TUNA*

SPECIES CANNED

Tuna canned in California is produced from four species within the mackerel family (*Scombridae*). Another species of this group, the bonito, is canned tuna style, but may not be labeled as tuna, nor may the yellowtail, which belongs to the family of jacks (*Carangidae*). The different tuna in order of commercial importance are:

YELLOWFIN (*Neothunnus macropterus*)

The yellowfin tuna may be distinguished by the rather long pectoral fin, reaching or almost reaching the front of the anal fin but not past it, as in the albacore. The series of 8 or 9 finlets following the second dorsal and anal fins and the tail, show a yellowish tint, giving the species its name. The color of the body is dark blue on the back and upper sides, shading into iron gray below. The State of California has set legal size limits beyond which this species may not be landed, with a minimum of 7.5 pounds and a maximum of 150 pounds. The yellowfin may reach weights of 300 to 400 pounds, but these larger fish are very scarce. The average size of the yellowfin is about 30 pounds. The season extends over most of the year. It ranges from along the Pacific coast of North and South America from southern California to northern Chile.

BLUEFIN (*Thunnus thynnus*)

Next in importance from standpoint of volume of pack is the bluefin, which is the largest of the tunas. It is also known as the "horse mackerel" or "leaping tuna" and is said to be the same species as the European tuna. Its distinguishing features are that the pectoral fin is shorter than the head, the second dorsal is sharper than that of the yellowfin, and the finlets and tail fin are bluish in color. The color of the back is deep blue, shading into iron gray on the sides and silvery below. The sides may show many small silver spots, while the freshly caught fish exhibits an iridescent sheen. The maximum legal size limit is 150 pounds, but it may attain a weight of over 250 pounds (Walford, 1931). The average size is approximately 30 pounds. It is found on the coast of Southern California and Northern Mexico from June through November.

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*This section prepared by O. W. [illegible], Geo. Williams Hooper Foundation, University of California and N. D. [illegible].

Source—[illegible] Canning [illegible]. [illegible] from Research Report 7, Fish and Wildlife Service, U. S. Department of the Interior. The complete report ([illegible] pp.) is a reference book on commercial canning of seafoods and is available from the Superintendent of Documents, Washington 25, D. C. Price [illegible] cents a copy.

SKIPJACK (*Katsuwonus pelamis*)

The skipjack, which is also known as the "striped tuna" is the smallest of the tunas. Its principal distinguishing characteristics are the 4 or 5 dark stripes which extend horizontally along the lower side of the body. The tail has a low keel on each side and the body is scaleless with the exception of a few large closely adhering scales in the region of the pectoral fin. The color of the body is bright blue above, becoming dull after the fish dies, shading into silver along the sides and below, with the stripes as above described. Skipjack range in weight from about 3 to 20 pounds but it is illegal under California law to land fish weighing less than 4 pounds. It is caught off the coast of southern California from August through November but is landed from clippers fishing off Mexico, Central and South America, at other seasons of the year.

ALBACORE (*Germo alalunga*)

The albacore was the first species of tuna canned in California. It is the only one that may be labeled as white meat tuna. It formerly was considered the choicest tuna, but now the fancy packs of yellowfin and bluefin tuna are considered by many to be equal in quality. The albacore pack was greater than that of all other tuna combined until 1925, when the run suddenly declined to a small fraction of the former size. The distribution of the albacore is from Puget Sound to Lower California, and occasionally southward. It also is found off Japan and Hawaii. It was formerly thought that only occasional stray specimens wandered north of Southern California, but since 1937 large catches of albacore have been made off the Oregon and Washington coasts where it is the basis of an important fishery and canning industry.

While the albacore may reach a maximum weight of 80 pounds, the average commercial specimen weighs approximately 25 pounds. The peak of the season in California is June to August and in Oregon it is August and September. The chief distinguishing characteristic is the great length of the pectoral fins which reach some distance past the front of the anal fin. The secondary common name of "long-finned tuna" has been given to it on this account. The color of the albacore is dark steel-blue above, shading into dull silver below.

