PACIFIC SALMON[7]

The salmon canning industry is located on the Great Circle of the North Pacific coastal area extending from the State of Oregon to northern Japan, although salmon are caught commercially in the United States as far south as Monterey Bay in California. The total annual world pack of canned salmon in this area averages about 10,000,000 cases of 48 one-pound cans. Alaska is the most important of the political divisions in this area, accounting for almost 90 percent of the United States pack of canned salmon and 60 percent of the world production. While methods of preservation such as freezing, salting and smoking are important, more salmon are canned than are preserved in all other ways.

Salmon are also caught on the Atlantic Coast of North America but are not canned in quantities of commercial importance as the supply of raw material is limited and the flesh usually has a very light color after canning.

SPECIES OF PACIFIC SALMON

The first and most important fact to be considered in connection with salmon canning is, that not one but five species of salmon are canned. To understand the conduct of the industry, from methods used in catching to sale of the finished product, this must be kept in mind. A discussion of these species is therefore required.

The Pacific salmon are all included in the genus *Oncorhynchus*. With them the fishermen incorrectly group the steelhead trout, which really belongs to the closely-related genus *Salmo*. As long ago as 1731 the species of *Oncorhynchus* were first made known by Steller, who, almost simultaneously with Krascheninikov, another early investigator, distinguished them with perfect accuracy under their Russian vernacular names. In 1792 Walbaum adopted the vernacular names in a scientific nomenclature for these fishes.

The 5 species are: (1) *Oncorhynchus tschawytscha;* chinook, king, spring, tyee or quinnat salmon; (2) *Oncorhynchus nerka;* red, sockeye, blueback, quinault or redfish; (3) *Oncorhynchus kisutch;* medium red, coho or silver salmon; (4) *Oncorhynchus gorbuscha;* pink or humpback salmon; and (5) *Oncorhynchus keta;* chum, keta, calico or dog salmon. The first common name given is that used where the canning of the species is most impor-

[7] This section prepared by R. W. Clough, Chemist, E. D. Clark, Director, Northwest Branch, National Canners Association, and Norman D. Jarvis.

tant, followed by names used less often, while the last names listed are those applied by fishermen in some areas but seldom or never to the canned product.

The various species, while closely related phylogenetically, differ greatly in size, coloration, duration of life cycle, the behavior of the young fish and the character of the food of the adult. A brief description of the species, useful to the packer for identification purposes, is presented in table 10.

CHINOOK

The largest of the Pacific salmon is the chinook or king salmon (*O. tschawytscha*). It has a deep, thick body with a small head. The back is a deep olive green and the sides and belly are a silvery hue, the back, dorsal fin and caudal fin are marked with a varying number of round black spots, and the sides of the head have a peculiar tin-colored metallic luster. The fish has an average weight of about 22 pounds but specimens weighing from 80 to 100 pounds are occasionally taken.

As a rule the flesh is of a deep salmon red but it may vary from this shade to white among different specimens in certain fishing areas. Even within the individual this color variation may exist.

Although of the 5 species the chinook salmon is the most widely distributed geographically, in general it is native to a few great rivers. The most important of these is the Columbia, which supplies approximately two-thirds of the world's production of this variety in the canned pack.

RED

The red or sockeye salmon is relatively small in comparison with other species of salmon, averaging about 6½ pounds, with a maximum of 12 pounds. The body is slender with the head small and roundly pointed. The color of the back of the head and body is a clear bright blue above with the rest of the body silver without spots or minor markings.

The flesh is a deep orange red, while the oil is red. The texture is firm, as a rule. The attractive appearance and flavor made this species a "fancy" pack early in the history of the industry. As a result the demand exceeded the amount available and it was necessary to can other species of salmon with lighter colored flesh in order to supply the market. This difference in color gave rise to rumors that other species of fish were being dyed and sold as salmon. Even if this were permitted by law, the technical difficulties in successfully dyeing the flesh are practically insurmountable and the added packing cost would make it uneconomical.

TABLE 10.—*Description of the five species of salmon and the steelhead trout before canning*

Scientific name and common name	Weight		Length	Shape of body	Size of scales	Color of raw flesh	Distinguishing marks
	Maximum	Average					
	pounds	*pounds*	*inches*				
Oncorhynchus nerka (red salmon)	12	6½	17 to 32	Symmetrical	Medium	Deep red	No spots
Oncorhynchus tschawytscha (chinook salmon)	100	22	24 to 60	Robust	Large	Red to white	Back, dorsal fin, and tail covered with round black spots
Oncorhynchus kisutch (medium red salmon)	30	9	20 to 36	Elongated and flattened	Medium	Light red	Faint spots on back, dorsal fin and upper part of caudal fin
Oncorhynchus gorbuscha (pink salmon)	14	4½	15 to 27	Slender	Small	Pink	Large, oblong, black spots all over tail and on back
Oncorhynchus keta (chum salmon)	30	9	25 to 37	Robust	Large	Light pink	No spots
Salmo gairdnerii (steelhead trout)	45	12	--------	Slender	Large	Pale pink	Small black spots on dorsal, adipose and caudal fins

MEDIUM RED

This is the silver salmon, so-named because of the general silvery color of the body. It has acquired the name "medium red" from the color of the flesh, which is usually somewhat lighter in shade than that of the red salmon, but deeper than the chinook.

This species is the second largest of the Pacific salmons in size. It has an average weight of 9 pounds and a maximum weight of 30 pounds. It has some resemblance to the chinook and is sometimes mistaken for that variety but the spots are fainter, fewer in number, and smaller in size. While it is generally distributed in the coastal streams from the Eel river, California northward, the silver salmon appears late in the season so that comparatively few are canned.

PINK

The pink salmon is the smallest of the Pacific salmons but is the most abundant and furnishes more than 40 percent of the world's supply of canned salmon. The pink salmon averages 4 pounds in weight and rarely exceeds 8 pounds.

The shape of this fish is slender, with a small sharp head and relatively large tail. The color of the back is a light olive green. The body has numerous black dots, particularly on the tail. Although the flesh is rather light in color, the delicate flavor, tender texture and high food value have made it quite popular, while the abundance has permitted the price to remain low. The pink salmon is found in nearly all salmon areas from Puget Sound northward.

CHUM

The chum salmon is occasionally known as keta or white salmon. The average weight is about 8 pounds while the maximum weight is 16 pounds. When the chum salmon first appears along the coast the color is dirty silvery, immaculate or sprinkled with small black specks. The fins are dusky and the sides show faint traces of gridiron–like bars. Later in the season the male is colored brick red or blackish, and the jaws are greatly distorted.

The color of the flesh in the canned product ranges from a light pink to a yellowish white. The texture of the flesh is firm and the oil light yellow in color. As a rule this species when caught has little color and less oil than other varieties, consequently canned chum salmon brings a lower price although it is rather high in food value and can be made into appetizing cooked dishes.

STEELHEAD TROUT

The steelhead trout (*Salmo gairdnerii*) is commonly considered as one of the salmon by fishermen and is therefore included here,

though it does not belong to the genus *Oncorhynchus*. It is closely related to the Atlantic salmon (*Salmo salar*).

The steelhead has a slender body with a small head. The common name of this species is supposed to have originated from the hardness of the head. Numerous small black spots appear on the head and on the dorsal, adipose and caudal fins.

While the usual specimen weighs from 8 to 15 pounds, individuals of 45 pounds or more are sometimes taken. The color of the raw flesh is a pale pink. This fades almost to white in the canned product which is very rich in pale yellow oil. Very little of this species (about 0.3 percent of the total pack) is preserved by canning due to its lack of color. The steelhead trout has a wide range and is believed to be most abundant in the Columbia River area.

FISHING SEASONS

Only when the Pacific salmon gather in schools for their spawning migration may they be taken in quantity by the fisherman. It is during this comparatively brief period that they are in best condition for they are neither immature and feeding, nor has the fat and protein content been reduced by a long stay in fresh water.

Fishing seasons are established by State law in Oregon and Washington, and by Federal regulation in Alaska. The seasons vary with the different areas and are fixed to cover the periods of greatest abundance. In some areas closed periods of a varying number of hours each week within the season are provided to permit sufficient escapement to the spawning beds for conservation purposes. Likewise local areas may be closed for an entire season.

Most of the Alaska red salmon catch is taken and canned in a period of a little more than a month. Particularly in Bristol Bay, the run appears almost invariably on schedule at the end of June. Red salmon usually run rather early in the season in all salmon fishing areas and few are taken after August.

The pink salmon, like the red, make a sudden appearance in coastal waters. The catch attains great volume quickly, then rapidly declines as the main runs enter the streams. The run begins somewhat later than that of the red salmon and is usually over by the middle of September.

