologists agree that only liquid which is canned without dilution should be termed "clam juice;" that clam liquor diluted with water should be called "clam broth;" for example, liquor obtained by boiling clam trimmings in water, and only liquor concentrated by evaporation is "clam nectar."

The method most extensively followed is to strain the liquor obtained in steaming the clams through cheesecloth or similar material, filling it into cans or bottles while still hot and sealing the containers immediately. No two packers use the same process, and some still cook in the open hot water bath, believing that as the product is liquid, commercial sterility may be obtained at 212° F. This is not true as the liquid is apt to be more highly contaminated with spoilage organisms than clam meat.

Some packers pipe the liquor from the steamer to a storage tank, then to a mechanical filter, after which it is pasteurized for 3 to 5 minutes at 180° F., and is then filled into containers and sealed immediately. Clam liquor is packed in tin containers as follows: 8Z short, 8Z tall, No. 1 picnic, 1 lb. tall, No. 2, No. 2½, and No. 3 cans. Glass containers used are bottles with a crown type seal, splits, half-pints, pints, quarts, and half gallon jugs. The tin containers most widely used is the No. 1 picnic-size can; the glass container, the half-pint bottle.

Canned clam liquor should have a pearly opalescent color. A brown tinge is an indication of over-processing. Suspended solids sometimes collect into a flocculent mass at the bottom but this is not a sign of deterioration. The amount present depends on the degree of filtration.

Processes indicated to be sufficient by research studies by U. S. Fish and Wildlife Service are: No. 1 Picnic cans 45 minutes at 228° F. (5-lb. pressure), or 30 minutes at 240° F. The pack should be water-cooled immediately after processing.

MUSSELS

The Atlantic mussel *(Mytilus edulis)* is the only species canned in the United States and is also the variety used most widely in Europe. Other species such as *Modiolaria nigra*, are found in the same area but are not canned since they are usually smaller in

size, differ in flavor and are more likely to be contaminated. The Atlantic mussel is commercially important only from Cape Cod to the Delaware River. It is found at depths from 1 to 60 fathoms.

Many are taken by pickers who scrape them from rocks on the shore, but dredges which resemble oyster dredges, although smaller, are also used in waters of the State of New York. The mussels are sorted for size and separated from undersized and dead mussels and debris such as pebbles, small stones and old shells, to which they are attached.

The catch must be landed within a few hours, and should be taken only from beds approved by the health authorities, as mussels are subject to extremely rapid decomposition, and are more liable to be the cause of food infections. (Tanner, 1933.) When the mussels are brought ashore they are cleaned of any seaweed clinging to the shells, and are freed from sand by a thorough washing in salt water. Any empty shells not removed in culling on board the fishing boat are discarded at this time.

The mussels are steamed at atmospheric pressure (212° F.) until the shells begin to open, which requires from 5 to 10 minutes. They are then emptied into pans or buckets and shucked. The byssus or "beard," a growth of horny filaments, by which the mussel attaches itself to rocks or other objects must be removed at this time.

The shucked meats are again thoroughly washed and held from 1½ to 3 hours in a 3-percent salt solution, to remove any remaining sand or grit from the meat and to give the proper salt flavor. The brine is drained off and the mussels then stand for 3 days in a 3-percent solution of distilled vinegar containing from 1 to 3 percent salt by weight. The pickling solution may acquire a bluish color during this time, but this does not affect the flavor of the product.

The next step is the preparation of a spiced vinegar sauce. To 4½ quarts of 6-percent distilled vinegar are added ½ ounce of bay leaves, ¼ ounce of white pepper, ¼ ounce of mustard seed, ⅛ ounce of whole cloves, ⅛ ounce of fennel and $\frac{1}{16}$ ounce of paprika. The spices are simmered, but not boiled, in the solution for 45 minutes. The spices are then strained out, the solution is filtered and set aside to cool.

The mussels are packed in 5-ounce glass tumblers or 8-ounce glass jars, after which the containers are filled with the spiced vinegar sauce, diluted one-half with water. In some instances the spiced vinegar sauce is used in the preliminary cure and a plain 3-percent vinegar is used to fill the jars. A portion of the pack is processed, but no accurate data are available on times and temperatures. Processing is said to vary from about 60 minutes in

a hot water bath (212° F.) to 25 or 30 minutes at 221° F. (3-lb. pressure).

Non-processed pickled mussels remain in good condition from 2 to 4 months, depending on the degree of skill used in preparation and on temperature of storage. The pack must be protected from light, since the meats gradually darken if light rays are too strong. Storage at temperatures from 34° to 40° F. increases the "shelf life" of both processed and nonprocessed packs.

JELLIED MUSSELS

Some mussels are packed in jelly. Shucked mussel meats are pickled for 3 days in a 3-percent vinegar solution. One-fourth pound of best quality gelatine is dissolved in 2 quarts of hot water to which is added ¾ ounce salt. When the gelatine solution is cool, it is mixed with 1 quart of spiced vinegar sauce diluted with 1 quart of water, and poured over the mussels packed in tumblers or screw top wide mouth jars. Jellied mussels are not processed and depend entirely on the pickling cure and on low storage temperature for preservation.

Mussel packs are prepared only in the vicinity of New York, Philadelphia and Boston, for sale to the delicatessen trade. Attempts to create a wider market have not been successful.

OYSTERS

EASTERN OR GULF OYSTER INDUSTRY

The oyster canning industry was first established on Chesapeake Bay, and for many years the bulk of the pack came from that locality, but today only one cannery is still in operation. Production in this area is irregular depending on the canned oyster market, and on the demand for fresh oysters. Raw material may come from any portion of the Chesapeake Bay oyster beds, and consists of "shell stock," sold to the cannery, if there is no great demand for fresh oysters.

Oyster canning has diminished greatly in importance on the South Atlantic Coast during the past 16 years. Tressler, (1923) listed approximately 38 canneries in North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida. Not more than 7 or 8 canneries were still in operation in 1939.

The Gulf-of-Mexico area is now the principal oyster canning district, producing about three-fifths of the total pack. At present, more oysters are canned in Mississippi than in any other State, although production in the State of Washington approaches that of Mississippi. Biloxi, Miss., with 13 canneries, now has the

title once possessed by Baltimore, the world's oyster canning center. Houma is the oyster canning center of Louisiana and most of the 5 canneries now operating are located in or near that town.

