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Canning Crabs, Lobster, and Shrimp

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CRUSTACEA

CRAB

Three species of crab are canned commercially in the United States and its territories, the "Dungeness" crab *(Cancer magister)* or common crab of the Pacific Coast; the "king," "deep-sea" or "Japanese" crab *(Paralithodes camtschatica)* taken in Bering Sea and the Gulf of Alaska, and the "blue crab" *(Callinectes sapidus)* or the common crab of the Atlantic Coast. Successful commercial canning of the latter varieties is a very recent development.

DUNGENESS CRAB

The Dungeness crab is taken as far north as Unalaska, but the commercial fishery in Alaska is confined to Southeastern and Central Alaska with Petersburg and Cordova as the two important producing centers. The Dungeness crab is fished commercially as far south as northern California, but is canned only at Marshfield and Newport, Oregon, Pillar Rock and Willapa Harbor in the State of Washington.

This species is much larger in size than the common or blue crab of the Atlantic Coast, some specimens measuring 9 inches across the back shell. It is illegal to take crabs measuring less than 7 inches across the widest part of the shell, under existing Alaska fishery regulations. Minimum size limits of 7½ inches are also fixed under the laws of the States of Oregon and Washington.

The crab fishing season in Alaska opens late in March, the date depending on weather conditions. Catches are light at this period, and the fishing is not at its best until warmer weather arrives about May 1. Fishing continues until December 1, but production slacks off about November 1. Alaska fishery regulations establish a closed season in which crab fishing is prohibited; which varies in the different fishing districts, but extends over a period of about 6 weeks when the crabs are soft and inferior.

Crab fishing is carried on during all seasons of the year in Oregon and Washington, but production is lightest in winter largely due to weather conditions. The canneries obtain most of their pack in summer months when prices for fresh crab are low. Fisheries regulations do not at present require a closed season in either Oregon or Washington.

The fishing method used most extensively in catching the Dungeness crab resembles Atlantic Coast lobster fishing in many respects. Traps are used, oblong and boxlike in shape, and the usual

dimensions are 3 by 2 feet, with a depth of 15 inches. The framework is made either of half-inch iron rods, or 1-inch strap or angle iron, and is covered with a heavily galvanized wire mesh. Into the two ends of the trap are fitted funnels of tarred cotton webbing, each fastened to a ring 6 inches in diameter at the inner end. The crabs enter sideways through these rings.

The trap is baited and the catch removed through a hinged door in the top. At each corner of the top is fastened an end of 6-thread steam-tarred bridle line running to a point about 2 feet above the center, where the lines are united and end in a loop. A buoy line ending in a wooden float is attached through this loop. Bait, either clams or fresh scrap fish, is placed in a webbing bag, hung in the center of the trap.

Details of fishing methods, transporting, and receiving are descriptive of the industry in Alaska. Methods differ to some extent on the Oregon-Washington coast, but the industry is largely centered in Alaska. The fishing is carried on at depths of 6 to 15 fathoms, and the traps are set at distances of 150 to 300 feet apart, depending on such condition as probable abundance of catch and nature of bottom. Small power boats equipped with a boom and power gurdy are used to set and haul the traps.

The tender picks up the buoy of the first trap on the line, and drops a previously baited trap nearby. The buoy line of the first trap is run through a block hanging from the boom, and is attached to the power gurdy, by which it is lifted to the surface and hauled inboard. On the way to the next trap, the crew of the tender remove the crabs and re-bait. This trap is then dropped by the second trap and the process is repeated until all the traps have been lifted. It is said that a crew of two skilled fishermen can handle a string of 150 traps a day, if the fishing grounds are good and weather conditions are favorable. Canners estimate that this number of traps, set on good fishing grounds, should furnish an average catch of 1,500 crabs per day. The catch is much less of course at the beginning and end of the season, if the bottom is not good, or if fishing conditions are unfavorable.

At the end of the day the fishermen take their catch to a live box anchored near the fishing grounds. The live box is a shallow crate, of no set dimensions, hung between two logs which act as floats, and is built of three-inch slats spaced two inches apart to permit a free circulation of water. The live crabs can be held in good condition for several days or even longer.

The live crabs may be taken to the cannery by a pick-up boat, calling at regular intervals, or the fishermen may use their own boat when enough crabs have been accumulated to make a load. Dungeness crabs are able to live out of water for several days if

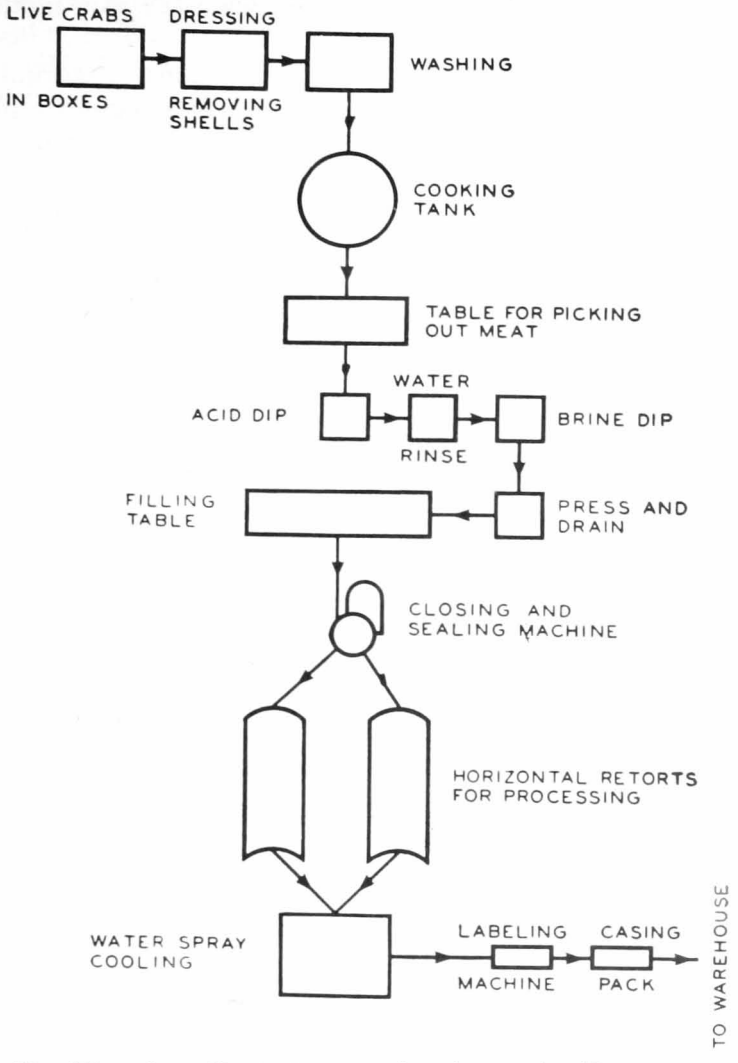

FIGURE 55.—Flow sheet illustrates procedure in canning Dungeness or Pacific crab.

kept cool and damp but die quickly in warm weather or if left in the sunlight. They are loaded into the hold of the boat where they are sprayed occasionally by a salt water hose. In cloudy cool weather a deckload may be carried. In this event, an awning is rigged above the deck and the crabs are kept sprayed with salt water.