Chum salmon are caught at the latter end of the season with the exception of a few Alaska districts which support an early run. They appear only in autumn months on the Oregon–Washington coast, where they are sometimes called "fall" salmon for this reason.

Chinook or king salmon are caught over a longer season than other species, and are taken in the Columbia River from May 1

to November 30, but the canned pack is made almost entirely from May to August. In many other areas the run occurs before the red salmon appear.

Medium red or silver salmon are also caught during a long season, but canning of this species is largely confined to late summer and early autumn.

FISHING GEAR AND METHODS

The types of gear used and methods following in catching salmon are influenced by the fact that salmon are taken only on the brief spawning run, that they must be taken as cheaply as possible, and must reach the cannery in good condition if canned salmon is to be sold in large quantities at a reasonable price.

Chinook and medium red (silver) salmon may be caught at sea by trolling a spoon lure but red, pink and chum salmon will not take a hook and can be caught only by other types of gear when they approach the coast on their spawning migration. Troll caught salmon are usually absorbed by the fresh and cured fish trade, with only a minor portion being sold for canning.

GILL NET FISHING

The gill net (Fig. 12) was the first form of fishing gear used in the salmon fisheries of the Pacific, with the exception of certain types in long use by the natives. The terms "drift" and "set" clearly differentiate between two kinds in general use. Both have floats at the top and lead sinkers at the bottom to hold the net upright in the water with the meshes properly distended in order that the moving salmon may thrust its head through and be caught behind the gills or be "gilled in the twine." In order that the salmon may hit the net hard enough to be caught it must not see the net, so this fishery is carried on at night or in muddy waters.

Drift gill nets are laid out roughly in the form of an "*L*" across the estimated path of migration. One end is marked with a buoy lighted at night and the other is retained by the drifting boat. From time to time the nets are drawn into the boat over a wooden roller and the fish removed. This is done rather frequently since the fish, caught in the gills, usually drown and begin to spoil and, furthermore, being dead or helpless, they are often preyed upon by other fish or seals.

Set gill nets frequently are smaller than the drift nets and have one or both ends staked or anchored. In form and principle they are the same as drift nets. The length, depth and size of mesh are prescribed by regulation as is true of the specifications of other types of nets and seines.

Various modifications of the gill net are in use, particularly on the Columbia River, to catch the different salmon which vary

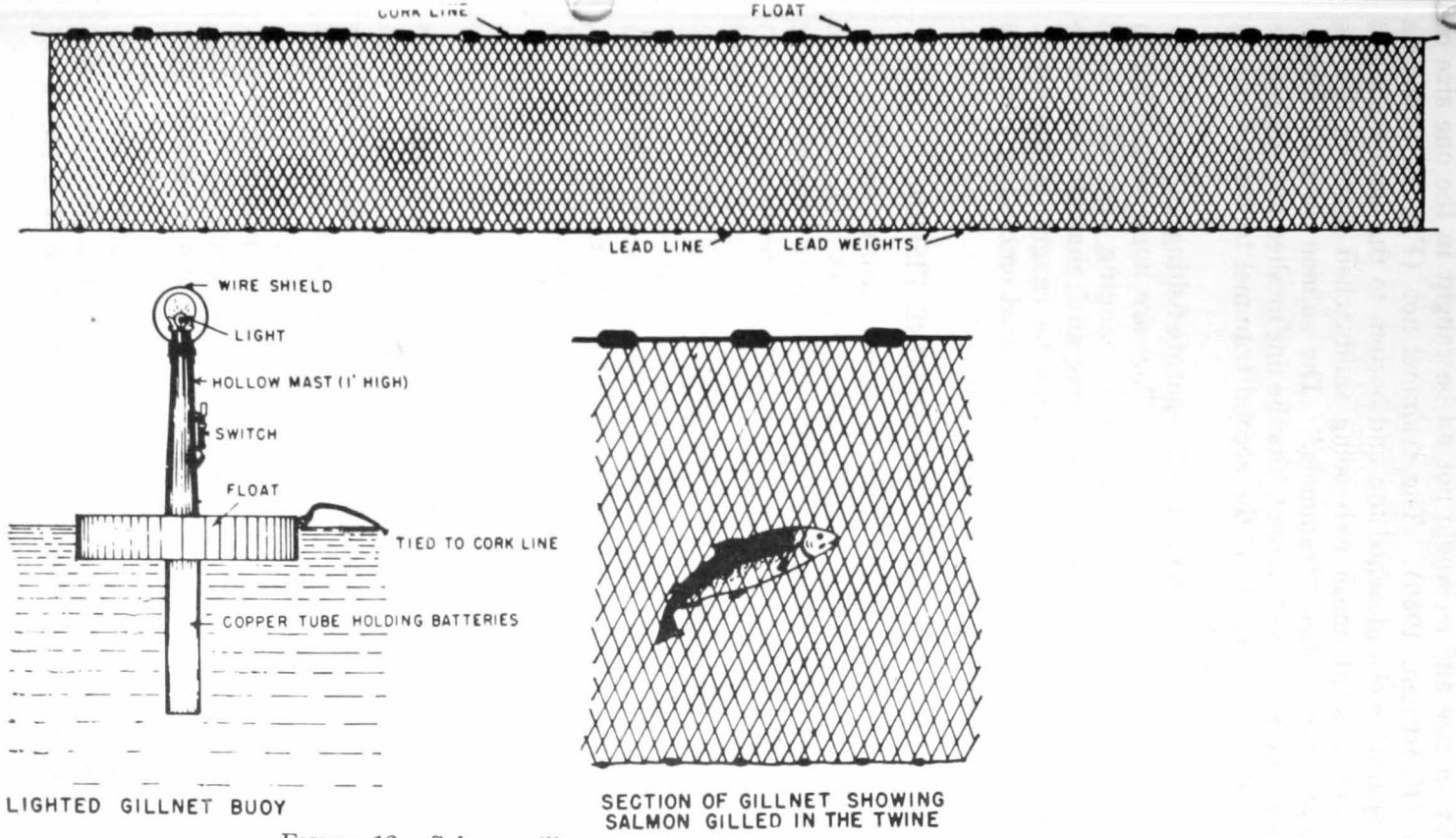

FIGURE 12.—Salmon gill net. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

greatly in size and so would not all be caught in the one size of mesh (Puustinen, 1930). The trammel net (Fig. 13) consists of 3 separate webs attached top and bottom to the same cork and lead lines, a small-mesh web being sandwiched between 2 webs of larger mesh called "trammels." The salmon swims through the large mesh of one trammel, hits the fine meshed net and pushes it through a large mesh of the second trammel to form a bag in which it is entrapped.

The "apron" gill net combines 2 separate fishing units, a "back-wall" and the "apron" into 1 net. They are hung hinge-fashion from the same corkline, the back-wall hanging vertically while the apron floats out horizontally forming an L shaped contrivance so that salmon veering from one may be caught in the other. Some of the nets in use are very complicated embracing both the apron and trammel principles in the one net.

HAUL-SEINE OR BEACH-SEINE FISHING

As indicated by the name haul seines or beach seines (Fig. 13) are usually hauled on the gravel beach at Karluk on Kodiak island or on the numerous sand bars found in the lower Columbia River at low tide. Buildings are erected on piles on these sand flats, in which the men and horses take refuge when the bars are covered with water. Operations begin as soon as a part of the bar is above water. The net, shallow at the ends and widening out to the "bunt" in the middle, is laid out in a large semi-circle, after which the two ends are brought to the beach, and the net is hauled out either by several spans of horses, as on the Columbia River, or by steam engine as at Karluk.

PURSE-SEINE FISHING

The purse seine is one of the most important types of gear in the taking of the salmon in general use in Puget Sound and on the coast of Central and Southeastern Alaska, proving very effective in these deep waters (Fig. 14). The seines vary from 50 to 250 fathoms in length, with a 3½- to 4-inch stretch mesh and a depth varying from 125 to 250 meshes. The foot line is heavily leaded and the bridles holding the purse rings are about 10 feet long. The purse line is made of 1½ inch hemp rope and is rove through 5-inch purse rings made of galvanized iron.

The purse seine vessels are built with square sterns and on an elevated section moving about a pivot is set a platform upon which the purse seine is stowed and from which it is payed out over a long roller.