The oyster canning industry on the Pacific Coast draws its supplies almost entirely from Washington, principally from the Willapa Bay-Grays Harbor district. In contrast to the industry along the South Atlantic and Gulf Coasts, the oysters are obtained almost entirely from privately owned or leased beds which are "cultivated." The use of a "planted" or "cultivated" oyster in canning is practicable because the Pacific or Japanese oyster *(Ostrea gigas)* grows much more rapidly than Atlantic Coast species *(O. virginica.)* On the Pacific Coast, as is true in the Atlantic Coast, the cultivated beds are more productive; the oysters are usually taken in better condition and marketing is more orderly. The cultivation or farming of oysters is suggested as a method of improving the quality of oysters taken along the South Atlantic and Gulf coasts for canning purposes.

SECURING RAW MATERIAL

Tonging and dredging are used in gathering oysters for canning. Tonging is used in creeks or in other shallow water areas along the shore, usually where oysters are found in small and scattered beds. It is also used on the public domain, where dredging may be prohibited by law at certain times or within certain areas, as a conservation measure. Tongs vary in length from 12 to more than 20 feet, according to the depth of water in which they are to be used. They are long scissor-shaped tools with toothed iron baskets fitting together at the tips. The long wooden handles are an inch thick and 3 to 4 inches wide at the hinge point (about 4 feet from the end, but varying with the length of handle) and taper toward each end. They are riveted, bolted or pinned together. The toothed iron baskets which catch and hold the oysters are as much as 3½ feet long and 10 inches wide.

When the tonger is over a patch of oysters, he grapples the bottom until a cluster of oysters have been gathered into the basket, then lifts the tongs and shakes them out into the bottom of the boat. A single fisherman will average about 4 barrels of oysters a day.

The oyster dredge may best be described as a harrow with a single toothed bar, above which is a triangular iron frame to which a bag of chain or heavy rope netting is attached. The dredge is dragged over the bottom at the end of a tow line and the toothed bar scrapes loose the oysters from the bottom. As it is towed forward the loosened oysters are carried back into the bag. The dredge when filled is lifted to the surface by winch. In the oyster canning areas, both the number of dredges which may be

operated by a boat and the size of the dredge, are limited by law. As a rule, a dredge may not be more than 6 feet wide and no boat may operate more than two dredges. In the States of New Jersey and Mississippi an oyster dredge cannot be operated by a power boat, so in these States when the boats are actually dredging they must be under sail. Boats may dredge oysters only when licensed for this purpose.

FISHING SEASON

The season during which oysters are gathered for canning depends on the condition of the oysters, the temperature, the demand for canned oysters and on legal restrictions. The length of the season has been reduced in recent years. It now runs from about January 1 to May 1 in all areas, but is changeable and may be altered by the state fishery agency. Few oysters are canned in the first and last portions of the season for the following reasons. If the oysters are still "thin" or "poor," the loss in packing would be increased, making canning unprofitable. If the weather is warmer than usual the reduced time in which live oysters may be held before spoilage takes place is a limiting factor. If the packers have a large sized "carry over" they are not apt to add to the over supply.

TRANSPORTING AND RECEIVING

The oyster dredges are drawn in over iron rollers fixed to the rail. Each of these rollers has another almost vertical roller at its after end, to guard against excessive wear of the dredge rope. As the dredge is being brought up it is raised and lowered through the water to give the oysters a washing which will remove some of the mud and sand. The dredges are emptied on deck and the catch is culled roughly to remove stones, dead shells and other debris, and the clusters are broken up to some extent, while another dredging is being made. Undersized oysters are replaced on the beds. The catch is then transferred to the hold.

The tonger also rouses the tongs about in the surface water, before emptying them into the boat, and culls his catch from time to time. The amount of debris to be culled in tonging is less than in dredging, since tongs are more selective in action.

On the Gulf Coast, oysters are usually canned in shrimp canneries. They usually are about 20 to 100 miles from the oyster producing areas. Oysters are much less difficult to transport than shrimp, and "shell stock" will remain alive from 2 to 5 days or longer if the weather is cool. Oysters are not usually unloaded immediately and placed in storage bins as for the fresh trade, but remain in the hold of the boat in which they were brought to the cannery until it is possible to pack them.

The method of unloading has not changed since early times. The bucket hoist is used for unloading the oysters from the boats to the canneries. The bucket is a heavy metal tub. It is hoisted by block and tackle attached to a swinging boom. The buckets of oysters are unloaded directly into the steaming cars which are strap iron wheeled crates on rails. These average about 8 feet long by 28 inches wide and 19 inches deep. Conveyors are only used in one or two canneries for unloading oysters. An oyster car usually has a capacity of 5½ barrels of oysters. In the oyster canning industry of the South Atlantic and Gulf States a barrel

FIGURE 49.—Oyster washer for cleaning oysters before steaming and oyster cars used to hold oysters in steam box.

of oysters in the shell is equal to 4 U. S. Standard bushels of 2,150 cubic inches, or 4.95 cubic feet, except in Mississippi, where a bushel of oysters measures 2,826 cubic inches, so in that State a barrel of oysters is 3 U. S. Standard bushels, and the capacity of a car is estimated as 5 barrels. A car is the unit of count for payment to the fishermen.

The oysters are not usually washed on unloading as it is claimed that washing is ineffective, and that steaming is much more satisfactory in cleaning the outside of the shell. One packer has recently installed a mechanical washer, and a few others spray the oysters with a hose after they have been loaded in the cars, but the practice is not widespread at present.

STEAMING

Loaded oyster cars are run along rails into a "steam box," a rectangular horizontal retort of sheet iron, with doors at each

end. Steam boxes are often made of such light weight material and have been pitted with rust to such an extent that it is a wonder that they do not blow up under the steam pressures used. The steam chests have capacities of 3, 4, or 5 cars. The doors are usually fitted with wooden gaskets, which allow a good deal of steam to leak out after being used a short time.