The crabs are generally landed at the cannery in the late afternoon or evening. They are unloaded into large boxes which are hoisted to the cannery dock, where they are left until morning or if the catch is larger than can be packed during the next day, the surplus is placed in live boxes. While the crabs are still alive in the morning, they are not as lively as on landing and are handled

more easily. As a general rule, the fishermen are paid a flat price per dozen crabs regardless of size.

The crabs are taken to cleaning tables where a workman removes the back shell or carapace, by hooking the edge of the shell over a stationary hook and giving a sharp jerk. Another workman then cuts each crab in half by bringing the body down across a large knife blade fixed to the table. The viscera are removed and the body of the crab is thoroughly washed in a jet of fresh clean water under considerable pressure. This water is warmed sufficiently so that the hands will not be numbed in washing the crabs.

The cleaned and washed portions are taken to large cooking tanks filled with fresh water heated by live steam. In some canneries, sodium bicarbonate is added in the proportion of ½ pound to 40 gallons of water. This practice is not recommended and should be abandoned. It serves no useful purpose, increasing the natural alkalinity of the crab meat and neutralizing the effect of the acid dip given later in the packing operation. The crabs are dumped into the tanks of boiling water and are cooked for an average period of 20 minutes.

Some packers precook the crab in a steam chest for about the same length of time at a temperature from 212 to 220° F. More of the flavor of the meat is believed to be retained by this process, but packers who use the boiling-water cook claim the meat is more readily picked from the shells.

The crabs are given to the pickers immediately after cooking as the meat is removed more rapidly and completely if picked before the crabs have cooled. In picking, the workers break the shell on the legs with a small wooden mallet, then pound the shell of the body against the pan in which the meat is to be picked, which loosens and releases the meat without breaking it into small flakes. Body- and leg-meat are kept separate and about equal proportions are obtained of each. Unlike the crab meat of the Atlantic Coast, the leg meat is considered as the higher grade.

The picked meat is dipped in a dilute acetic acid solution for about 1 minute. This solution is made up in the proportion of 2 ounces of 28-percent acetic acid to 1 gallon of water. Following this treatment it is washed in fresh water and dipped in a 100° salinometer brine. The meat is then pressed to remove excess moisture, drained and taken to the filling tables.

Dungeness crab is packed in cans of three sizes, "half flats," "pound flats" and "No. 2" cans, with net weights of 6½, 13 and 17 ounces respectively. All cans are lined with "C" enamel, seafood formula, and a lining of vegetable parchment paper is inserted before filling as an added protection. Hand packers fill the

cans with a layer of leg meat on the bottom, top and sides, while the center is filled with body meat (Fig. 56). About ¼ ounce of salt is added to each can.

The trays of filled cans are sealed in a vacuum closing machine. The sealed cans are packed in salmon coolers and processed. There is some variation in processing, but all packers agree that it must be closely controlled, and that steam pressures around 10 lb. have

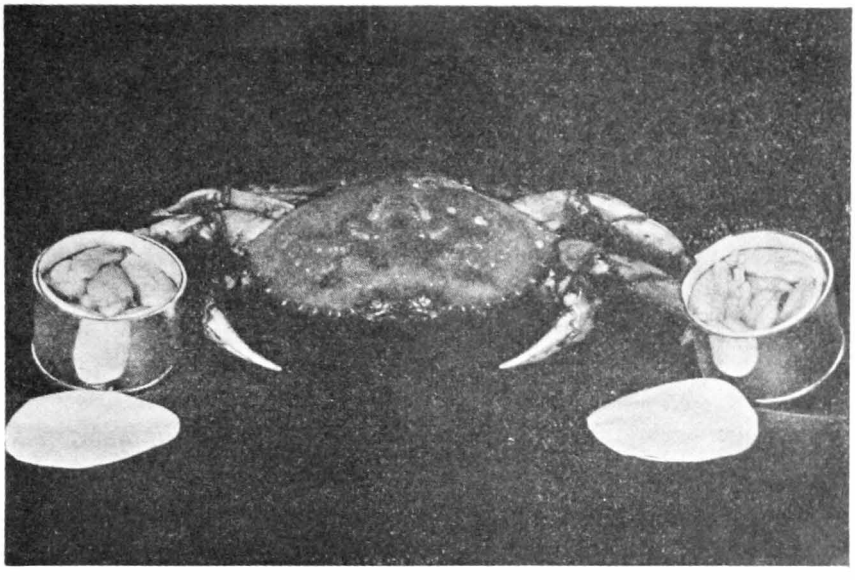

FIGURE 56.—Dungeness crab and cans of crab meat showing method of filling.

an adverse effect on the color of the crab meat. Representative processes now in use are: Half flats 90 minutes at 221° F. (3-lb. pressure) ; and for 1-pound flats and No. 2 cans 80 minutes at 228° F. (5-lb. pressure). The cans are cooled by a water spray system upon removal from the retort. When the cans are thoroughly cooled and cleaned they are labeled and packed in wooden or fiberboard cases holding 96 half flats, 48 pound flats, or 24 No. 2 cans.

KING CRAB

The United States fishery for king or deep sea crab is carried on off the coast of Alaska, mostly in the Bering Sea, with the Port Moller district as a favorite fishing area, but also to some extent off False Pass on the Pacific side of the Aleutian Islands and in the vicinity of Port Alitak. The king crab has been taken experimentally along other portions of the Alaskan coast, but is not fished commercially in these areas as yet. The fishery off the coast has been conducted by Japanese floating canneries but a domestic canning industry has been created within the last few years.

The king crab has a moderately sized body with extremely long legs. Some specimens may measure as much as 6 feet from tip to tip of legs, though the average range in size is from 3½ to 4 feet. It is estimated that the meat from one leg is equivalent to the contents of two 1-pound cans of crab meat.

The king crabs taken by the Japanese floating canneries are caught in anchored gill or "tangle" nets. These nets, made of tanned cotton twine, measure approximately 150 feet along the lead line, 165 feet along the cork line and 81 feet deep, according to data collected by the Fish and Wildlife Service. Japanese sources agree as to the length but give 10 feet as the depth. Japanese regulations call for a minimum legal net mesh of 18 inches, stretch-measure. Glass buoys, 5 inches in diameter, are used in place of floats or corks. They are enclosed in a net-like casing of manila fiber and are attached to the cork line by a short length of manila line. Bower (1931) reported that the buoy ropes are 30 to 50 percent longer than the depth of water, thus preventing the net from hanging as a vertical wall in which the crabs would not become entangled. Rocks are used as leads and one sinker is used to each float.

The nets are set and hauled from "Kawaskisen," open fishing boats of Japanese type about 9 foot beam, 45 feet in length, and equipped with a 10 horsepower semi-diesel engine. Each boat carries 500 nets, with a crew of 8 or 9 men, and from 4 to 10 boats are operated from each floating cannery.