When the lookout sights a school of fish a skiff is launched to hold one end of the seine, while the seiner quickly circles the

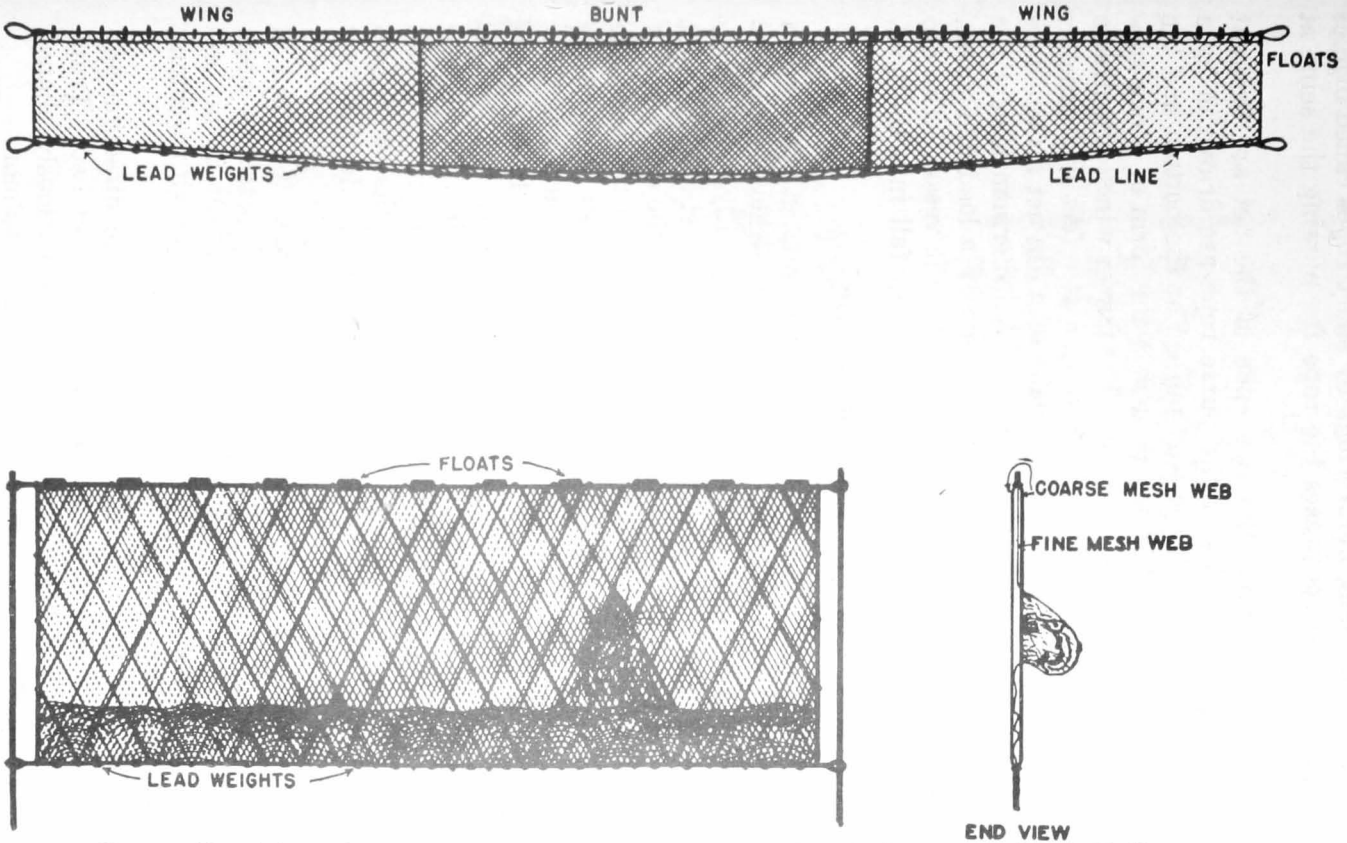

FIGURE 13.—Salmon beach or haul seine (above) and trammel (below) net. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

school, paying out the seine. The corks hold the head rope at the surface and the net hangs straight down to the leaded foot line. From the foot line hang purse rings by short ropes called bridles and through these rings passes the rope for pursing the seine at the bottom.

As quickly as possible, the two ends of the net are brought together and the two ends of the purse rope are drawn in by a power winch until the seine is well pursed at the bottom and the fish impounded in the net which is now in the form of a bag supported by the cork line and the boat. The power winch also draws in the net until the circular area is only a few feet in diameter. The salmon are then lifted out by means of a dip net attached by appropriate tackle to the hoisting boom. A fisherman lowers the net into the seine by its long handle, scoops up a load of salmon, and guides the apparatus as it is lifted over the vessel. The dip net is then tripped and the salmon allowed to fall into the hold.

POUND NETS OR TRAPS

Pound nets or traps (Fig. 15) have proved very effective when well located and appropriately constructed, but they are expensive to build, and in exposed positions are frequently wrecked by storms and floating debris. This type of gear is stationary, but may be either driven or floating, depending upon the character of the bottom and on the depth of water. The driven trap was the first type used. Long wooden piles are driven into the bottom in a pattern designed to turn the migrating salmon from their course and lead them into an outer heart, an inner heart, a pot and a spiller. Webbing and wire netting of a mesh fine enough to stop and turn the salmon is hung upon the piling of the lead and hearts from slightly above high water to the bottom. The pot and spiller are furnished with a webbing bottom so that these two parts of the trap are in reality huge bags in which the fish may be retained alive until needed at the cannery.

The floating trap is constructed along the same lines but is suspended from large floating logs anchored in place by huge concrete anchors and weights. Since the mesh walls do not extend to the bottom it is necessary to floor the hearts with webbing as well as the pot and spiller.

Some traps are designed to fish only from one direction and others from two. Some have one spiller and others two. Traps may have but one heart or be supplied with variously shaped "jiggers" of meshed walls to turn back escaping salmon.

The salmon are removed from the trap spillers to waiting scows or boats by a rectangular net apron called a "brailer," which is attached at one end to the scow or boat. The other end is fastened

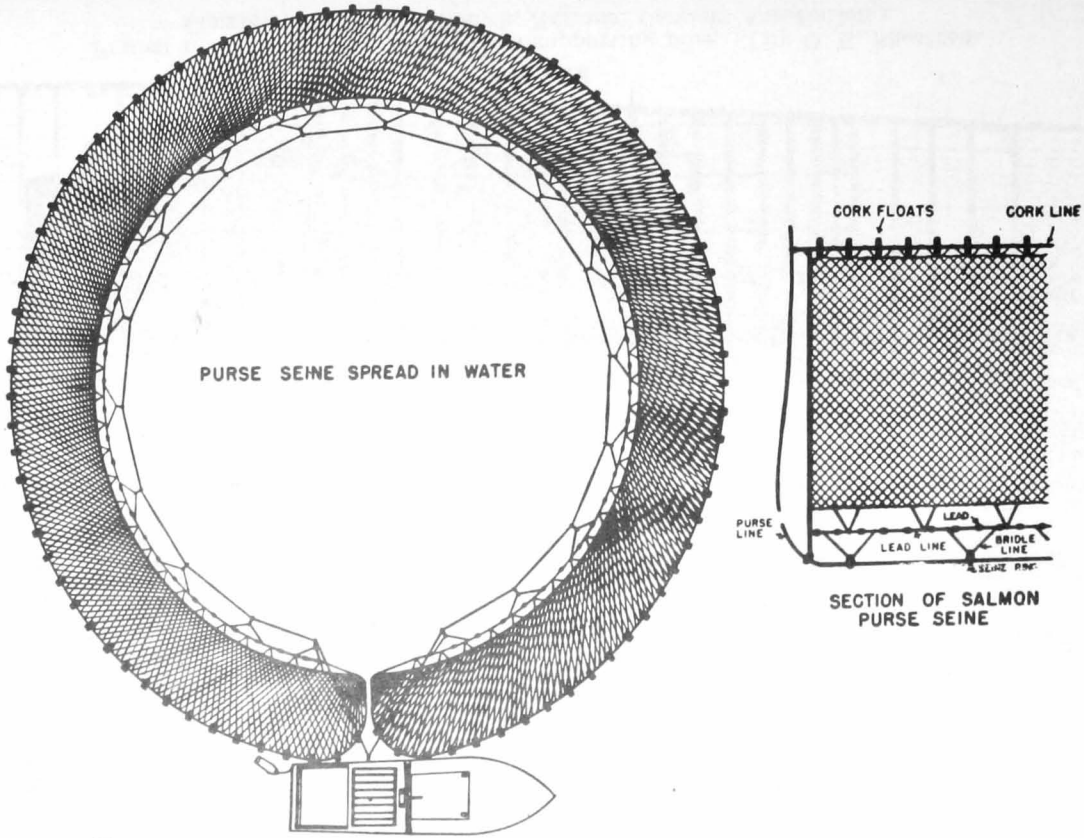

FIGURE 14.—Salmon purse seine. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