The U. S. Food and Drug Administration (1937), recommended the following equipment for a steam box:

1. An adequately perforated steam inlet pipe running throughout the length of the bottom of the steam box.

2. A blow-off vent of at least 2 inches inside diameter in the top of the box.

3. A safety valve of at least 1 inch inside diameter in the top of the box.

4. Vents of at least ½-inch inside diameter in the top of the box not more than 1 ft. from each end of the box.

5. One-eighth inch bleeders in the top of the box not more than 1 foot from each end of the box.

6. A pressure gauge of a range from 0 to 30 lb. with scale divisions not greater than 1 lb. Such gauge shall be connected to the steam box by a short, gooseneck tube. The gauge shall be not more than 4 inches higher than the gooseneck.

7. An indicating mercury thermometer of a range from 170° F. to 270° F., with scale divisions not greater than 2°, in the top of the steam box.

8. Drains of at least 1 inch inside diameter in the bottom of the steam box, one at each end of the box.[15]

All steam boxes are equipped with pressure gauge, thermometer and some sort of drains in the bottom of the steambox, while some canneries use all the recommended equipment.

The oysters are steamed from 10 to 15 minutes at 245° F. (12-lb. pressure) the length of time depending on initial temperature, steam supply and to some extent the size and condition of the oysters. Some canneries steam from 6 to 10 minutes at 250° F. (15-lb. pressure). The periods given do not include the "come-up" or "blow-down" times. The "come-up" time is usually 6 to 8 minutes and "blow-down" time is 1 minute. The oysters must be steamed sufficiently to open the shell, and to permit the meats to be shucked without tearing the "eye" or adductor muscle. Poor steambox operation has been found to be an important cause of loss in oyster canning. Under-steaming seems to be a more serious problem than over-steaming, which does not appear to affect the flavor

[15] Food and Drug Administration, 1937. Tentative supplement to revised regulations for inspection of canned shrimp authorizing extension to oysters. 10 pp. Food and Drug Administration, U. S. Department of Agriculture, Washington.

or result in excessive shrinkage. Under-steamed oysters may be torn, making them of a lower grade.

The loss of raw material totals about 93 percent in oyster canning. This loss is largely shell, mud and the juice or nectar lost in steaming.

SHUCKING

The cars of steamed oysters are rolled into a shucking room, where the meats are at once removed from the shells by workers using a dull-edged knife with a small thick blade. Oysters must be opened while hot for clean removal of the "eye." The meats are shucked into small perforated metal cans holding from 8 to 10 pounds of meat. The shuckers in gangs of 8 work directly on the car. Shells are dropped on the floor to be shovelled into wheelbarrows for removal to the shell pile. A few canneries have installed conveyors to remove the shells but it is claimed that expense of installation and operation of a conveyor system makes the older method more economical in most canneries.

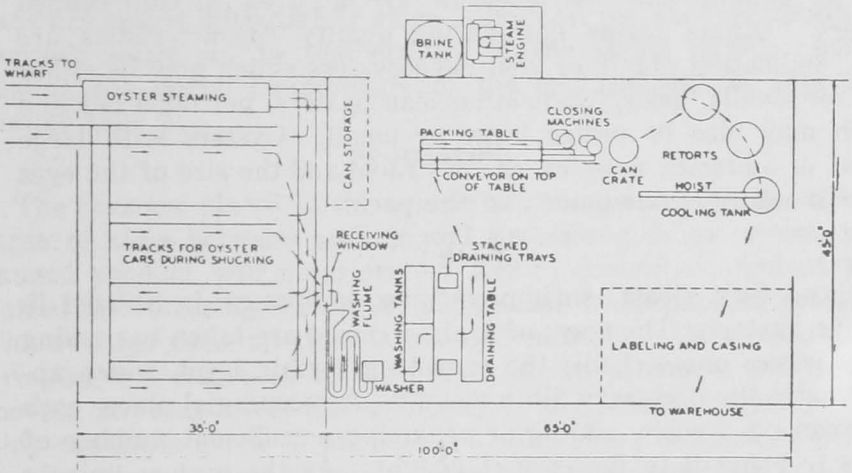

FIGURE 50.—Floor plan of typical Gulf oyster cannery.

Fifteen gangs of shuckers are needed to shuck 1,000 barrels of oysters in a 10-hour day. If the oysters are large, 10 gangs or 80 workers will be able to open this amount of oysters, but if they are smaller than usual it may take 18 gangs. The worker takes a full can of meats to a receiving window, where the meats are weighed and the shucker is paid immediately, usually 10 cents per can. Some canners inspect the meats for evidences of poor workmanship such as the inclusion of bits of shell or the presence of torn meats.

WASHING

After inspection the meats are emptied into a galvanized flume in which they are conveyed by cold running water to the washing

tanks. A considerable quantity of grit and shell particles is washed from the meats and trapped by baffles fixed at intervals in the flume. The meats are washed from 20 to 30 minutes after which they are removed by dip nets and transferred to screen-bottomed metal trays about 24 by 18 by 4 inches in size. The filled trays are placed on tables where they are left to drain for 20 minutes.

INSPECTION AND GRADING

While draining, oyster meats are inspected and discolored, torn or otherwise defective meats are removed. According to the American Can Company, oyster canners on the Gulf Coast do not usually grade for size,[16] although packers segregate certain packs made with loads of oysters which are noticeably large or small. Oysters classified as large usually average 4 to 5 steamed meats per ounce while small oysters average 9 to 12 meats per ounce. They report that practically all oysters canned on the Gulf are classed as standards although some selects are packed. Terms such as "counts" and "extra-selects" are not used for Gulf canned oysters. Others terms designating quality characteristics are "fat," indicating plump or well filled oysters which may be either large or small; "poor," indicating lean oysters, not filled out and which may also be either large or small. Oysters with large "eyes" or adductor muscles, are desirable and the size of the eyes is one measure of the quality of the pack.

FILLING

On the Gulf Coast, shrimp packing equipment is utilized in canning oysters. The trays of drained meats are taken to packing tables where one girl fills the cans to a certain level, which approximates the necessary fill-in weight. A second girl places each filled can on a scale, adding or removing a sufficient number of meats to bring it to the correct weight. As the oysters gain in weight during processing and storage, the amount of meats filled into the can will be somewhat less than the drained weight. The fill-in weight is usually 3½ ounces if the drained weight is to be 4 ounces, 4½ ounces if it is to be 5 ounces, and 9 ounces for a drained weight of 10 ounces. The fill-in weights are varied to a certain extent throughout the season, depending on the condition of the meats. Plain cans without inside enamel are used, and approximately 70 percent of the pack consists of No. 1 Eastern oyster (211 x 400) cans, with a drained weight of 5 ounces. The standard case consists of 48 cans of this size and fill.