The boats select a favorable fishing ground and set the nets. These are not anchored singly, but are attached to each other in gangs or lines of 20 nets, though longer strings may be operated. The fishermen first set out an anchor, with a large marker buoy, then pay out the nets, usually in a line parallel to the shore or with the current or prevailing wind. The end of the last net is anchored and marked by a flag and marker buoy. Fishing is carried on at depths of from 20 to 50 fathoms. The total amount of net fished at each set is estimated at from 10 to 14 miles. After all the gangs of net are set out, the fishing boats return to the cannery ship. A period of from 3 days to a week is allowed before hauling the nets, depending on weather and probable abundance of catch. Experimental studies by the Fish and Wildlife Service indicate that the otter trawl may be a more efficient type of gear than the tangle net, or small trap which is also used to some extent.

The fishing season has not yet been determined accurately in the domestic fishery, owing to the very recent development by United States interests. Japanese reports give a fishing season extending from April to September on the Alaskan coast, with the peak of production in late May and June. American interests have op-

erated from April until late in November and state that the peak of production is in the fall and winter months, with very light catches from June to October.

With a single exception, floating canneries are used by all canners, both American and foreign, on the coast of Alaska. These are factory ships entirely self contained, moving from one part of the coast to another as fishing conditions dictate, while the catch is both canned and stored on board the ship which transports its own production back to the home port.

As soon as the crabs are landed on the cannery ship, they are dismembered. The back shell is torn off, the viscera and other waste portions are removed and the portions to be utilized are washed and thoroughly cleaned. Butchering and cleaning before precooking is an important point in the method for canning king crab. If the butchering and cleaning were not done until after cooking as is the practice in preparing fresh cooked crab meat on the Atlantic Coast, a much longer period would be required, thereby increasing the possibility of discoloration in processing. Research data indicates that cooked crab meat deteriorates in quality much more rapidly than uncooked meat and is also more difficult to clean (Oshima, 1931).

The cleaned portions are placed in large wire baskets which are lowered into tanks of boiling salt water and cooked from 10 to 20 minutes. Immediately after the precook, the baskets are plunged into cold water in order to cool the meat to a stage where it can be handled promptly. The crab is then taken to cutting tables where the leg, claw and body meat are separated from shell and tendons and piled in baskets according to grade.

Four grades are used in sorting the meat. The meat obtained from the first segment of the legs is classed as fancy; leg meat of smaller sizes make up the second grade; broken pieces of leg meat comprise the third grade, while the body meat is considered as fourth grade and lowest in quality. The graded meat is washed thoroughly and picked over to remove any remaining fragments of shell, tendon, partially cooked flesh or other offal. The washed meat is allowed to dry on trays, each containing a single grade. When thoroughly dry the meat is delivered to the "cutters" who trim the pieces to fit the cans.

The crab meat is packed in cans known as "quarters," "halves," and "ones," with fill-in weights of 3½, 6½ and 13 ounces respectively. Most of the crab is packed in "halves." The cans used are inside enameled with "C" enamel, seafood formula, and are lined with vegetable-parchment paper. Foreign packers use either a three-piece lining or the ordinary one-piece lining. American packers use a special parchment-paper cup designed to fit the can.

The largest pieces of leg meat are laid out in a layer on the bottom; a layer of body meat is filled into the center and is followed by a top layer of leg meat followed by about ¼ ounce of salt. Under conditions where the pH of the meat has been increased between catching and cooking, or cooking and canning, or where there is a possibility of discoloration, about 20 cc. of a weak solution of organic acid, either acetic, citric, lactic or tartaric is added to each half-pound can.

The covers are clinched loosely and the cans are given a steam exhaust of 7 to 10 minutes at 200 to 212° F. Sealing is completed by a can closing machine as the cans emerge from the exhaust box. Vacuum closing machines are also coming into use.

Immediately after sealing the cans are piled in trays and are then processed. Information differs as to the process to be recommended, but it is agreed that a process too high in temperature or too long in time will affect the color and flavor of the product. The processing of "half-pound" cans may vary from 90 minutes at 221° F. (3-lbs. pressure) to 80 minutes at 228° F. (5-lbs. pressure). Bower, (1931) reported that the optimum process is 80 minutes at 221.5° F.

After the cans are removed from the retort they are scrubbed in hot water to remove any grease or other debris and then plunged immediately into cold water. It is essential to cool the product in the shortest possible time in order to prevent the deterioration in quality which would occur if the product were air-cooled. After the cans are removed from the cooling tanks, they are dried in air currents.

When the cans are sufficiently cool they are sent through an automatic lacquering machine, where they receive a light coating of colorless enamel as a protection against rust, after which they are labeled and packed in cases. A standard case consists of 48 "halves." The standard case of imported canned crab is 96 "halves" and weighs approximately 80 pounds.

BLUE CRAB

Although the blue crab accounts for 90 percent of the production of crab meat in the United States, it is marketed almost entirely as fresh meat. A method was developed for canning this crab as far back as 1878, but the pack has never amounted to more than 2,000 or 3,000 cases, and in some seasons has not been prepared at all. The most important obstacles are:

1. Size. The blue crab is much smaller than either the Dungeness or king crab, and the cost per pound of picking the meat is greater.

2. Markets. The fisheries for this crab are within easy reach of the principal centers of consumption. Under normal conditions

a more satisfactory price has usually been obtainable for the fresh crab meat.

3. Discoloration. The meat of the blue crab is more subject to discoloration than other varieties, and in contrast discoloration is not limited to the surface and in most cases is apparently not caused by metallic sulfides. Discoloration is the principal obstacle to the development of an Atlantic crab canning industry.

Fellers (1936) has developed a method overcoming discoloration in blue crab meat, and a commercial pack of canned blue crab, using this method was placed on the market in 1938. This method may be used only on payment of license fees to the patent holder. The essential factors of his method are:

1. Precooking the crabs at a minimum time and temperature.
2. Picking and packing the meat as soon as possible after precooking.
3. Treating the precooked meat with a dilute aqueous solution of aluminium sulfate (maximum of 0.04 percent added to meat).
4. The use of higher processing temperatures and shorter times.

LOBSTER

Lobsters are canned only occasionally and in small amounts within the United States today. The last large commercial pack in the United States was canned in 1907. United States lobster canners moved their canneries to British North American territory when depletion of the lobster supply and regulations governing the size of lobster which might legally be taken made commercial operation generally unprofitable here. The canned lobster consumed in the United States is packed almost entirely in the Canadian maritime provinces and the colony of Newfoundland. Small amounts are packed occasionally in the United States in glass containers, but the pack has no great commercial importance, selling exclusively to a specialized delicatessen trade. Lobster canning is practicable in British territory as regulations do not forbid the use of "shorts," that is, lobsters less than 9 inches, as is the case here. Raw material is also cheaper and more abundant.

The American lobster, found on the Atlantic Coast of North America from Cape Hatteras to the Labrador, belongs to the genus and species *Homarus americanus*. It looks like the freshwater crayfish but is much larger in size. It has large claws which are not common to the sea crayfish, "spiny lobster" or "rock lobster" (*Panulirus interruptus*). The latter is not a true lobster. The lobster is dark green in color when alive and may reach a record length of 24 inches and 34 pounds in weight. The greater part of the catch does not weigh much more than 2 pounds each.