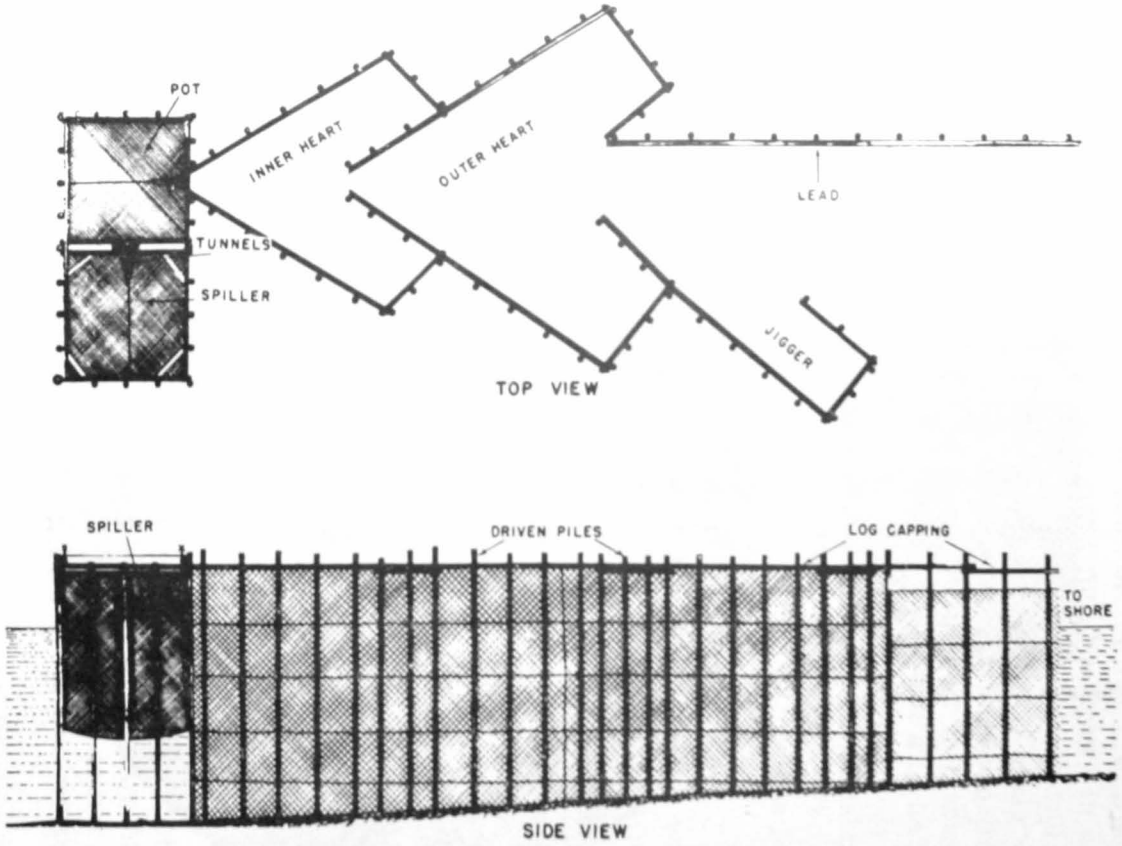

FIGURE 15.—Salmon trap with driven supporting piles. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

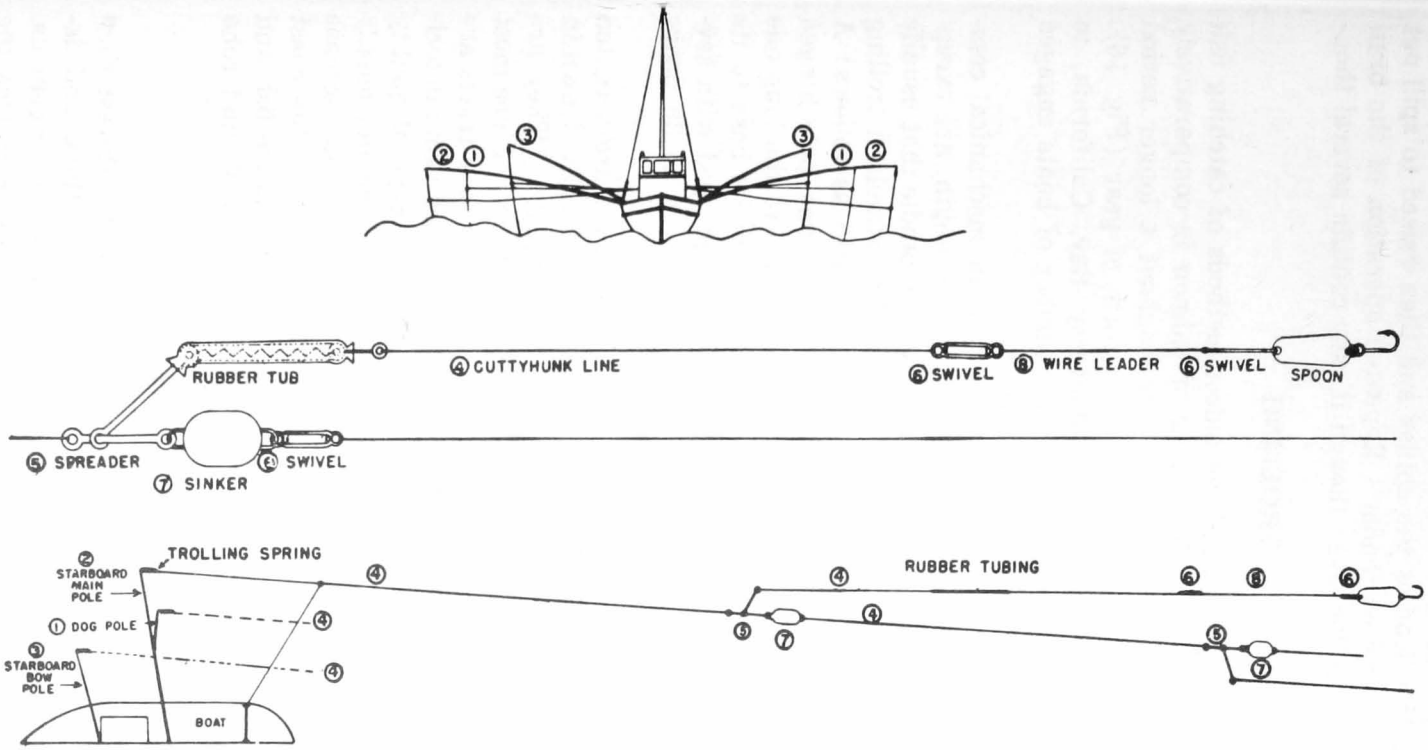

FIGURE 16.—Salmon trolling; showing detail of trolling gear. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

to a long iron pipe from which runs a line through a block on the derrick of the tug or tender to a winch. The apron is let down, drawn across the floor of the spiller and then raised to spill out the fish on the scow or tender. Repeated operation of the brail soon empties the spiller even though it may contain several thousand fish.

TROLLING

Although angling is one of the oldest methods of catching fish its use commercially for the taking of salmon is comparatively recent. Trolling can be carried on throughout a longer period of the year than fishing with any other form of gear (Fig. 16). Today trolling is followed from Monterey Bay, California, to Prince William Sound, Alaska, and the number of boats engaged is second only to those of the gill–netters.

Trolling boats have increased in size and in mechanical complexity. They range up to 50 feet or more in length, are exceptionally seaworthy and so compact and easy to handle that usually only one man is required to operate them. The standard trolling rig consists of 6 poles, 3 on each side, arranged as follows: A rather short pole near the bow of the boat, a long pole hinged to the deck near the mast and a short pole lashed to the long one at a point about two thirds of the distance from its base to its tip. Each of the 6 poles carries a fishing line equipped with several hooks so arranged by spreaders that as many as 30 hooks may be actively engaged from a single boat.

Many of the boats have power line–pullers which are actuated by the strike of a salmon and the fish are mechanically drawn in and held until the fisherman can pull them aboard. They are immediately cleaned and placed in bins of crushed ice. Since most of the troll–caught fish are still feeding, their digestive tracts are filled with food and unless they are promptly dressed rapid deterioration sets in. The bellies become soft and the general quality is lowered. Fish caught by this method are in demand mostly for mild–curing and the fresh fish market. The rapid increase of trolling and purse–seining on the feeding banks off the coast has resulted in the taking of many small and immature fish and threatens to seriously deplete the supply of chinook and coho salmon.