Atlantic and Gulf coast oysters will yield an average production of 13 cans (5 oz.) per barrel measuring 4.9 cubic feet if the

[16] American Can Co. *The Canning of Gulf Oysters.* New Orleans Research Department Memorandum. American Can Co., Inc., 8 pp., New Orleans.

oysters are "thin" or "poor." The yield will be from 18 to 20 cans if the oysters are "good" and 20 to 24 cans if they are "extra good." The general average is estimated at about 20 cans per barrel.

Only 4 girls, 2 filling and 2 weighing, are required for continuous packing when the cannery is handling 1,000 barrels of oysters per day. Most canners use from 6 to 8 workers at the packing table and only can the meats intermittently as the can sealing and processing capacity is far greater than the steaming and shucking capacity.

EXHAUST OR VACUUM AND SEALING

As the filled cans are conveyed to the can sealing machine or double seamer they are filled with hot 1-percent brine from a perforated pipe. In some canneries a 35-grain salt tablet is dropped in each can, which is then filled with hot water. This is done to overcome the waste of salt where the brine spray is used. The cans are sealed immediately after filling and the vacuum obtained depends solely on the temperature of the added liquid. After sealing the initial temperature of the can contents is approximately 160° F.

PROCESSING

The cans are placed in the retorts as soon as possible for if the lapse of time between sealing and processing is too great, the canned product will deteriorate. Retort control equipment required in processing shrimp should be used when packing oysters. The average come-up time is about 3 minutes. Carelessness in bringing the retort up to the proper steam pressure, and in removing air, may affect the sufficiency of the process. Oyster canning processes given in publications on canning technology prior to 1936 are no longer followed since processes of greater sterilizing value developed through research studies have been generally adopted by the industry after that date.

Containers smaller than the No. 1 Picnic or 5-ounce can are now processed for 17 minutes at 240° F. (10-lb. pressure), or for 8 minutes at 250° F. (15-lb. pressure); No. 1 Picnic cans are processed for 18 minutes at 240° F. or for 9 minutes at 250° F. No. 2 Short (307 x 400) and No. 2 (307 x 409) cans are processed for 19 minutes at 240° F. or for 10 minutes at 250° F. Research laboratories of the canning industry suggest using processes at 250° F. in preference to those at 240° F. A short process at high temperature and pressure apparently gives a product of better texture and flavor. A come-down period of 1 minute is allowed at the end of the processing time, to bring the pressure within the retort down to atmospheric level.

COOLING AND WASHING

The retort baskets are lowered into small tanks where they are water cooled, until the temperature within the cans has been reduced to approximately 98° F. Alkaline cleaning solutions are not needed as oil or particles of the product do not collect on the cans during packing. The retort baskets are sometimes cooled under sprays of water. There is also a pronounced tendency toward cooling in the retort as is done in canning "wet pack" shrimp.

STORAGE, LABELING AND SHIPPING

The cans are dried and are stored for a few days before labeling. The majority of the packers code mark the cans, but code lots are not stored separately as yet. Labeling is usually done by hand as a slack time occupation, although some labeling machines are used in the larger canneries.

The drained weight of meats contained in the can is usually stated on the label rather than the net weight of the total contents, as the regulations of the U. S. Food and Drug Administration specify definite drained weights of oyster meats which must be packed in each size of can. That agency has recently expressed the opinion that inasmuch as the liquid in the cans is also used as food, it is advisable to state net weight or total contents, on the label, rather than drained weight or amount of solids. *This interpretation does not alter the drained-weight specifications, which are still in force.* Drained-weight declarations now used on the labels with corresponding net weights suggested to comply with Federal and State regulations are tabulated below:

Can size	Drained weight and packer designation of can size	Net and proposed label weight	
	ounces	*pounds*	*ounces*
211 x 212	3	0	7.0
211 x 300	3½	0	7.0
211 x 304			
211 x 306	4	0	9.0
211 x 400	5	0	10.5
211 x 405	6	0	11.5
307 x 400	8	1	9.0
307 x 408	10	1	4.0
307 x 409	10	1	4.0
307 x 414	12	1	5.0

The No. 1 Picnic or Eastern oyster can is occasionally packed with a drained weight of 4 ounces, but solely for the export trade on specifications of the buyers and the drained weight is declared on the label. This pack cannot be sold in the United States.

EXAMINATION OF CANNED OYSTERS

When examining the canned product the first requirement is that the can should cut out to the proper drained weight. Color standards cannot be set, but the cans should not contain oysters

obviously discolored or "specked" when packed. However, a fairly large percentage of Gulf oysters called "cock" oysters are naturally very dark colored. These oysters are not inferior and must be distinguished from discolored oysters.

The product should have a characteristic sweet odor and should not contain grit, sand or bits of shell. The liquid should be opalescent but not turbid. In old packs and with inferior oysters, the color of the liquid will be dark gray. The presence of one or two torn meats in a sample may be disregarded, but if they appear with any regularity, it should be regarded as evidence of poor workmanship in packing and an indication of inferiority. If the oysters are sold as "fancy" or "large" a 5-ounce No. 1 Picnic can should contain from 16 to 20 in number, if "choice," 20 to 30, and if "standard" from 45 to 60.

PACIFIC OYSTERS

OBTAINING RAW MATERIAL

On the Pacific Coast, all oysters used in canning are grown on beds owned or leased by the packers. The beds are "seeded" with oyster spat purchased from Japanese seed oyster-growers who specialize in that business. The Pacific or Japanese oyster *(Ostrea gigas)* is a different species from those found in this country. It is larger, more irregular in shape, has a pronounced dark fringe banding the edge of the mantle which is not found in American oysters, and shows very rapid growth in areas where water conditions are favorable and the food supply abundant. Other species of Japanese oysters are imported on a very small scale. Of these the Hiyushima oyster *(O. cucullata)* is the most important. It appears to be a good variety for canning purposes, possibly better than the Pacific oyster as it has a regular shape, is of medium size, and its flavor is good. These factors together with uniform light color, a minimum of dark fringe banding the edge of the mantle, and an absence of dark, mottled spots on exposed surfaces, decide the suitability of oysters as raw material for canning purposes.