Lobsters are caught by the use of small flat-bottomed and semi-cylindrical traps or "pots," averaging about 4 feet long, 2 feet wide and 18 inches deep, constructed of spruce or pine building lath nailed lengthwise to a framework of half hoops made of green hardwood. The ends are fitted with funnels of tarred cotton or manila netting, 1 inch mesh tapering to a 6 inch wire ring or wooden hoop at the inner end which extends about 12 inches into the pot. The trap is baited and the catch removed through a hinged door in the top of the trap. The trap is weighted with bricks, stones or other weights. Scrap fish or fish waste such as cod, haddock or halibut heads are used as bait, the variety depending on the kind of bait available. Menhaden, flounders, sculpins and skates are used quite commonly. Lightly-salted half-rotten herring is a favorite bait in some localities. Some fishermen claim that stale bait is most effective as lobsters are attracted by the odor.

Lobsters may be taken at any season, but are most abundant and considered in best condition in summer. At this time of year the traps are set close together at depths of 2 to 10 fathoms. In winter lobster pots are set farther apart at depths of 10 to 25 fathoms. A fisherman may haul his traps every day in summer or about 3 to 4 times a week in winter. He may take his catch directly to the dealer or buyer, or may hold it in a live box until a buyer calls. The live boxes of the fisherman are usually rectangular boxes made of lath or light planking on a heavier framework, with sufficient space between planks to allow a free circulation of water. If the lobsters are not to be canned immediately they are transferred to live cars at the cannery. Any delay between killing and canning increases the possibility of blackening in the canned product.

The lobster catch is graded for size by the fisherman when hauling his pots. Lobsters over 9 inches long are kept for sale as fresh lobster, and the greater portion is sent to the United States. Lobsters 9 inches in length and under are shipped to the lobster canneries. Large lobsters are also canned occasionally when prices are low and demand poor in the fresh lobster market. So far as known there is no difference in quality between the meat of large and small lobsters.

When the lobsters are to be canned they are dropped alive into a tank of boiling water containing from 3 to 5 percent salt. In a few of the smaller and more primitive canneries the water is heated by fires directly under the boiler. Other plants use boiling tanks fitted with closed coils along the bottom and the water is heated by steam. The lobsters are cooked from 15 to 30 minutes after the water again starts to boil, the amount of variation de-

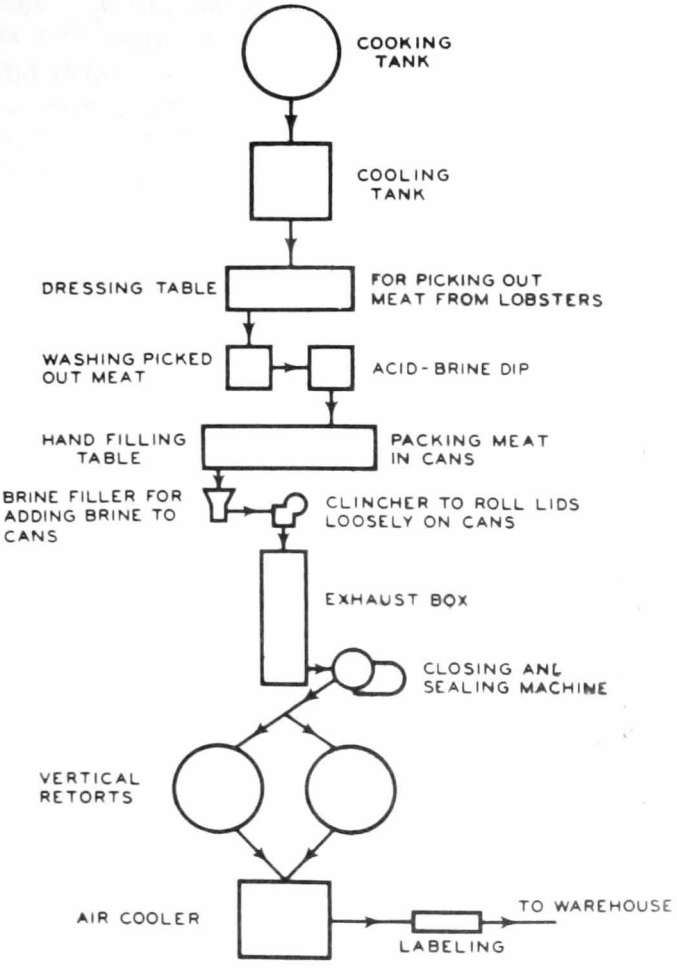

FIGURE 57.—Flow sheet for lobster canning.

pending on the quantity to be cooked at one time, and the size of the individual lobsters. The larger and more modern canneries cook the lobsters in lots of 500 pounds in live steam for 15 minutes at pressures from 5 to 10 pounds.

The cooked lobsters are cooled in a water spray or are lowered into tanks of water containing 5 to 6 percent salt. Cooling in sea water is not regarded as a good practice. Salt is added in cooking, both as a flavoring agent and to make the flesh somewhat firmer in texture. The lobsters are then piled on dressing tables where the tail and claws are pulled off, the body is split open, and the offal is removed. The meat is picked out by hand using a specially designed heavy knife. The tail is cut so that the meat may be removed in a few large pieces, the claws are cracked and the meat is pulled out with as little breakage as possible. The

flesh from the legs is picked out in small pieces. The meat is sorted in picking and each grade is kept separate.

The picked meat is cleaned of clotted blood or other offal and is washed thoroughly but is not allowed to soak in running water. After draining it is dipped in brine containing a small amount of organic acid, usually citric, though acetic acid may be used. The added acid reduces or prevents darkening of the flesh through the formation of iron sulfide and lowers the pH. The amount used is so small that no acid flavor may be detected in the canned product.

Lobster is packed in quarter, half, three-quarter, No. 1 flat, No. 1 picnic and No. 1 tall cans having net weights of 3, 6, 9, 12, 7½ and 16 ounces respectively. The cans are "C"-enamel lined, seafood formula, with a second lining of vegetable parchment paper. Most of the pack is put up in quarter- and half-flat cans.

Cans are filled by hand, placing the tail meat on the bottom, the small pieces of leg meat in the center and claw meat on top, dark side up in "shingle fashion," alternating right and left claws to secure a good fill. To be suitable for canning, white meat must be free from discoloration and the red meat must have a clear bright color. Fancy grade canned lobster should contain only tail and claw meat. As the meat shrinks about 14 percent in processing, allowance must be made for this factor in filling the cans. Thus 7 ounces of meat are necessary to secure a cut out weight of 6 ounces. All filled cans are weighed to guard against under filling.

A small amount of 2- to 2½-percent salt solution is added to each can, that is, about ½ ounce for quarters, 1 ounce for halves, and 1½ ounces for ones. The brine must be freshly made and is boiled 30 minutes previous to use. It preserves the fresh lobster flavor in the canned product and aids in reducing darkening of the meat through over-processing.

Covers are clinched loosely on the filled cans which are exhausted for 9 to 12 minutes at 210 to 212° F. in hot water or steam exhaust boxes. The "exhausted" cans are sealed and processed. There is a great deal of variation in processing. The processes given here are used commercially but their accuracy has not been determined and the canner must judge their desirability on use. Quarter-pound (300 x 108 cans) with a 3-ounce fill are processed 40 minutes, half-pound cans (207 x 200) with a 6-ounce fill 45 minutes, and one-pound (404 x 206) cans with a 12-ounce fill 75 minutes, at 240° F. (10-lb. pressure).