REEF-NET FISHING

When the white men first came to the Pacific Northwest they found the natives along the coast using various methods and devices for catching the salmon. Some of these were very ingenious. The most important native Indian salmon fishing gear was the reef net constructed of willow bark netting and ropes of twisted

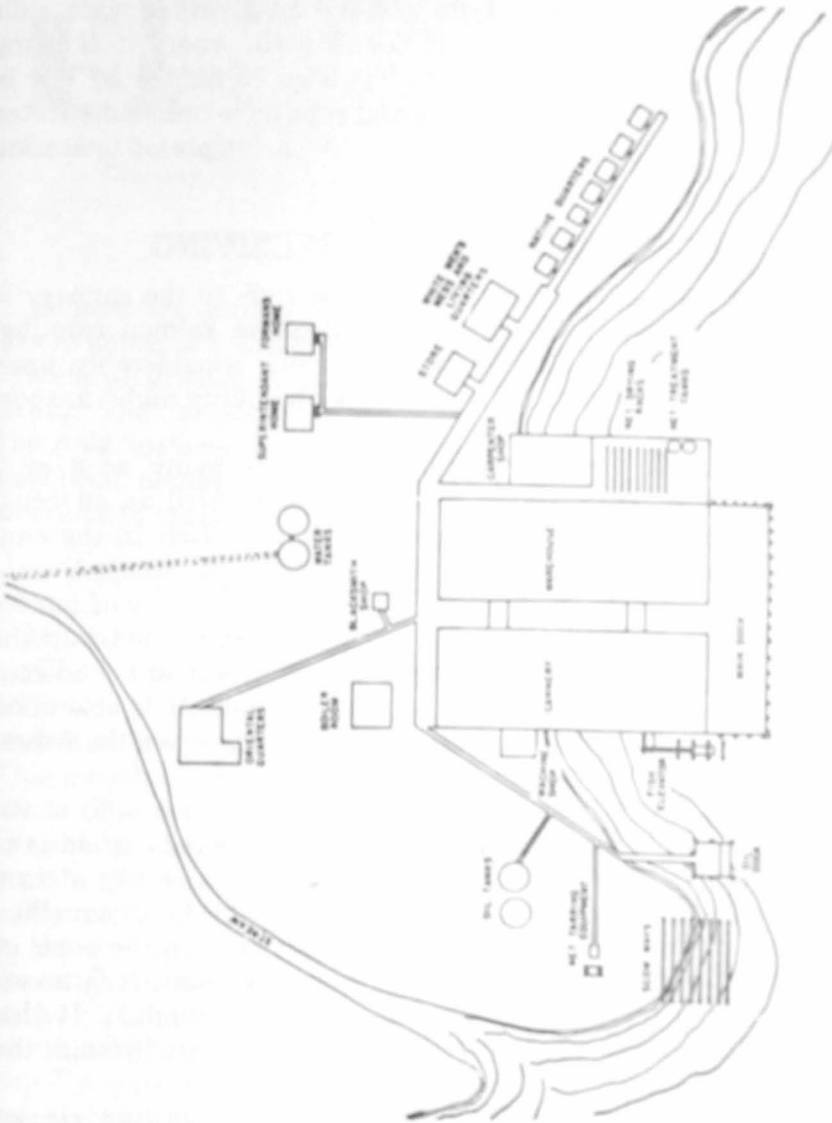

FIGURE 17.—The general layout of a typical salmon cannery. (By O. E. Sbostrom. Courtesy, Northwest Branch, National Canners Association.)

withes. The nets, some 25 feet in width and 40 feet in length, were fished between 2 canoes lashed to logs and anchored over the top of a reef. Leads and aprons of kelp and willow led the salmon to the net which was lifted from time to time and the captured fish placed in the canoes. It is reported that at times as many as 3,000 fish were taken on a single tide.

The reef net has recently been adopted on a rather wide scale by white fishermen in the Puget Sound area, where it is being substituted for the fish trap which has been forbidden by law in the State of Washington. Webbing and rope have been substituted for materials used by the Indians but the principle of operation is the same.

TRANSPORTING AND RECEIVING

Transporting the catch from fishing grounds to the cannery is expensive, and one of the biggest problems in salmon canning. The quality of the finished product depends considerably upon the method used and care exercised in the handling and transportation of the raw material.

Large canneries (Fig. 17) may require as many as 6 or 7 large-sized power boats known as tenders, as well as an equal or greater number of scows, for bringing the catch to the cannery. Salmon from the traps are "brailed," or scooped, onto scows, or directly into the holds of tenders. In the case of purse-seine and gill-net boats the fish are taken from the net into the fishing boat. Fishermen occasionally take the salmon to the cannery in their fishing boats, but much time is lost. It is also more difficult to control the quality of the raw material when the fishermen land their own catches.

Upon arrival at the cannery, salmon are unloaded onto elevators of the endless chain-bucket type. The preferred system is to sluice fish from the scow onto the elevators by a strong stream of water. Salmon may be unloaded more rapidly by this method with less handling. When salmon are unloaded from the holds of tenders or from purse seiners and other fishing boats, it is necessary to pitch them onto the elevator, using a "peugh." If this method must be used, salmon should be peughed only through the head.

Salmon usually are unloaded from the elevator into a series of water-tight bins all sloping to one point, which leads to the butchering machine conveyor. The bin doors may be short boards fitting into grooves. In some plants the bin entrance may be provided with a short chute having an undercut gate which is forced up into the stream of fish from below, controlling their passage to the "iron chink" (Fig. 18).

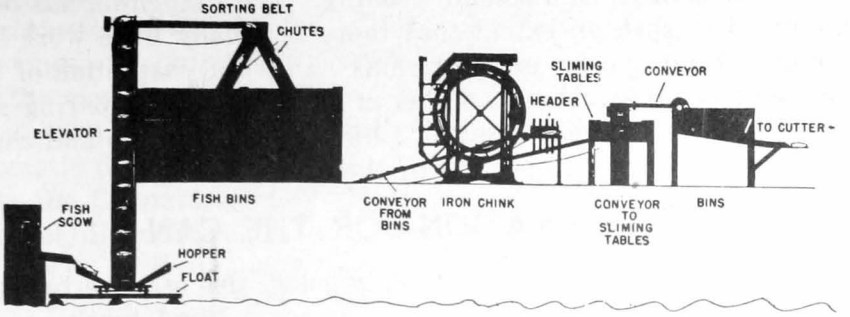

FIGURE 18.—Salmon canning; unloading and butchering. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

GRADING

Salmon are graded as they are unloaded from the boats, each grade going to a different bin. At the present time the principal system of grading is by species, locality of capture and type of gear. The "spring pack" of Columbia River chinook salmon is the only instance in which quality factors such as color of the raw flesh, amount of oil and freshness are used in grading salmon previous to canning.

DRESSING AND WASHING

Formerly, all salmon were cleaned and dressed by hand, usually by Chinese as they were considered the most satisfactory labor for the task. But now these workers have been displaced by a machine known as the "Iron Chink" because it is doing their work (Fig. 18). This machine is able to dress and clean as many as 3,600 fish in an hour. The chinook or king salmon which are large and extremely variable in size are still cleaned by hand, the only portion of the pack in which the old method is still used.

The salmon, traveling by conveyor from the fish bins are fed to the iron chink at the rate of about 60 per minute. The first operation of the machine is to remove the head with a revolving knife. The headless body is then caught between 2 revolving drums which grip and hold it firmly, back down and tail first. Rapidly whirling saws and knives split the belly and remove the fins and tail, while revolving brushes and sprays of water clean the belly cavity. The heads and other offal fall through a hole in the floor onto a conveyor.

After passing through this machine, the salmon is carried onto a belt conveyor through a tank of running water where it is scaled and washed by hand. Any bits of viscera, fins or other offal which have not been removed previously are trimmed away and

the fish is then given a second washing. The iron chink has been improved to such an extent that there is usually little work left for this cleaning crew except to make a careful inspection of the dressed fish. The amount of loss in cleaning and preparing salmon for the container averages: Chinook 30, red, coho and chum 33 and pink salmon 35 percent of the original weight.