BONITO (*Sarda chiliensis*)

The bonito has a flesh somewhat darker and more strongly flavored than the four species of tuna just listed. It resembles the tunas generally but the body is more slender. The pectoral fins are short and a series of finlets extending from the second dorsal fin and the anal fin are each 6 to 8 in number, while the tail has a

fleshy keel on each side. The body is striped obliquely or horizontally above the lateral line with narrow blackish stripes. The color is blue above with greenish reflections and a metallic luster, shading into a silvery hue below. The bonito has a range extending from the coast of Oregon southward along the coast of South America, and is also found off the Hawaiian Islands. It is caught throughout the year but is most abundant in the summer months. The bonito reaches a maximum length of some 30 inches and a weight of 20 pounds but the average weight is given as approximately 8 pounds.

YELLOWTAIL *(Seriola dorsalis)*

The yellowtail has a range extending from Point Conception on the coast of California, southward to the Galapagos Islands, but the California fish and game laws do not permit the canning of yellowtail taken off the coast of that State. Yellowtail is canned to some extent, utilizing fish caught off the coast of Mexico. The distinguishing characteristics are: Two dorsal fins, the first being composed of spines; the second of soft rays, and the two are practically in contact. The longest spines of the first dorsal fin are less than half the height of the first soft rays and there is a blunt, low keel on each side of the caudal peduncle. The color is bright metallic blue above, becoming silvery on the sides and below; and a yellowish brown horizontal band extends along the side of the body from the eye to the tail (Walford, 1931).

The yellowtail is found in the summer months from Mazatlan and Cape San Lucas on the coast of Mexico, north to Santa Barbara, California. It reaches a length of 3 feet and an average weight of 20 pounds.

MISCELLANEOUS

Frozen albacore and frozen oriental tuna *(Thunnus orientalis)*, which is the species taken in greatest quantity off the coast of Japan, are imported for canning purposes. The tuna canned in New England has the common name of "horse mackerel" and is classified as *Thunnus thynnus*, differing but slightly from the bluefin tuna of the Pacific coast.

FISHING AREAS

The area fished by the southern California tuna fleet reaches from the coast of southern California to and slightly beyond the equator extending from the continental mainland to points approximately 800 miles off shore and includes areas around practically all the islands within these general limits, including the Revilla Gigado Islands, Clipperton Island, Cocos Island and the Galapagos Islands.

The large "bait fishing" vessels, forming the high-seas tuna fleet, which fish for skipjack and yellowfin, bring in from 60 to 70 percent of the total catch and work the fishing grounds as follows: In the winter months, or from November to the end of February, the fleet is found off the Galapagos Islands. The boats then fish off the mainland coast of Central America through March, April, and May. In June and July they may fish in the Gulf of California or around Cape San Lucas. In August and September the fleet covers the lower California coastal area with the neighboring banks and islands as far as Clipperton Island. In the fall months they mostly return to the mainland coast of Central America. While this is the general procedure, the judgment and experience of the individual captain as to fishing conditions in the various known areas and advance information on the availability of bait, or presence of fish, are the principal factors governing exploitation of the fishing grounds.

The albacore fishing area off the coasts of Oregon and Washington is such a recent development that it is not yet definitely established. Commercial landings have been reported to date from British Columbia to southern Oregon. Catches have been made as close as 5 miles from shore and as far distant as 50 miles. Searches for fish have been made in the area from 50 to 200 miles off shore but so far have not been productive.

FISHING CRAFT

A special type of craft, the "tuna clipper," has been evolved in the live bait fishery for tuna, and was described in detail by Gordsil (1938). These vessels range from 65 to 145 feet in length. The hull has the same general appearance as that of a destroyer of the World-War I period with a high bow or raised forecastle deck, except that the tuna clipper is wider in beam and does not narrow sharply toward the stern. In place of the depth charge racks of the destroyer, large bait tanks are erected on deck aft and are used to carry the live sardines or anchovettas essential as bait or "chum". These tanks are supplied with a constantly circulating flow of water by large pumps which lift seawater through an 8 to 10 inch suction inlet on the bottom of the hull.