The cans are water-cooled immediately after processing in a heavy water spray, or by immersion in cooling tanks. They are then cleaned, inspected for defective containers and stacked for labeling.

The cans may be labeled either by hand or machine after which they are packed in wooden cases of 96 halves or 48 ones for the European export trade. Lobster shipped to the United States is usually packed in fiberboard cases containing 1 or 2 dozen cans. Storage at temperatures about 40 to 50° F. is considered preferable if the pack must be held any length of time before sale and shipment. It is estimated that an average of 200 pounds of live lobster is required for a case of 96 halves. Breast, knuckle meat and liver are made into lobster paste. The lobster bodies are ground, packed in cans and sold as animal food.

SHRIMP

Shrimp packing is the most important seafood canning industry of the Gulf of Mexico and South Atlantic areas of the United States. It is estimated that the common shrimp, *Penaeus setiferus*, furnishes about 95 percent of the commercial catch, and the grooved shrimp, *P. brasiliensis*, 2.5 percent (Weymouth, Lindner and Anderson, 1933). These are the only species utilized in canning. The shrimp has a very short life history. According to Johnson and Lindner (1934), they probably survive barely a year. These references contain detailed accounts of the life history of the common shrimp together with much information on methods in this fishery.

The shrimp canning industry has placed itself under a voluntary inspection system administered by the Seafood Inspection Service of the U. S. Food and Drug Administration. To obtain this service the individual packer desiring inspection must apply for it. In order for his request to be granted, his equipment must comply with certain standards and the operation of the plant must conform to certain regulations drawn up by the Administration. The pack may not be shipped until passed by the inspector as satisfactory. Approximately 90 percent of the total pack is prepared under this inspection system, which has done much to improve the quality of the product and has resulted in the introduction of improved methods.

FISHING AREA AND EXTENT OF INDUSTRY

Shrimp are packed at 50 canneries located in Texas, Louisiana, Mississippi, Alabama, Florida, and Georgia. In Texas shrimp are canned at Corpus Christi, Aransas Pass and Palacios. Louisiana is the most important State in the shrimp canning industry and accounts for approximately half the catch. The industry is centered around New Orleans and Houma. The majority of the Mississippi shrimp canneries are in Biloxi and in Alabama shrimp are packed only at Bayou la Batre. In Florida shrimp are canned

at a single locality on the Gulf Coast, Appalachicola, and only at Fernandina and St. Augustine on the Atlantic Coast. The Brunswick and Savannah districts are the shrimp canning areas of Georgia. Canning has been found unprofitable and has been abandoned on the northern coast of Georgia and in North and South Carolina.

The canning season opens about August 15, with the heaviest production usually in September and October on both the Atlantic and Gulf Coasts. Production declines gradually until after the first of the year when it reaches a minimum. The Gulf of Mexico also has a spring canning season running from about April 15 to June 10 with the peak of the season usually in May.

FISHING METHODS

The otter trawl is the chief type of gear used in catching shrimp for canning. This net, known as the shrimp trawl in the shrimp fishery, consists of a long bag in which the shrimp are caught and held; wings or walls of netting at each side of the bag, used in guiding shrimp into the bag; an "otter board" at the outer end of each wing, with the function of keeping the wings stretched apart and the mouth of the net open, while they also force the net to the bottom; and two tow lines, manila ropes 5/8 inch in diameter, attached to the otter boards and made fast aboard the fishing boat.

The nets vary from 20 to approximately 100 feet wide at the mouth. As a rule the smaller sized nets are used in the Gulf of Mexico. Molded leads are fastened to the "foot rope" or lead line at the bottom of the net, spaced from 4 to 20 inches apart, the intervals between leads shortening towards the otter boards. Corks or floats 3 to 4 inches in diameter are spaced from 2 to 8 feet along the top or "cork line." Shrimp trawls are made of cotton webbing, with a mesh of from 1½ to 2 inches, stretch measure. The mesh of the bag, or "cod end" is usually smaller and of heavier twine.

Unlike other otter trawls, two tow lines are used, one to each otter board. In the Gulf area these lines run to a winch in the bow, through snatch blocks mounted on each side of the wheelhouse at front and rear. The winch has usually been operated by hand, though power winches are now coming into wide use.

When the fishing boat is over a likely spot, the end of the trawl is thrown over and the net is allowed to run out over the stern as the boat goes ahead at slow speed. When the net is on the bottom, the otter boards act like kites, spreading out at an angle of 45° to the course of the boat, holding the mouth of the net open. The boat then goes ahead at a speed of about 2 to 4 miles

an hour, dragging the trawl along the bottom. Any shrimp between the wings are thus forced into the bag. The length of time spent in dragging depends on the judgment of the fisherman, and may vary from 30 minutes to 2 hours. The depth of water in which the trawl is fished now varies between 5 to 90 feet, as productive areas at greater depths than were formerly fished have been discovered through the shrimp investigations of the Fish and Wildlife Service.

When the drag is completed, the boat is stopped with stern to windward so it will not drift down on the net, and the trawl is hauled in for removal of the catch. When the trawl is brought alongside, the "cod end" or bag is fastened to the sides of a collapsible rectangular wooden frame extending out from the side of the boat. The shrimp are removed by dip nets, which are "roused" or agitated in the water before lifting, to wash the shrimp. About 50 percent of the shrimp are already dead when they are taken out of the net and the rest die almost immediately. Fish, crabs, sticks, seaweed, and other debris are caught as well as shrimp, so the catch must be sorted and the trash discarded after it is brought on deck. The scrap fish may amount to as much as 50 percent of the catch.

TRANSPORTING THE CATCH

In the Mississippi and Louisiana areas, the canneries are located up bayous or at other points from 20 to 100 miles from the fishing grounds. Therefore, a transporter or "ice boat" must be near the grounds at all times, not only to receive the catch from the shrimp trawlers, but also to supply the fishermen with food and other necessities. A transporting boat usually anchors at some central spot to which the trawler brings its catch.

All transporters are shallow draft, with a maximum hold depth of not more than 5 feet. The hold is usually divided into compartments by removable board partitions, but is not insulated as experience has shown that the ice should melt at a fairly rapid and constant rate if the shrimp are to reach shore in good condition. The hold has a capacity of from 50 to about 200 barrels. A standard barrel of whole shrimp weighs 210 pounds. The hold is loaded in alternate layers of finely crushed ice and shrimp each about 6 inches thick. If the weather is warm, the layers of shrimp may be only 3 inches thick and the catch must be re-iced at the end of 12 hours if the boat has not reached the cannery.

Canning technologists believe that two improvements might be made in handling and transporting shrimp in order to further improve the quality of the canned product. First, the freight boats should follow the fishing fleet more closely, transferring the

catch on the fishing grounds. This would reduce the variation in condition of raw material within a single load. Secondly, the heads should be removed as soon as the shrimp are caught, icing down only the edible tail portions. When shrimp are headed within 30 minutes after catching, the objectionable "black streak" or intestinal vein is removed with the head. Absence of the black streak would probably do more than anything else in the opinion of the housewife to improve the quality of canned shrimp. Elimination of the head and viscera would also reduce the rate of spoilage in the raw material. Shrimp boats of the South Atlantic Coast head shrimp when they are caught but only when the catch is light or the shrimp are large.