PREPARATION FOR THE CAN

After the washing and cleaning process, the fish are brought to the cutting machine, either by conveyor, hand trucks or by flume (Fig. 19). The salmon is cut into can-length portions by a machine which consists of a wooden vertical carrier with ledges or buckets operating on a chain. These buckets are wide enough

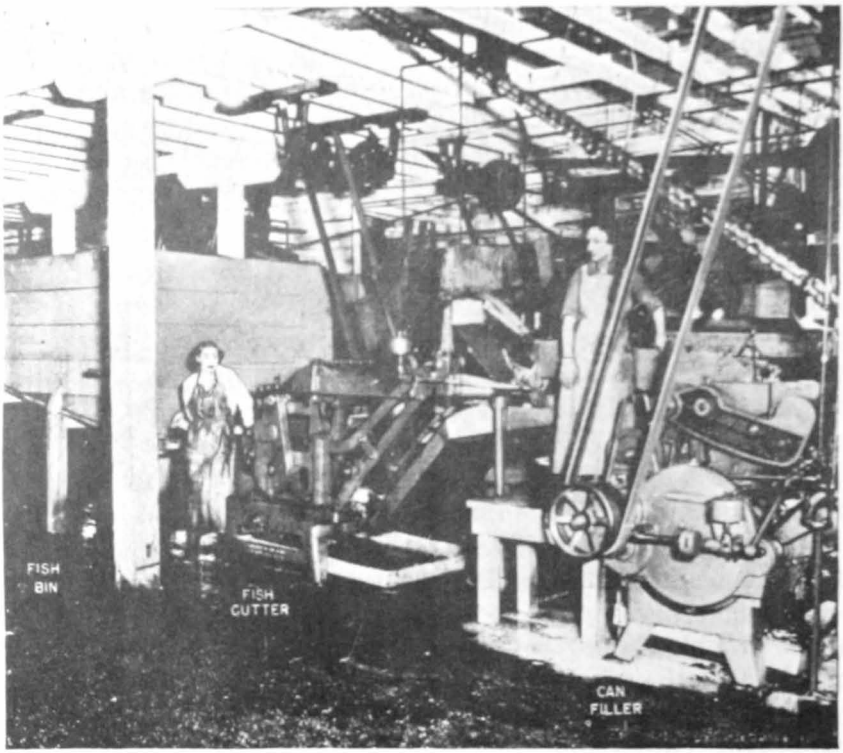

FIGURE 19.—Salmon canning line; fish bin, fish cutter and can filler. (Courtesy Continental Can Company, Inc.)

to hold a salmon and are slotted in cross section through the ledges and outer casing, to receive gang knives. The carrier and gang knives each operate independently on individual shafts. As the buckets come into horizontal position, a workman lays a fish on each as they pass by. The salmon are then carried to revolving gang knives where they are divided in sections and slide into a

chute leading to the filling machine. The gang knives or cutters are adjusted to cut the fish transversely into sections of the correct length for the can. The tail pieces are sometimes segregated, and the meat is cut into small pieces to be used in completing the fill of cans that have not received the required amount in the automatic filling machine.

On the Columbia River and in some of the smaller canneries in other districts, especially those making the greater part of their pack in flat cans, the gang knives are operated by hand. These knives are not circular like those on the cutting machine but have elongated blades and operate after the principle of the old fashioned plug–tobacco cutter. Several knives are mounted on a single axle at a distance far enough apart to cut pieces the length of a can. A lever is fixed in position at one end of the axle to serve as a handle. In operating this gang knife, the salmon is placed in position under the knives and the handle is brought down.

The most recently equipped canneries have filling machines which take the whole cleaned fish and cut them into suitable lengths just before they reach the empty cans. In these canneries the separate fish cutter is omitted. This is an advance in salmon canning as it reduces the amount of handling.

FILLING

Automatic filling machines have replaced hand-packing except for a few small canneries or in the filling of oval or other odd–sized cans and in packing flat cans on the Columbia River.

While the first filler was capable of filling 48 cans a minute, the latest have been operated at a speed of 270 cans per minute although this rate is undoubtedly too fast for good workmanship in packing. However, a speed of 200 cans per minute is common and can be maintained.

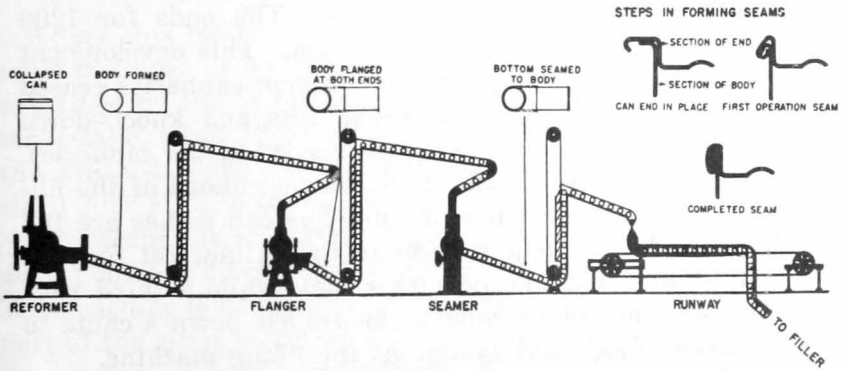

FIGURE 20.—Reforming collapsed cans. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

Empty cans are fed into the filling machine by a conveyor from the "can loft" or reforming line as the case may be. As each can enters the machine it receives from ¼ to ⅜ ounce salt from a receptacle adjusted to deliver the required quantity (Fig. 20).

The pieces of salmon, as received from the fish cutter, or as cut from the whole dressed body by the late model filling machine, are fed into a cylindrical measuring box with a capacity equal to that of the cans to be filled. Appropriately placed and frequently sharpened knives cut off any excess fish. A plunger then pushes the salmon from the measuring box into the can, together with an ingenious and accurately timed device called an extractor, which permits the escape of air, as the cylinder of fish enters. As soon as the extractor and plunger are withdrawn, the filled can is thrust out of the machine to pass on to the inspection table.

The various sizes of cans used in salmon canning, with the average fill in weight are: No. 1 tall (301 x 411), 16.6 oz.; 1-lb. flat (401 x 211), 16.2 oz.; ½-lb. flat (307 x 201.25), 8.0 oz.; ¼-lb. flat (301 x 107), 3.9 oz.; 1-lb. oval (607 x 406 x 108), 16.0 oz.; ½-lb. oval (309 x 515 x 103), 7.9 oz.; ¼-lb. oval (211 x 404 x 100), 3.9 oz. and No. 5 (602 x 403), 64.0 oz.

THE COLLAPSED CAN

One development in the manufacture of the tin can is peculiar to the salmon industry. Due to their isolated locations in Alaska most salmon canneries are at a great distance from can factories. Formerly, the larger canneries manufactured their own cans but this was not feasible for the smaller companies. It costs as much to ship empty cans by boat as filled cans, since water freight rates are based on cubic measurement.

It was found that the can bodies, before the end was rolled on, could be collapsed from a circle to form a narrow oval as viewed from the end. The collapsed can bodies are packed 360 to the case which holds only 48 completed cans. The ends for 1200 1-pound tall cans are packed in a single case. This development was so revolutionary that practically all salmon canneries ceased making their own cans. With collapsed cans and knock-down cartons much less can storage space was needed in the canneries.

A can reforming line (Fig. 20) is placed just ahead of the filling machine and run at the same speed. The can bodies are fed into a reformer which expands them to the cylindrical form, a second machine puts a flange on either end, while a third rolls on the bottom end and the completed can travels down a chute to receive its charge of salt and salmon at the filling machine.

This procedure can be used with lithographed cans or even with key-opening cans which have been scored entirely around

the body near one end. The completed can is equal in every way to those which have not been collapsed.

INSPECTION AND WEIGHING

Some canneries use an automatic weighing machine at this point in the canning line. If the can contains the proper weight, the machine allows it to pass on, but if the can is underweight or grossly overweight it is side tracked. Inspectors then adjust these cans to the proper weight. These workers also trim off projecting bits of flesh, repack cans which show pieces of skin or bone on the top and generally do whatever they can to improve the appearance and uniformity of the pack.

EXHAUSTING AND SEALING

Until recently the standard method of "exhausting" to obtain a vacuum in the can, still used to some extent, was the steam "exhaust box." This apparatus by a series of chain belts, alternately traveling in opposite directions, shunted the cans from belt to belt and forced them to travel for more than 100 feet while in contact with the steam. The contents expanded and forced out most of the air. If the can was sealed while still hot a suitable partial vacuum was produced when the can was finally cooled after processing.

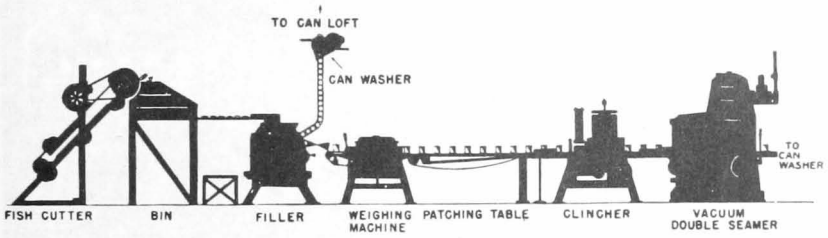

FIGURE 21.—Salmon canning; filling and closing the cans. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

Where this method is still used, the cans pass through the exhaust box open or with the lids rolled on loosely. This loose seam is formed by the "clincher." Through such a loose seam the air can escape, while the "second operation" converts it into a tight and finished seam. The cans are "exhausted" at temperatures about 209° F. for a period averaging 10 minutes.

The steam box as a means of removing part of the air has been almost entirely displaced by the vacuum–closing machine (Fig. 21). This machine is essentially a large vacuum chamber, from which a part of the air is withdrawn by a powerful pump. The cans, with tops rolled on loosely, pass from the clincher into this chamber through pockets or ports in a carefully synchronized revolving, air

tight valve. A portion of the air in the can is drawn out and the seam rolled tightly, after which the can leaves the chamber through another valve.