The deck above the fish hold is sheathed with 3-inch cork insulation. This insulation may be continued down the sides to the turn of the bilge and ceiled over with planking. It is not usual to insulate the hold below the turn of the bilge. These vessels are driven by diesel engines with a maximum of 600 horsepower. The holds are refrigerated to prevent the ice from melting rapidly, but the fish are usually not frozen, unless they are in close proximity

to the coils of ammonia pipes. The direct expansion ammonia system is the customary type of refrigeration. A tuna clipper requires a refrigeration capacity of up to 10 tons.

Purse-seine boats fishing for tuna are of the same type as those engaged in the herring, mackerel, salmon or sardine fisheries. This fishery requires a large sized boat with considerable cruising range so that the existing purse seine fleet has not been especially satisfactory for use in tuna fishing. The first seiner designed especially for tuna fishing was built in 1937. This craft was built on the general lines of other purse seiners but has a length of 121 feet, is made of steel and is fitted with refrigeration compressors, a complete sea-water refrigeration system and other special equipment.

Salmon-trolling boats are used in fishing albacore off the Oregon and Washington coasts. These are described in detail in the discussion of salmon canning.

FISHING METHODS

In the Oregon albacore fishery "jigs" or artificial lures of the type evolved during the early days of the California tuna fishery are employed. The fish are taken in much the same method as are salmon by trolling, so that the salmon trollers have taken readily to fishing for albacore. The bone, rag, or feather jigs are towed about 100 feet astern of the fishing boats operated at speeds of from 4 to 7 knots.

In the live bait fishery the method is as follows: When the fishing grounds are reached, lookouts are stationed to watch for signs of tuna. The presence of a school of fish is detected by tuna leaping clear of the water. When near but not breaking the surface, their presence is indicated by a dark ruffled spot which may be seen at a considerable distance on a clear day. At other times the presence of a school of fish may be revealed at great distance by a flocking of birds working overhead since the tuna in pursuit of food will drive their quarry to the surface. The seabirds hover overhead following the school, swooping down when the opportunity serves to pounce upon what food they can secure. Thus to the tuna fisherman "working birds" invariably mean fish (Godsil, 1938). The tuna in their search for food drive smaller fish and squid to the surface where they are consumed by porpoise which follow the tuna so that the presence of a school of porpoise is a sign of tuna.

When a school of tuna is found they are attracted to the sides of the vessel with live bait, dipped from the bait tank and scattered over the water by a "chummer." His special duty is to "chum" the tuna to the side of the fishing craft and he is responsible for the

condition of the live bait, keeping the tanks cleaned, and in good repair; feeding the bait, and so far as possible, keeping it in good condition.

If the tuna are biting they dart savagely at the live bait, causing a swirl at the surface of the water known as a "break." The fishermen clamber out on racks hanging outboard and around the stern, almost at water level. The racks are made of steel rods, and are approximately 6 feet in length by 3 feet in width. Each rack has a knee rest on its outer side some 18 inches above the floor. The fishermen are equipped with heavy bamboo poles about 6 or 8 feet long with a 3 foot length of heavy cotton line fastened to a loop of strong linen at the end of the pole. A 2-foot leader of No. 18 to 22 piano wire is fastened to the end of the cotton line in such a manner that it can be removed easily and quickly changed for another.

Lures are preferred to fishing with bait as the fish are taken more rapidly and easily. The typical lure consists of a barbless hook fixed in a tubular piece of brass filled with lead, with feathers partially concealing the hook. This is known as a "squid" or "striker." The feathers are encased in an animal parchment to prevent damage when fish strike the hook. When water-soaked, the lure resembles a squid. The "squid" are flickered along the surface and the tuna, striking viciously, are swept aboard by a carefully timed heave and swing as the expert fisherman strikes simultaneously with the tuna and lifts him over the rail (Anon., 1938).