At shrimp canneries operating under the voluntary inspection system of the United States Food and Drug Administration, the ice boats cannot unload until the inspector determines the general condition of the raw material. If he gives permission the shrimp are unloaded. If he decides the shrimp are unfit for canning, the load must be destroyed or taken to a reduction plant.

Several methods of unloading are in use. In the area including Texas, Louisiana and Mississippi, a man in the hold scoops the shrimp into a galvanized wash tub with a blunt edged shovel. He lifts the filled tub by hand and passes it to a man standing on the deck who in turn transfers it by hand to a man standing at

FIGURE 58.—Unloading, washing and inspection of shrimp. (Courtesy, Southern Shellfish Company.)

the head of the washing tank and inspection belt. Another common method is to swing a boom over the hold and hoist the tub of shrimp by block-and-tackle above the level of the wharf emptying it onto the end of the washer.

Some of the larger plants are introducing belt elevators of the general type used in other food canneries. The boot of the elevator is lowered into the hold, a man shovels the shrimp directly into the elevator and they are carried up to the washer by a belt with baffles spaced at regular intervals.

WASHING AND INSPECTION

There are many minor differences in the mechanical set-up of the apparatus used for washing and inspection of the shrimp upon unloading at the cannery. Generally, they are unloaded into a metal water tank with a baffle plate fixed several feet from the end extending above and below the surface of the water. The shrimp sink and are carried under the baffle plate and out of the tank on a conveyor belt. The ice in which the shrimp may have been packed is held back by the plate. The shrimp then fall into a revolving drum or "squirrel cage," where they are tumbled about, removing surplus water and any bits of debris such as seaweed, which is important, as shrimp are bought by weight. In Alabama, Mississippi and Louisiana some canneries use wire-mesh belt conveyors or vibrating screens for this purpose.

From the drum the shrimp are carried to the sorting conveyor which is usually an endless belt of wire mesh about 3 feet wide, 8 feet long and on a framework approximately 3 feet high. The shrimp are sorted as they pass over this belt by employees who work under the supervision of a government inspector. (Fig. 58.) Shrimp that are broken, torn, soft, discolored or otherwise defective are removed. This is an inspection for freshness and condition of raw material only. Other grading factors are not considered.

The shrimp fall from the end of a conveyor into a basket or metal lug box standing on platform scales. When the scales show a reading of 100 pounds net, the weight is checked, then noted down on tally sheets by a plant employee and the government inspector. Payment for the "green" shrimp is usually based on the figures shown on the tally sheets.

In Texas and on the Atlantic Coast, after washing and inspection the shrimp are iced down in refrigerator boxes or on the picking tables. This is done because the shrimp are landed at the cannery within an hour or two after catching and must be kept in ice several hours or they are not easily peeled. Shrimp landed at canneries in other areas have usually been held in ice long enough so that the shell is removed readily.

PICKING

As a rule, the baskets or lug boxes of shrimp are taken directly from the inspection belt to the picking room, where they are "picked" or "peeled." Shrimp are peeled entirely by hand, requiring a great deal of labor, as a satisfactory machine for this purpose has not yet been developed.

In picking, the body portion of the shrimp is grasped with the left hand, with the legs pointing outward and the head extending beyond the thumb. With the right hand the picker seizes the head and breaks it off, then inserts the thumb of the right hand between the rows of legs, breaking open the shell and peeling off a section about 1 to 1½ inches long. A pressure of the left hand on the tail of the shrimp forces the meat from the remainder of the shell. If the workmanship of the individual pickers is not inspected, the tails are apt to be torn off in order to increase the rapidity of picking. Thus, the last segment of meat is lost, increasing the loss in weight and also lowering the quality. It is believed the amount of clear, red color in canned shrimp is associated with the presence of this tail segment and decrease in amount of color makes the pack less desirable from a grade standpoint.

The picking room is entirely separated from the rest of the cannery, and the picking operation, like other steps in shrimp canning, shows evidence of improvement in handling. No two plants have exactly the same equipment and layout, but generally the whole shrimp are emptied from the baskets or lug boxes onto long metal or metal covered tables. These are about 25 feet long by 4 feet wide, usually sloping slightly from the sides toward the center, with each side divided into numbered spaces. A worker is assigned to each space and is given a corresponding number for identification. A metal flume is suspended above the middle of the table in some canneries or the table may be constructed with built-in flumes, running down each side.

The shrimp meat is dropped into the flume by the pickers as soon as the hull is removed. The hulls are dropped into a numbered bucket by the side of each worker. The piecework payment wage depends on the number of buckets of hulls picked by the worker. This method eliminates the delay which has always occurred previously in shrimp canning, through holding the meats in "cups" while picking. It also helps in washing the meats and is considered so highly that it was made mandatory in 1938 for all shrimp canneries under Federal inspection.[20] Only those canneries not under inspection now pick the meat into cups.

[20] U. S. Food and Drug Administration. Revised regulations for inspection of canned shrimp effective July 1, 1938. 12 pp. Food and Drug Administration, U. S. Dept. of Agriculture. Washington.

A cup of alum water stands by each picker, into which the hands must be dipped at frequent intervals as the shrimp heads contain digestive juices which have a corrosive effect on the skin, unless this solution is used. A picker will peel from 100 to 400 pounds of shrimp in a day, depending on the size of the shrimp and the skill of the individual. The loss of weight in picking averages from 50 to 55 percent.

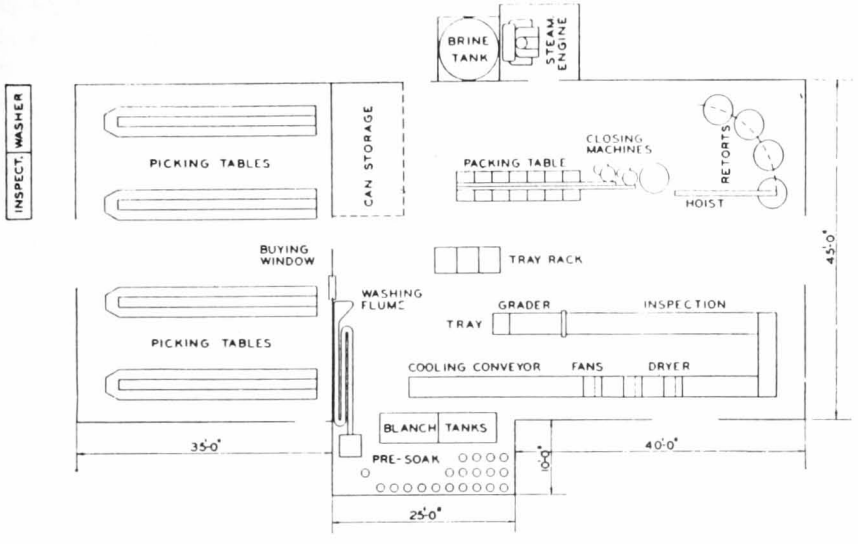

FIGURE 59.—Floor plan of a typical shrimp cannery. (Courtesy, American Can Company.)