The oyster spat is shipped from Japan in wooden boxes. Each box contains 700 oyster shells with an average of 15 seed oysters clinging to each shell. A box of seed oysters cost $3.50 C. I. F. Seattle in 1938 and 15 boxes of seed oysters are required to plant an acre of bottom. This quantity should produce an average of 40 bushels of oysters for canning. The seed is planted in alternate squares of about one-half acre each on two successive years to secure a more equal distribution of food for the growing oysters, and so that some oysters may be gathered each year. The seed oyster requires approximately 2 years to reach a size suitable for canning.

Each shell acts as the base for a cluster of from 10 to 30 half grown oysters after 1 year. Workers walk over the beds at low tide, breaking up the shell into small clusters of 3 or 4 oysters with a hammer and distributing them over the ground. The cost of cultivation is estimated at $1.50 per box of seed planted.

When the oysters are to be harvested, light scows are "spotted" over the area at high tide, and at low tide the pickers go over the bare ground gathering the clusters into bushel baskets which are emptied into the nearest scow. The cost of picking averages 40 cents per case of 48 one-pound talls. In 1938 pickers were paid at the rate of 5 cents per bushel. When the oysters are quite thick they may be gathered by tonging at high tide. The high cost of labor in gathering oysters by hand has resulted in attempts at dredging, which is cheaper, but is said to tear up the bottom to an undesirable extent. It is estimated that 80 percent of the oysters are gathered by hand.

TRANSPORTING AND RECEIVING

The loaded scows are towed to canneries nearby at high tide. At the cannery the oysters are shovelled into an elevator consisting of a water tight wooden trough in which runs an endless chain with wooden cross bars about 6 inches apart. As the oysters go up the elevator they are washed by a spray of water at a pressure of 50 pounds per square inch. The used water runs down the trough, washing off some of the mud before the oysters reach the spray.

The oysters are discharged directly from the elevator into a receiving bin on the wharf, with a capacity of 500 to 600 bushels of oysters. Some bins are lined with iron plate.

PRECOOKING

There are two systems of precooking, both differing from the method followed in the eastern oyster canning industry.

Batch process.—In the first method the oysters slide from the receiving bin into an empty steaming car halted below (Fig. 51). The loaded cars are pushed along the track to a steam chest, which is a cylindrical, horizontal retort of heavy construction with doors at each end (Fig. 52). There is a 4 inch drop in the grade of the track through the retort allowing the loaded cars to be pushed out easily when precooking is finished. The steaming cars used on the Pacific Coast are approximately 3 feet wide, 5 feet long, and 1 foot deep, and have a capacity of 8 standard U. S. Bushels. Steam chests are built in several sizes from a capacity of 3 to 7 cars.

There is wide variation in the time and temperature of precooking, depending on size and condition of the oysters, but also due to the preference of the individual canner. In one representa-

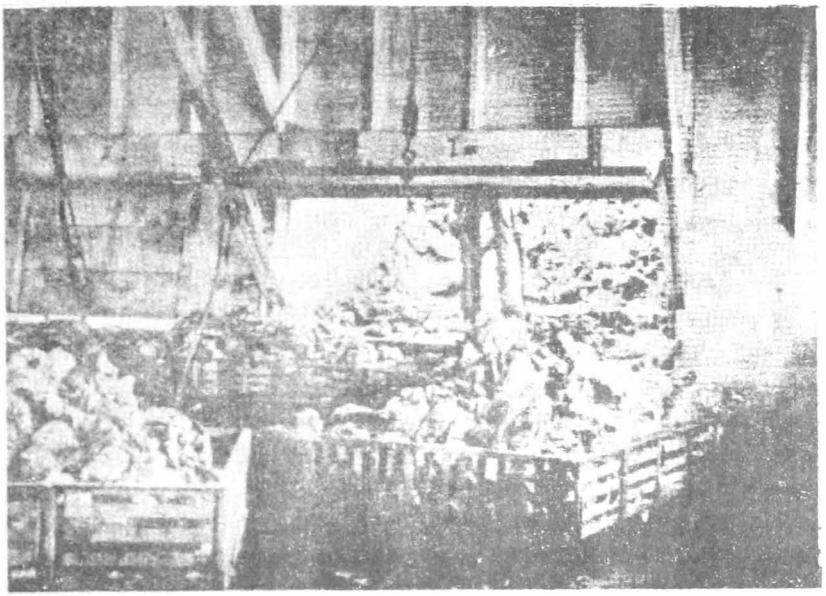

FIGURE 51.—Loading steaming cars of Pacific oysters from a receiving bin. (Courtesy, O. Wendt, H. Cron Company.)

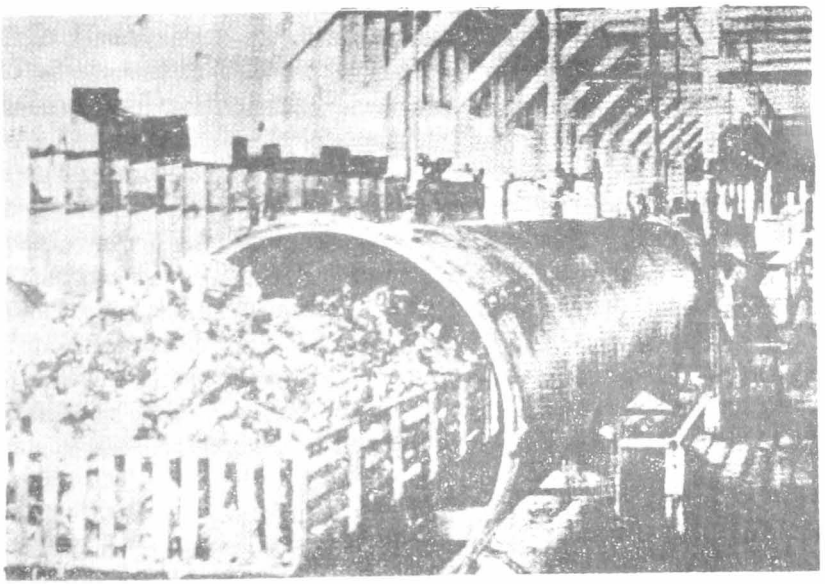

FIGURE 52.—Steamed Pacific oysters emerging from retort. (Courtesy, O. Wendt, H. Cron Company.)

tive modern plant, oysters are steamed from 3½ to 4 or 6 minutes at 240° F. (10-pound pressure). Other precooks used are 10 to 15 minutes at 212° F. (atmospheric pressure) and 5 to 10 minutes at 240° F.[17]

The shucking tables are large troughs in which the cars run on rails. There are wide ledges on each side, level with the top of the loaded cars. The oysters are shucked from the cars into 3-gallon buckets, which contain 1 gallon of water or 2- to 3-percent brine. The brine prevents crushing or bruising of the meats when they are placed in the bucket. Water or brine is also necessary to prevent oxidation of the meats, since the protective mucous coating of the oyster meat is destroyed in precooking, and the meats discolor rapidly if exposed. The method of shucking and the knives used are the same as in the Gulf Coast oyster canning industry. Shells are tossed into the trough, falling onto a conveyor below the tracks, which carries them to a shell conveyor outside the cannery.