After the cans have been sealed, they pass along a belt through a washer which is essentially 2 perforated pipes which shoot jets of water under strong pressure on the cans, removing any bits of fish or other material from the can surface. The cans then roll down an incline, and are arranged mechanically or by hand in iron trays known as "coolers," which are placed 6, 10 or 12 deep according to the size of the can, on small trucks or cars. A cooler will hold 12 dozen No. 1 tall cans or twice that number of ½-pound flats.

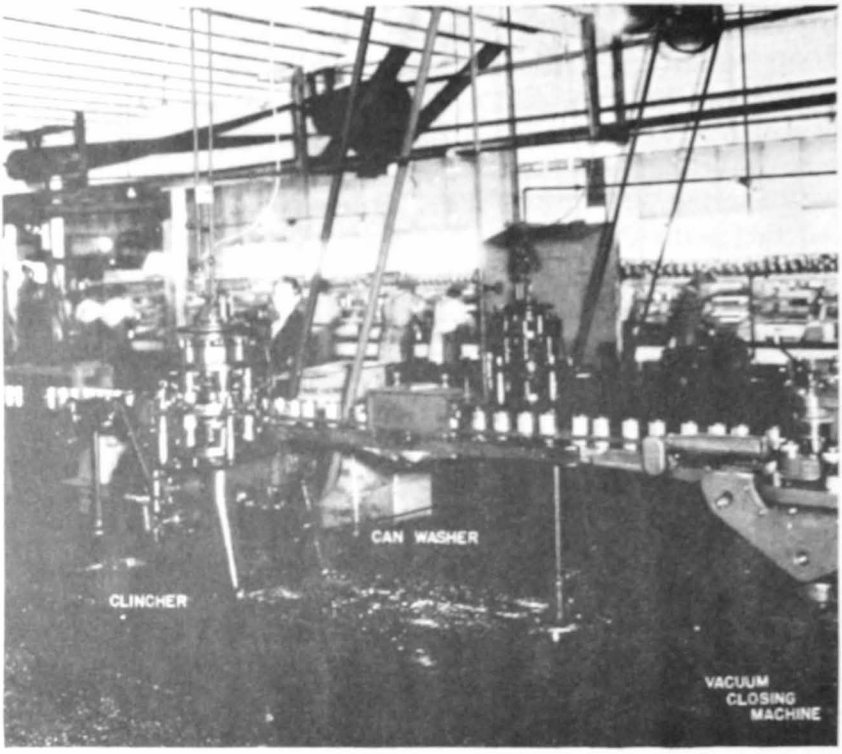

FIGURE 22.—Salmon canning line; clincher, can washer and closing machine. (Courtesy, Continental Can Company, Inc.)

PROCESSING, COOKING, OR "STERILIZING"

The truck loads or cars of salmon holding up to 864 tall cans, are shoved into retorts as soon as they are loaded. The retorts are large horizontal iron cylinders used for cooking the hermetically sealed cans under pressure. Retorts are constructed to hold 3, 4, 5 or 10 cars. As many as 11,000 cans are cooked at one time in an individual retort. Many retorts are equipped with automatic

control devices to insure against faulty operation as to the temperature and time of cook.

When the retort door is tightly sealed, the steam is turned on but several vents are left open for a time in order that all the air within the retort may escape. At this time the thermometer should read about 212° F. and the pressure gauge about zero. The vents or valves are then gradually closed and the retort is brought up to processing temperature and maintained there for the duration of the desired cooking period. The thermometer and pressure gauge should be in agreement, that is, a temperature of 240° F. should correspond to a pressure of about 10 pounds. This is the temperature used generally except for a few companies which prefer one slightly higher.

After a period of about 90 minutes the steam is turned off and the valves gradually opened to allow the steam to escape and air to enter. When the pressure falls to zero the door may be opened and the can trucks pulled out. A few of the more recently constructed retorts have a door at each end with a slightly inclined internal track facilitating by gravity the filling and emptying of the retort and also simplifying the routing of the raw and cooked fish.

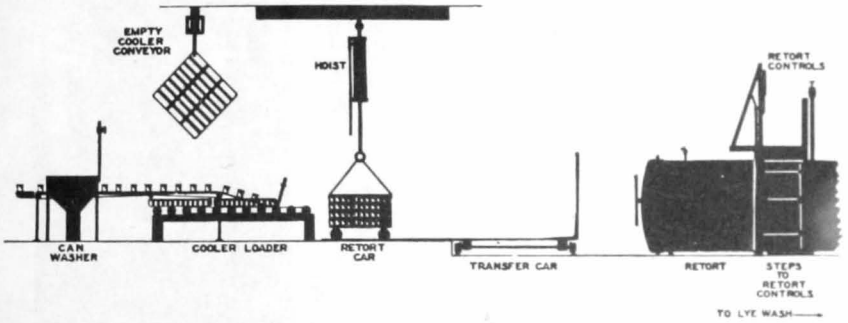

FIGURE 23.—Salmon canning; washing cans after sealing; loading cans and transferring to retort for cooking (retorting). (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

While 90 minutes is the standard processing time for the 1 pound can, other sizes containing from ¼ to 4 pounds require more or less time according to size. The cook for salmon was established partly on the basis of softening the bones to the point where they could be easily eaten. There used to be three divisions into which the process could be divided; the precook in the exhaust box by means of which the can entered the retort hot and reached a sterilizing temperature quickly, the main cook and the period of cooling during a portion of which the center of the can remained at the sterilizing temperature. The exhaust box has been almost eliminated and methods for more rapid cooling are contemplated. This will put the entire burden of sterilization

upon the main cook, which may have to be increased. Processes now used for cans holding less than 1 pound are: ½ pound cans for 80 minutes and ¼ pound cans for 70 minutes at 240° F. (10 lbs. pressure). The processing used to date for "4 pound" (602x403) cans is 195 minutes at 242° F.

WASHING THE CANS

As the cans come from the retorts they may be greasy or dirty due to handling or the escape of oil from some of the cans during cooking. The trays (coolers) of cans, therefore, are passed through a weak alkaline washing solution known as the "lye wash" in which the can tops receive a scrubbing. At the same time the

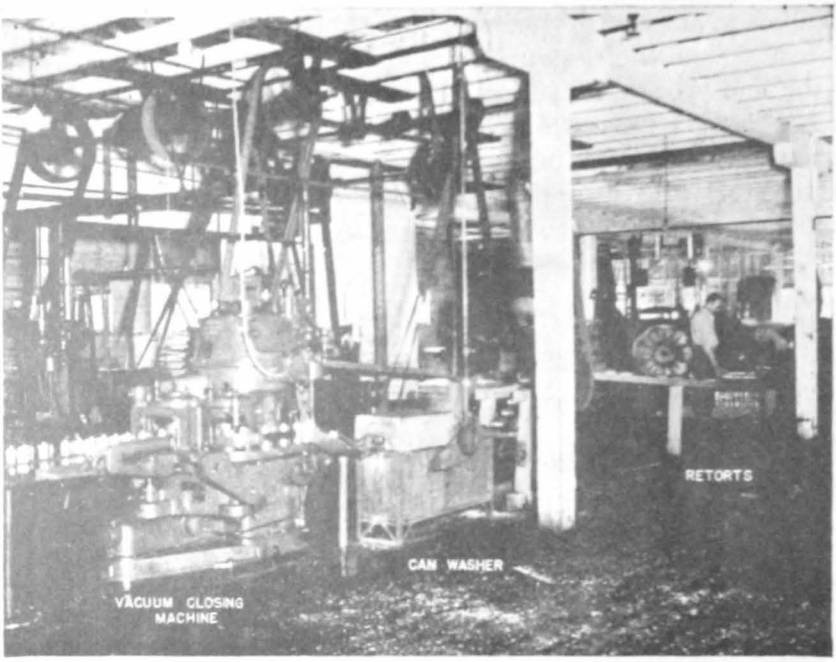

FIGURE 24.—Salmon canning line; closing machine, can washer, retorts. (Courtesy, Continental Can Company.)

cans are carefully watched for signs of defective seams. Such cans will float or give off bubbles of air in the water. From the lye bath the cans pass to a fresh-water tank and sprays of fresh water remove all traces of lye which would damage the appearance of the cans if allowed to remain.

Formerly, the washed cans were then taken to the warehouse and coolers spread out on the floor to remain until cool enough to case or stack. With increased speed of production, the space available for cooling has become inadequate and the cans are

sometimes stacked while still too warm, which results in a prolonged cook of the salmon. A more rapid method of cooling has become not only desirable but imperative.