PREPARATION FOR THE CAN

WASHING

After the shrimp have been peeled and the meats inspected, they are emptied into a washer. This is of the flume type and is usually constructed with built-in riffles or turns, whereby the meats are shaken about more vigorously and the effectiveness of the wash in increased. This flume also acts as a conveyor. At the end of the washer is a perforated metal plate or table where the wash water is drained away and the meats are again inspected.

BLANCHING

The "brining" or "pre-soaking" step has recently been abandoned by many packers. In theory it made the meats firmer in texture and was supposed to improve the color. This purpose is now accomplished by increasing the "blanch" or "pre-cook."

The washed and drained meats are emptied into metal baskets with a capacity of about 25 pounds. These baskets are lowered into a tank of boiling 50° salinometer brine. If the shrimp are to be canned "wet pack" they are blanched from 8 to 10 minutes, varying with size, or if preparing "dry pack" shrimp, 10 to 12

minutes. At the end of the blanching period, the baskets are raised by block-and-tackle and automatically dumped on a belt conveyor-drier.

One packer uses a continuous blanch which consists essentially of a tank of boiling brine, through which a conveyor passes. Wire baskets of shrimp are sent through the tank on this conveyor. The special features of this patented apparatus are the equipment for insuring uniform blanching.

Wooden blanching tanks described in the literature are no longer used, nor is brine made by adding salt to water in the blanching tank. Wooden equipment is not permitted, and practically all packers now use salt dissolving apparatus, manufacturing brine in quantities and storing it in tanks until it is required. The brine used in blanching is now tested and brought to strength between each batch of shrimp. The tanks are emptied and filled with an entirely fresh brine after every seventh cook.

Blanching is very important in determining the quality of the canned product. If the strength of the solution drops below 30° salinometer, the brine in the canned product may congeal, or "jell." Insufficient washing is also a factor in the congealing of canned shrimp during winter storage. Insufficient time in blanching may also cause jelling. If the brine solution is used for too many cooks or if too many shrimp are put in a basket, the brine will become "ropy" and the shrimp will have a ragged appearance. If the brine is not kept boiling vigorously, the meats will link together. This means that they will not curl, and therefore cannot go through the mechanical grader. The trade demands a well-curled shrimp and poorly curled shrimp are regarded as inferior. The loss in blanching or precooking is 45 percent of the picked weight.

DRYING

Some of the driers are simply moving wire-screen belts, above which are fixed large fans of the paddle wheel type. Others are enclosed by removable metal hoods and the fans are of the blower type. The shrimp which move over the conveyor at the rate of about 11 feet per minute are cooled and dried by currents of air from these fans. Approximately 3 minutes are required to dry the surface moisture from the cooked shrimp. The fan drier also removes antennae or "whiskers" and bits of shell. Drying is constant and not varied according to atmospheric conditions as was formerly the case. Therefore, portable screen trays on which cooked shrimp were dried in the open are no longer used.

INSPECTION AND GRADING

From the end of the drier the shrimp empty onto an inspection belt where they are scanned by several women who remove meats

which are broken or otherwise unfit for canning (Fig. 60). From the inspection belt the shrimp pass to the grader, which consists essentially of an inclined aluminum plate in which numerous holes are bored. It is divided into three sections. In the first the holes are $\frac{5}{8}$ inch, in the second they are about 1 inch, while in the lowest they may be $1\frac{1}{2}$ inches in diameter.

When in operation, the grader moves from side to side with a vibrating motion. The small shrimp fall through the holes at the top of the plate. The larger meats pass over the small holes, but fall through the larger holes near the bottom. The biggest shrimp or "jumbos" fall over the end into a basket. Underneath each section of the plate is a metal chute with a double tray. The shrimp fall through the holes, down the chute and into the trays. The

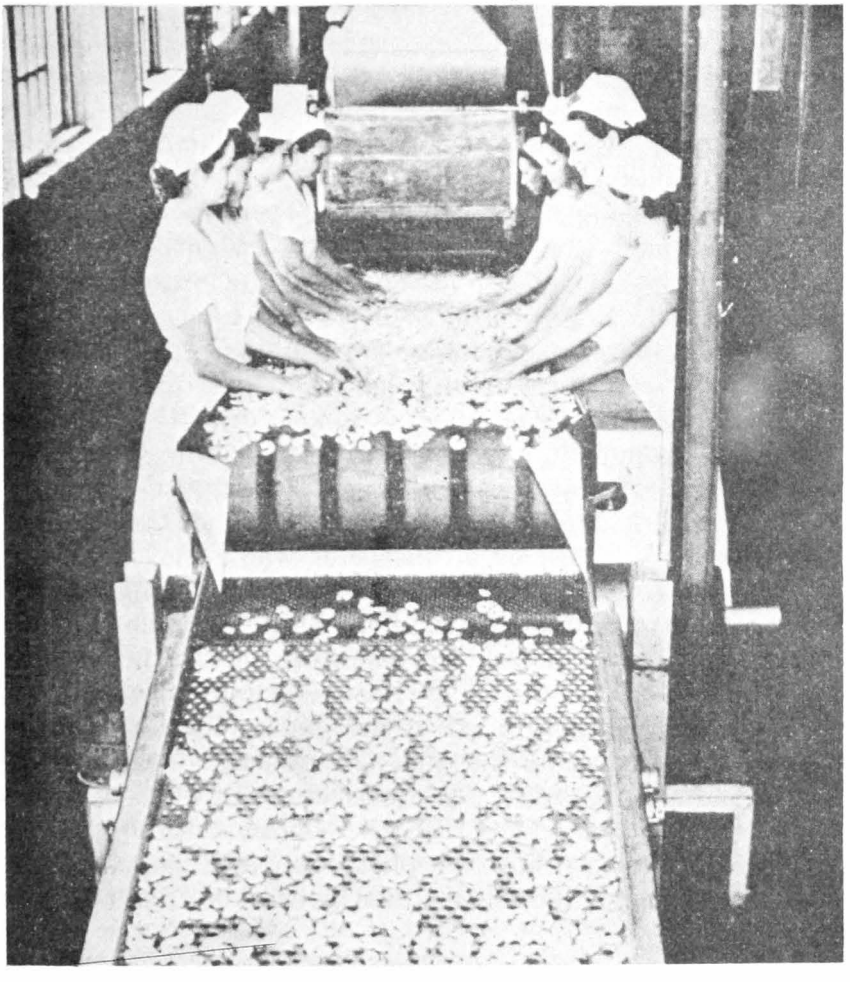

FIGURE 60.—Inspecting the cooked shrimp meats. Mechanical dryer in the background and a grader in the foreground. (Courtesy Southern Shellfish Company.)

filled trays are stacked in a rack nearby until sufficient shrimp of a size have been accumulated to justify packing that particular size or grade.

The "count" or number of shrimp filled into the can is the most important factor in grading. If the shrimp are to be packed as "extra large" or "jumbo," the count to a standard No. 1 can should be 20 or less, "large" may run from 20 to 25, "medium" from 25 to 40, and "small" over 40. "Pieces" must be so graded or as "broken" shrimp.