Continuous precook. — In the second or continuous precook method, the oysters are conveyed from the washer, or storage bins, to a continuous cooker. Workers along the conveyor inspect the oysters and remove dead shell. The continuous cooker is simply a slat conveyor enclosed by a cylindrical or rectangular housing, which should be at least 12 gage galvanized iron, and insulated with asbestos.

According to McKee (1938) the slat conveyor which carries the shell stock through the cooker consists of two parallel chains, riveted pintle type, riding on angle iron rails on each side of the cooker. Wooden slats are bolted across, joining the two chains and forming the conveying surface. These slats may be of 1 by 2 inch material and 40 inches long, depending on the width of the cooker. A space between the slats of about ¼ inch, allows steam to circulate, and the slats may be perforated in order to provide additional circulation. Instead of the wooden slats, metal cross ties or bars may join the two side chains at 24 inch intervals and over these cross ties may be laid a chain link conveyor belt which has been woven from 12-gage wire with a ¾-inch mesh. This type of conveyor surface allows a maximum of steam circulation and is more sanitary as it permits more thorough cleaning.

Perforated steam pipes extend the full length of the conveyor both above and below, providing moist steam so that the oyster meats will not be burned. The cooker is supplied with dry heat by a series of unperforated steam pipes, also extending the full length of the cooker, with no outlet except a small "bleeder" valve

[17] American Can Co. The canning of Pacific (Japanese) oysters. Bull. Research Dept. 11 pp., 1 fig. Portland, Oregon.

at the lowest end. The maximum temperature in the cooker is not more than 210° F. The entrance and discharge ends are partially closed by means of a series of canvas baffles hanging from the top of the cooker. Clusters of oysters push the baffles aside which fall down into place again as the oysters pass.

The approximate length of the precooker is 75 feet and the average time required for precooking is 7½ minutes. When it is necessary to increase or decrease the rate of operation with change in the size of the oyster clusters, age of the oysters, or the ability of the shuckers to care for the output of the cooker, speed of operation may be altered by a variable speed device.

From the cooker the oysters are discharged onto a 12-inch wide steel opening belt which passes between two parallel rows of galvanized iron bins. The steamed oysters are plowed off the steel belt and into the bins within reach of the shuckers, who work at intervals about 30 inches on each side of the opening belt, opening the oysters on short boards placed across the bin in front of them. Shells are thrown through an opening under the steel belt falling on the lower or return half of the belt, and are carried to the far end where they are plowed off onto the shell pile conveyor. A 75-foot cooker with a 140 foot opening belt delivering to 30 shuckers on each side, will handle 4,000 bushels or more in an 8 hour day, depending on the size and condition of the oysters.

According to McKee[18] the advantages of the continuous system over batch precooking in retorts are:

1. Continuous flow of raw material.
2. Less labor is involved.
3. Less room is necessary and the whole process may be arranged in a straight line if so desired.
4. The loss through shrinkage is less.
5. The volume of raw material which can be handled is greater.

He reported the disadvantages of the continuous method of precooking as:

1. The first cost of equipment is higher since the installation of more machinery is required.
2. It is more difficult to remove the oysters from the shell, and more care must be taken to prevent cut and torn oysters since the oysters are not cooked so thoroughly.

WASHING AND GRADING

The shucked oysters are washed in a metal tank equipped with a perforated plate just above the bottom which is similar to the washer used for fresh shucked oysters. Compressed air is admitted below the false bottom aerating and agitating the wash

[18] McKee, Lynne G. Personal communication to Norman D. Jarvis, 1938.

water with which the tank is filled. Oyster meats placed in the tank are kept in constant circulation. Washing with this apparatus is a batch operation and the efficiency is at least partially dependent on the hand labor employed.

One packer has invented a special washer which works very effectively, is continuous in operation and is not so dependent on the cannery employees. It consists of a long shallow water tank through which a wire mesh belt conveyor travels near the surface of the water. Compressed air is blown through the water so that it is well aerated. The shucked oysters are emptied onto the belt conveyor and by the time they reach the discharge end any shell, sand or other debris is removed, leaving clean meats.

The oyster meats fall from the washer onto an endless white rubber grading belt of the type used in fruit canneries. Six girls act as graders, separating the meats into grade sizes and placing the oysters in large enamel basins as they are sorted. The grade sizes are usually large, medium and small, with the cut or damaged oysters as a fourth grade known as cuts or soup stock. Any dark or discolored oysters are discarded.

The best types of canning oysters are those which are round and fat. Round oysters pack into the containers more easily than elongated oysters and result in a better quality pack from the standpoint of appearance. Processed oysters which are too thin have a grayish-yellow color in the region of the livers.

FILLING

The packers count the oysters into the cans by hand (Fig. 53). The count per No. 1 tall can is usually 6 to 7 if the oysters grade large, 8 to 14 if medium, and 15 to 20 if small. The filled cans are weighed to insure a correct fill-in weight and an extra oyster is placed in each can to counter any excess shrinkage in processing. In contrast to Gulf Coast oyster canning methods, the greater part of the shrinkage occurs in processing, the amount of shrinkage varying according to the district from which the oysters were obtained, the condition of the oysters and the season. The filled cans pass under a perforated pipe and are filled with hot 2½- to 3-percent salt brine.