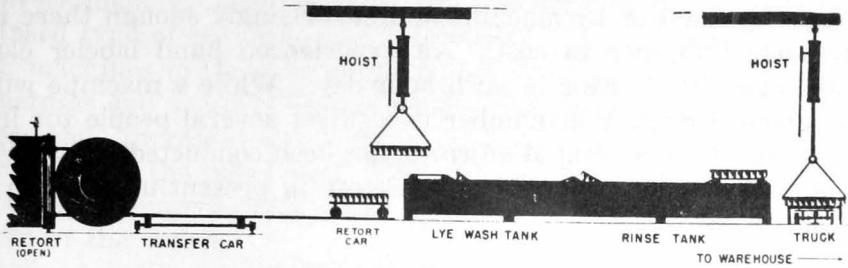

FIGURE 25.—Salmon canning; removing cans after retorting, washing cans, and transfer to warehouse. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

LACQUERING

Rusting of cans has been a serious problem to canners from the first days of the industry. The first salmon cans were coated with red paint. Later variously colored lacquers were produced which dried rapidly. The cans were passed through a bath of the lacquer and dried by a hot air blast. The advantages of lacquering are offset by certain disadvantages such as higher cost, fire hazard and inconvenience. The practice has been almost though not entirely discontinued. Enameled tin plate for can ends and for a small percentage of can bodies has been substituted for lacquering. Some canners use only plain cans and under favorable conditions experience no difficulty.

LABELING

The first labels used were very crude, printed in one color on inferior paper and did not surround the can. About 1870 some Pacific Coast canners imported full-sized labels encircling the cans and printed in four or five colors with a variety of panels and grotesque designs. In recent years labels have been greatly improved, usually in the direction of simplicity and attractive design.

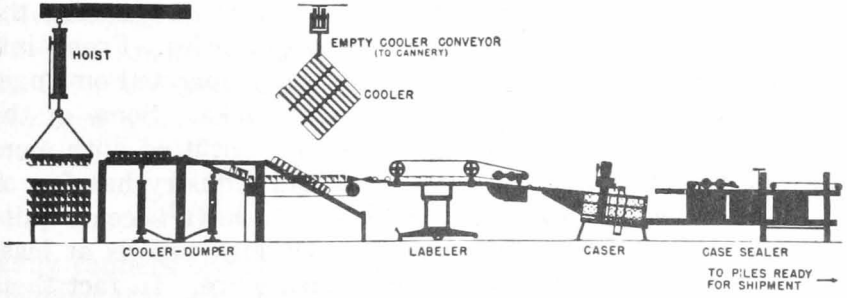

FIGURE 26.—Salmon canning; labeling and casing. (By O. E. Shostrom. Courtesy, Northwest Branch, National Canners Association.)

When canning operations are slack, some cans may be labeled at the cannery, but a larger proportion of the Alaskan pack is shipped unlabeled to warehouses in the United States for later labeling by warehousemen, jobbers or wholesalers. Labeling may be done by hand or by machine and surprisingly enough there is not much difference in cost. An experienced hand labeler can handle over 10,000 cans in an 8 hour day. While a machine will label about 5 times that number it requires several people for its operation. A great deal of research has been conducted on pastes, gums and label paper, and most of those in present use are very satisfactory.

BOXING OR CASING

Canned salmon formerly was shipped entirely in wooden boxes and a small percentage of the pack still reaches the market in that container. Fiberboard cartons have largely displaced the wooden box.

The standard "case" for statistical purposes consists of 48 1-lb. cans, 96 one-half pound cans, 192 one-quarter pound cans or 12 four-pound cans. The 1-pound cans are usually shipped 48 to the case but a few are marketed in cartons holding 24 or even 12 cans. The ½-pound cans are usually packed 48 to the carton but occasionally 24 and in Canada they are packed 96 cans to the case. The ¼-pound cans which are a specialty pack are usually attractively packaged in small cartons of 12 or 24 cans.

FLOATING CANNERIES

The original salmon cannery on the Pacific Coast was built on a scow in the Sacramento River in 1864, and, in a sense, may be called a floating cannery. In 1867 a crude counterpart was built on the Columbia River, also on a small scow measuring 50 by 20 feet. From that time until 1911 the salmon canning industry seems to have built its canneries on land or at least on piles extending out from the shore. In the latter year the old ship "Glory of the Seas" was fitted out as a cannery and became the prototype of all subsequent floating salmon canneries. From time to time new ships have been outfitted and have operated on Puget Sound, Southeastern, Central or Western Alaska. Some of the earlier ships have been discarded and others outfitted with more modern equipment until today the American industry has five or six floating canneries and their use seems to have become quite firmly established. The Japanese had two such vessels at least as early as 1932 and more have been added since. In fact their competition with the Japanese shore canneries became so severe

that the Japanese government had to interfere and restrict their activities somewhat.

The elimination of the space–consuming steam exhaust–box, the development of large double–ended retorts, the use of the collapsed type of can completed as needed, and the improvement of all machines in the canning–line have all contributed to the compactness and speed of operation which make the floating cannery feasible. Increased speed of production and the almost complete adoption of the fiber carton have, however, increased the difficulties of adequate cooling of the cans before they are stored in the hold of the vessel.

The American floating canneries have all been remodeled from vessels previously devoted to other uses. Much ingenuity and skill have been displayed in the utilization of the necessarily limited space. The fish bins are usually placed on the upper deck from which the fish can descend by gravity to the iron chink and the cleaning tables and then enter the canning line proper. A recently outfitted floating cannery has fish bins and iron chink both fore and aft with a canning line extending along each side of the vessel terminating in large 10–car, double ended retorts.

The floating cannery has one advantage over the shore cannery in the ability to transport supplies and crew to and from the fishing location and to bring back a large part of pack. There is a considerable saving in passenger fares and freight charges. Repairs and changes in the machinery may be carried out during the winter to good advantage by bringing the cannery back to its home port.

Some liberty of action is possible with the floating cannery since it may be operated in more than one location during the year. However, a convenient shore location from which a sufficient supply of fresh water may be obtained, usually by tank scows, is essential. Lack of adequate space for cooling the cans has led to attempts at cooling by water. For this purpose fresh water must be used, necessitating strain upon the supply. The advantages of the floating cannery appear to be offset by its inherent disadvantages.

The five American floating canneries operating in 1938 packed some 216,000 cases mostly in the western part of Alaska. This constituted about 3.2 percent of the total Alaska pack and 3.0 percent of the total United States pack for that year.

CANNED SALMON INSPECTION

Many canners open cans from their pack at frequent intervals throughout the packing season in order to detect and correct any imperfections or faulty practices before much harm is done. The

completed pack is subject to the examination of the State and Federal inspectors, who by their watchfulness and criticism have done much to improve the pack. A very large percentage of the annual production is made in Alaska and upon shipment to the Pacific Coast States is immediately in interstate commerce and subject to federal inspection. Moreover this portion of the pack is handled at a few ports, which permits centralized inspection and control.

In addition to governmental inspection the industry has voluntarily supported its own inspection service carried out by the National Canners Association. Nearly all of the Alaskan pack and much of that produced in Oregon and Washington is examined by the Association. This examination is concerned not only with the condition of the fish from the standpoint of freshness but also with workmanship and quality. Every defect is pointed out to the packer in order that changes in the process of manufacture may be made and the product improved. A separate report is made to the packer on each code packed and at the end of the season a tabulated report on the entire pack is submitted which may be compared with a similar report covering all of the pack inspected by the Association.

A generous number of sample cans is drawn for examination and if a single objectionable can is found, from 48 to 96 additional cans are drawn from the code involved and another examination is made. The packer is invited to be present at any of these examinations and particularly at re-examinations in order that any objectionable condition may be pointed out and changes in cannery practice may be recommended. The value of government and association inspection is clearly apparent in the steadily decreasing number of objectionable cans found in the pack. Few food products are as thoroughly examined as canned salmon.

TABLE 11.—*Description of different species of Pacific salmon and of steelhead trout after canning*

Species (Scientific and common name)	Color of oil	Color of flesh	Texture of flesh	Size of flakes	Size of vertebrae	Size of scales
Oncorhynchus nerka (red salmon)	Deep red	Deep red	Very firm	Small, thin	Small	Medium
Oncorhynchus tschawytscha (chinook salmon)	Deep red through orange to almost white	Bright-red to white	Soft	Large, thick	Large	Large
Oncorhynchus kisutch (medium red salmon)	Light red to yellowish pink	Light red with orange shade	Rather firm	Large to medium, thick	Large	Large
Oncorhynchus gorbuscha (pink salmon)	Deep pink to light yellow	Pink	Tendency to be soft	Small, thin	Small	Small
Oncorhynchus keta (chum salmon)	Light pink with orange shade to yellow	Light pink	Firm	Medium	Medium	Medium
Salmo gairdnerii (steelhead trout)	Light orange to yellow	Pink with orange shade	Rather soft	Large, thick	Large	Large