FILLING

The trays of shrimp are taken to metal surfaced packing tables with slotted spaces, just wide enough to hold a tray of shrimp. As a rule two girls work at each tray, one filling the cans while the other adjusts them to the correct weight (Fig. 61). No. 1 picnic (211 x 400) cans are used for the largest part of the pack. If "wet pack" shrimp are canned the drained weight must be 5¾ ounces for this size container, which requires a fill of 5⅜ ounces of shrimp meat as there is a slight increase in weight during processing, due to absorption of brine.

"Dry pack" shrimp in No. 1 cans are required to have a net weight of 5 ounces and are given a fill-in weight of 5⅛ ounces as there is a slight shrinkage in this method of processing. Cans for dry pack shrimp are usually lined with a one, two or three piece vegetable parchment paper liner. A three piece liner may be placed in the can more readily than a one piece liner. All cans are inside lined with "C"-enamel, seafood formula. Other sizes of cans used commonly, together with the fill-in weights are: Squat (307 x 208), wet pack 5⅜ ounces and dry pack 5⅛ ounces, and No. 1½ (307 x 400), wet pack 9¼ ounces, dry pack 9 oz.

The filling is watched by an inspector who removes occasional cans from the conveyor belt, checks the weights, empties out the contents, counts the number of shrimp to check the grade and watches for evidence of poor workmanship such as broken meats and bits of shell. In packing wet pack shrimp two methods are used in filling the cans with brine. In some establishments sprays of hot 2-percent brine fill the cans as they pass along a conveyor belt to the closing machine. In other canneries a 50- to 75-grain salt tablet, the size varying with the container, is dropped into each can, which is then filled with hot water as it passes along the belt. The tablets may be added either by hand or from a mechanical dispenser.

EXHAUST AND SEALING

Wet-pack shrimp are sealed immediately by a closing machine operating at a speed of 60 cans per minute. As the cans are filled

FIGURE 61.—Filling the containers with shrimp and checking the fill-in weight. (Courtesy, Southern Shellfish Company.)

with hot brine, creation of a vacuum mechanically or by heat exhaust is regarded as unnecessary.

Dry-pack shrimp may be given a mechanical vacuum seal or the cans may be sealed cold, without heat exhaust or mechanical vacuum. Vacuum packed shrimp are regarded as of superior quality, with a better color and flavor than non-vacuum packs, and constitute about 75 percent of the production of dry pack shrimp. Regulations of the U. S. Food and Drug Administration require a vacuum of not less than 12 inches in the can after processing, if it is to be labeled vacuum pack. The same process is given as for a non-vacuum pack. The process is shorter only if the cans are sealed with a vacuum in excess of 25 inches.

PROCESSING OR RETORTING

The sealed cans are stacked in retort baskets which hold about 640 No. 1 cans. A retort has a capacity of either 2 or 3 baskets. "Retorting" or "cooking" is controlled closely under the inspection regulations which also specify process times and temperatures. Wet-pack shrimp in No. 1 or squat cans are processed 20 minutes at 240° F. (10-lb. pressure) or 10 minutes at 250° F. (15-lb. pressure). No. 1½ cans are processed for 23 minutes at 240° F. or 12 minutes at 250° F. Dry-pack shrimp in No. 1 or squat cans are processed 85 minutes at 240° F. or 60 minutes at 250° F. if the can is lined with a one-piece parchment liner. If there is no liner or if a three-piece liner is used, the process is 70 minutes at 240° F. or 53 minutes at 250° F. While processing at 240° F. is permitted, the use of a 250° F. process is recommended as the better canning practice.

COOLING AND WASHING

At the end of the processing period the cans are water-cooled to a temperature of 98° F. before they are stacked in the warehouse. Canned shrimp may be cooled in special tanks or in the retorts. In the more up to date canneries or in the great majority of cases, the pack is cooled in the retorts. In canning wet-pack shrimp cooling in the retorts aids in preventing overcooking and softening, while in dry-pack shrimp it aids mechanically in pushing the can ends back in place, that is, where a non-vacuum seal is used. Alkaline solutions are not required in cleaning shrimp cans after processing.

STORAGE, LABELING AND SHIPPING

Shrimp usually are held about 48 hours before labeling and casing. Conditions of labeling, storage and shipping are specified in the inspection regulations. All inspected cans are now coded so that any lot may be identified. No lot or code may be labeled until it has been examined and passed by the inspector. In addition the thermometer chart must be checked to determine sufficiency of cook and each cook must be identified with the corresponding code mark and date. The packer is required to keep these records at least one year. A standard case of canned shrimp contains 48 No. 1 picnic cans.

Any labels used for inspected canned shrimp must be approved by the U. S. Food and Drug Administration; this ruling applies to canned shrimp only and not to other canned products. Such labels may bear the statement "Production supervised by U. S. Food and Drug Administration," which may not appear on uninspected canned shrimp or on shrimp intended for export. Both

labeling machines and hand labeling are used in labeling the cans. Each lot or "code mark" is stored and must be held separate. No lot may be shipped until the inspector issues a certificate to the packer, stating that the parcel complies with all regulations.

SHRIMP PACKED IN GLASS

An increasing amount of shrimp is being packed in glass. Only the best color grades in the larger sizes are packed in glass, since appearance is the principal sales appeal factor. The method of handling the shrimp is identical with packing in tin up to and including filling.

Several sizes of glass containers are used, but the most common are the 8-ounce tumblers, with a drained weight of 5¼ ounces and a fill-in weight of 5 ounces; and the 9-ounce tumbler which holds 6¾ ounces drained weight and 6⅛ ounces fill-in weight. If the containers are overfilled "jelling" occurs, while "slack fill" shrimp soon present a ragged, unattractive appearance. Other containers used are a tumbler holding 2½ ounces, packed principally for the English market, and a "nappy" jar for "cocktail" shrimp filled in rosette style. The containers are filled with a 3-percent brine, filled hot at temperatures varying from 160 to 180° F. The jars are sealed in a glass pack vacuum closing machine, under a vacuum of not more than 20 inches. Higher vacuums cause ebullition with loss of brine.

The sealed containers are placed in retort baskets with a rubber mat between each layer. Mats protect the enamel lids against damage during processing, such as fading, scratching or blistering. The process times specified for glass containers under inspection regulations are: 5 to 9 ounces inclusive, 22 minutes at 240° F. (10-lb. pressure) or 14 minutes at 250° F. (15-lb. pressure).

The pack is cooled in the retort under pressure so that lids will not be blown off the jars. The cooling water is admitted at a temperature of 190° F. until the retort is one fourth full; then at 170° F. until the half-way mark is reached; at 140° F. until it is three-fourths full, when the temperature is dropped to 100° F. When the retort is full, water runs through at normal temperature or at from 60 to 70° F., for about 10 minutes. The entire cooling process requires about 35 minutes (Anchor Cap and Closure Corp., 1926).

After cooling, the containers are dried, labeled by hand and packed in corrugated fiberboard cartons, 2 dozen jars to a carton. Glass-pack shrimp are very attractive as a display product, but the retailer should be warned that the glasses must not be left long in a strong light, as the shrimp may then become "light-struck."

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