The usual range of fill-in weights used in canning Pacific oysters is: 7 to 9 ounces for a No. 1 Picnic (Eastern oyster) can with a cut-out (drained) weight of 5 ounces after packing; 10 to 13 ounces for a No. 1 tall can with a drained weight of 8 ounces; 14 to 16 ounces for a No. 2 can with a drained weight of 10 ounces. Regular cuttings should be made of each day's pack to make sure that the required cut-out weight is obtained.

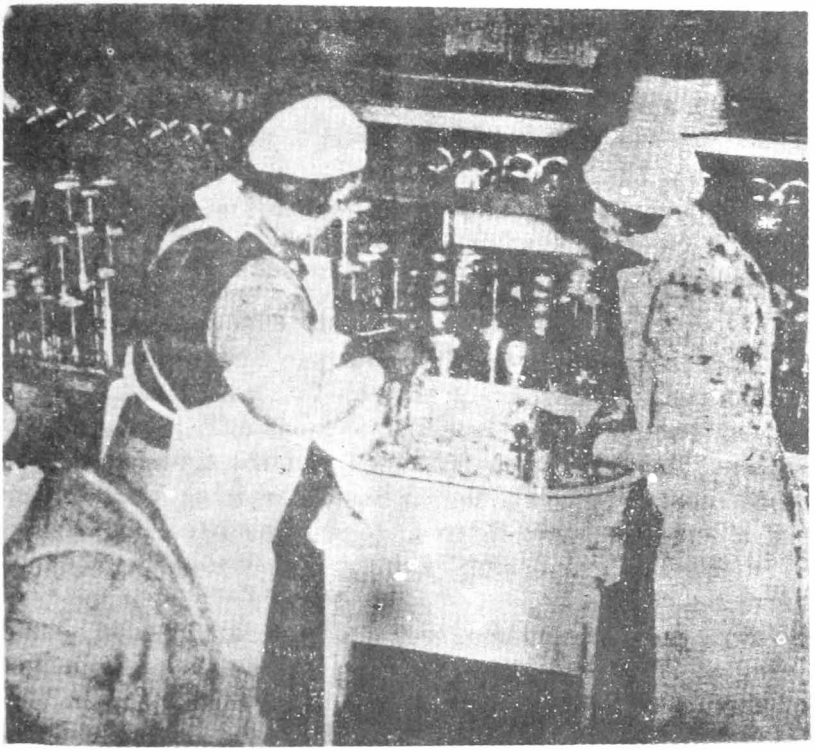

FIGURE 53.—Filling the cans with Pacific oyster meats. The oysters are counted into the cans which are then weighed. (Courtesy, O. Wendt, H. Cron Company.)

EXHAUSTING AND SEALING

The conveyor then carries the cans through a "clincher" which crimps the lids on lightly, and through an exhaust box where they are given a steam exhaust of 5 minutes at 208° F. Some packers seal immediately after brining. This is not considered a good practice as the vacuum obtained does not average much more than 3 inches, where it should be not less than 10 inches. The use of vacuum closing machines in canning Pacific oysters is particularly recommended by canning technologists, but these machines are not yet used to any great extent.

Regardless of the method of exhausting, the cans should be filled so that the solids do not protrude above the liquid level, since the exposed surfaces will acquire a brownish-yellow discoloration due to oxidation during the process. If a heat exhaust is used, cans may be filled entirely full of brine when the end is applied. If a vacuum closing machine is used, the cans should be uniformly filled with brine allowing from $\frac{3}{16}$- to $\frac{1}{4}$-inch headspace to insure a satisfactory vacuum being created in the can by the closing machine.

The cans of oysters are discharged from the exhaust box onto the conveyor of a closing machine, which completes the seal. The sealed cans are stacked in salmon "coolers" which are loaded on trucks and taken to a horizontal retort.

PROCESSING

Representative processes used in canning Pacific oysters are: No. 1 Picnic (Eastern oyster) cans, 20 minutes at 240° F. (10-lb. pressure); No. 1 talls, 35 minutes, and No. 2 cans, 42 minutes at the same temperature and pressure.

COOLING, WASHING, AND STORAGE

The pack is water-cooled in the retort by heavy sprays from perforated pipes. It is usually allowed to stand at least two days in the warehouse before labelling and casing. Practically all of the canned Pacific oysters are coded, but the code is not as elaborate as those used in salmon or shrimp packing, usually consisting of a letter and two figures. The labels are similar to those used in the Eastern oyster canning industry in design but are modernized.

The cans used are not lacquered but have outside enamelled ends. A lining of "C"-enamel, seafood formula, is also recommended to avoid discoloration of can and contents through the formation of metallic sulfides. The methods of storage and examination of the canned pack are similar to those used in the Atlantic and Gulf Coast oyster canning industry.

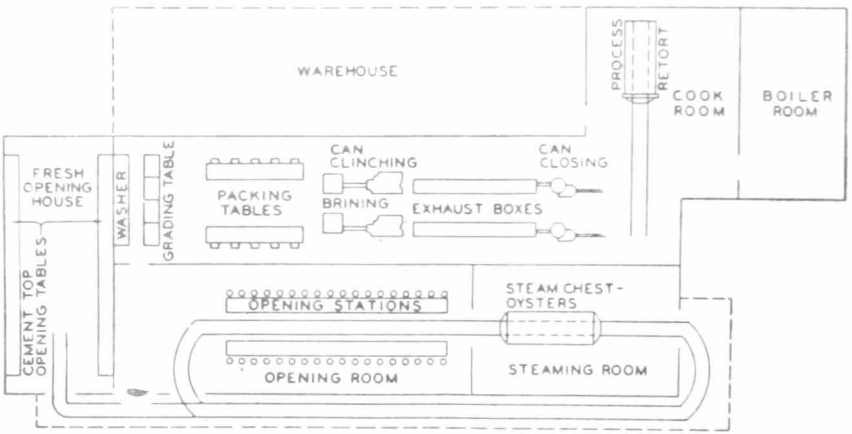

FIGURE 54.—Floor plan of a Pacific oyster cannery. (Courtesy, American Can Company.)

SMOKED OYSTERS

Smoked oysters, packed in "quarter oil" sardine cans have been imported into this country for some years. However, a method of smoking and canning oysters has recently been developed by packers of Pacific oysters in the State of Washington.

Smoked oysters are strictly a specialty product and are sold as an appetizer. Pacific oysters are used which have not attained normal growth in the first 9 months to 1 year after planting, due to adverse growing conditions. Medium-sized Pacific oysters may be used if the pack is to be fancy-grade. Experimental packs of canned smoked oysters have also been made with oysters too large for the commercial processed oyster pack and these are cut into pieces 1½ to 2 inches square prior to smoking. However, no commercial packs of cut smoked oysters have yet been made.[19]

Smoking.—The washed and drained oyster meats are placed in heavy galvanized wire mesh bottom trays. Only one layer of oysters should be placed in a tray, spread so that the smoke can penetrate uniformly. The wire mesh should be oiled with lard oil or a tasteless salad oil before use to prevent the meats from sticking. The filled trays are stacked 5 or 6 deep on fixed racks inside the smokehouse though movable racks may be used.

The smokehouses used for smoking oysters are of the same general type as for smoking salmon. They consist of a lower story, 8 to 10 feet high, sometimes called the "fire pit," in which the fire is built, separated from the upper story, usually from 8 to 12 feet high, by a grid of iron, which serves as a place for the workers to stand in loading and unloading. Drafts in the fire-pit door, and movable louvers in the top of the upper section provide for circulation of smoke. The smokehouse may be of brick, concrete or heavy galvanized iron construction but use of the last is not recommended as humidity and temperature are more difficult to control.

Crab-apple wood is preferred for smoking, but any hardwood should be suitable. A low fire is built down the center of the fire pit floor and allowed to burn with a clear flame for 1 to 2 hours, until the oyster meats have dried. The fire is then partially smothered so that a fairly dense smoke is obtained. The meats are cured in this smoke for 3 to 4 hours. If they are to be canned, oyster meats should not be smoked until dark and hard, because a light cure is regarded as producing a more appetizing product both in flavor and appearance.

Filling.—After cooling, the meats are filled into ¼-pound salmon cans by hand. The amount of oysters placed in each can is 2¼ ounces by weight or 4 to 6 meats by count. Approximately ½ ounce of edible vegetable oil is added to each container.

Exhausting and closing.—Either heat exhaust or vacuum closure may be used to produce a vacuum which should be not less than 9 inches. If the cans are heat exhausted in a steam exhaust box,

[19] American Can Co. Canning of Smoked Pacific (Japanese) Oysters. Bull. Research Department 9 pp. Portland, Oregon.

the covers are clinched on loosely before containers enter the box. Five minutes at 209° F. should be sufficient for this style pack. Canning technologists recommend use of a vacuum closing machine in place of a thermal exhaust but so far as is known it is not used in the commercial canning of smoked oysters to date.

Processing and cooling.—The sealed cans are stacked in salmon coolers and taken to the retort for processing. A process of 60 minutes at 240° F. is used in commercial practice. The pack is water-cooled in the retort to a temperature of 100° F. by a spray cooling system and is usually allowed to stand 48 hours before labeling and casing.

SQUID

In the United States squid are canned only in the Monterey Bay area of California. The pack is small but is increasing in size, with the most important markets in the Philippine Islands and in California. The Chinese and people of Latin or Greek descent are the principal consumers of canned squid in California.

The only species canned is the common squid *(Loligo opalescens)* of the Pacific Coast, which has an elongated, pointed body, with triangular fins near the posterior end. The range of this squid is from Puget Sound to San Diego. While a few squid are caught throughout the year the period from about April 1 to June 30 is considered the regular squid fishing season.

The fishing area is almost entirely within the limits of Monterey Bay, with the waters off Moss Landing and Watsonville as important catching areas. Sardine nets such as half-ring nets are probably used most widely, with some lampara nets and a few purse seines. Like sardines, the schools of squid can usually only be located at night in the "dark of the moon," by the phosphorescence of the water resulting from their movements. The only distinction in locating squid rather than sardines, is that the former species causes a "fluttery" or "wriggly" phosphorescence in the water while for sardines it is more or less in straight lines.

The squid are landed at Monterey within 2 or 3 hours after catching, so that no special care in handling is required. They cannot be unloaded by the sardine pumps at the canneries, so are unloaded at the fresh fish market dock The squid are unloaded into wooden fish boxes which are transported to the cannery by truck or they may be piled loose in a deep truck body.

At the cannery the squid are transferred to storage bins, from which they are removed as required. The method of handling depends on the style of pack which may be either "with ink" or "in oil." If the squid are to be canned "with ink," that is, without removing the sepia bag, they are simply washed thoroughly and

are not eviscerated. If they are to be canned "in oil," they are washed and dressed, removing the sepia bag.

For precooking, the washed and drained squid are piled in thin layers in sardine frying baskets, 18 inches square and approximately 6 inches high. If the cannery is equipped for tuna canning, the baskets are trucked into tuna cookers; if not, they are placed in the processing retort and are given a precook of 45 minutes at 216° F.

After precooking the squid are cooled for about 2 hours and then taken to packing tables to be filled into containers. Three sizes of container are used, No. 1 picnic, No. 1 tall, and ½ tuna cans. Girls fill the squid into the first two sizes "asparagus style," that is, vertically. Squid packed in ½ tuna cans are coiled in horizontally. A No. 1 picnic or 9 ounce can as it is called locally, should hold 3; a No. 1 tall, 4; and a ½ tuna, 2 squid. The first two sizes of cans are used when packing "with ink" while squid in ½ tuna cans are packed only in oil.

The filled cans travel by conveyor to the exhaust box. If squid are being packed in oil, a girl stands by the conveyor and pours 2 ounces of cottonseed oil into each can. The cans are exhausted without lids for 20 minutes at 210° F. Then the tops are placed on the cans and they are sealed by a double seamer.

The processes used are: No. 1 picnic and No. 1 tall cans, 75 minutes at 240° F. (10-lb. pressure), while squid in ½ lb. tuna cans are cooked 55 minutes at the same temperature and pressure. The cans are washed after processing and allowed to air-cool.

RAW PACK

The "raw pack" method was formerly used most widely in canning squid and is still followed by some packers. The raw squid are washed thoroughly then packed into ½ tuna, No. 1 picnic or No. 1 tall cans with fill-in weights of 8, 10 and 16 ounces respectively. The filled cans are exhausted for 15 to 17 minutes at 208 to 210° F. in a steam exhaust box. The exhausted cans are filled with hot 3 percent salt brine from a perforated pipe. The cans are then sealed, run through a can washer and given the same process as precooked squid.