The barbless hook usually frees itself as the fisherman heaves the tuna inboard and the "squid" immediately is dropped into the water ready for the next fish. If a barbed hook were used it would be more difficult to disengage, and the catches would therefore be much smaller. If the tuna will not take a lure, a plain galvanized barbless hook is fastened at the end of the wire leader, and live bait is used. The hook is passed through the back muscle of a sardine or anchovetta so that it can still swim about.

If the tuna weigh less than 30 pounds each man fishes individually. If the weight ranges between 30 and 50 pounds, the cotton lines of 2 poles are yoked together, to a metal ring, from which hangs a single wire leader and hook and the fishermen work in teams of two. For tuna weighing more than 50 pounds, 3 lines are joined together. This is known as 2- or 3-pole fishing, and its success requires each team to work together in perfect unison. Four and sometimes 5 poles are used together in catching the very largest fish.

The amount of catch depends on the readiness of the fish to bite and the length of time they will remain near the vessel. Godsil

(1938) stated "In a fast bating school there is a steady rain of fish upon the decks and it is not uncommon to take 30 to 40 tons in an hour or two * * *" Such is not the rule, however. On an average trip, a crew will count upon two or three 'good' days of fishing with a daily catch of 20 to 50 tons. The balance of the catch is less sensational and at times dishearteningly slow. It is far more common to get a ton or two from the first attack into a fresh school, with returns dwindling upon each successive try." This publication contains a thorough discussion of tuna fishing craft, gear and methods.

Purse-seine fishing for tuna is conducted on the same principle as for other species. The special features in tuna fishing are that the set must be made and the net pursed more speedily than for other species, or the tuna will escape. The net is of the typical purse-seine design, but is the largest and heaviest that can be operated. Mackerel purse seines have been used in fishing tuna but are apt to be badly torn, as these nets are too light to withstand any effort of a large tuna to escape.

TRANSPORTING AND UNLOADING

As a rule the fishing vessels also deliver their catches, with the exception of a small amount taken off the coast of Costa Rica, which is frozen in Costa Rica and shipped to San Diego or San Pedro by freight ship. It should also be noted that some of the albacore caught in the newly developed fishery off the Oregon and Washington coasts are landed at Astoria or nearby ports, packed in ice and shipped to California canneries by railway express, insulated motor trucks or by tuna vessels acting as transporters. Some frozen Japanese albacore or "Mebachi" and skipjack, are imported from that country in refrigerated ships and canned in California.

The hold of a tuna fishing vessel is divided into bins by removable partitions of 2-inch planks. These are not painted or given any special slime or moisture resistant treatment though the boards are washed and aired thoroughly when the vessel is unloaded.

In filling a bin, a layer of crushed ice about 6 inches in depth is placed on the bottom. The fish are shunted down from the deck on wooden slides and are laid out in rows in a neat, comparatively even layer. Finely crushed ice is shovelled over the tuna until all interstices between and around the fish are filled and the surface completely covered. The layer of ice covering the surface of the fish is usually from 3 to 5 inches in depth. The refrigeration coils which line the hold are intended to reduce the rate of melting, not to take the place of ice in packing.

Brine chilling systems have been installed on the more recently constructed vessels. The hold is divided into wells by a series of water-tight bulkheads. The wells on the port and starboard sides are separated by a shaft alley which extends from the engine room to the stern of the vessel. The wells are partially filled with sea water into which the fish are placed. The sea water, which is chilled through a shell and tube cooling system is circulated continuously in and around the fish thus providing, through direct contact, a highly efficient means of heat exchange. A temperature of 28° F. is obtained where sea water is used as a cooling medium.

According to a more recently developed system of refrigeration the fish are first chilled in precooled sea water to 28° F. as previously described. The sea water is then pumped overboard and a precooled salt brine with a density of 18 to 23 percent, held at constant temperature, is then circulated continuously through the well. A rapid and efficient rate of freezing to temperatures of from 9° to 10° F. is then secured. After continuous circulation for at least 48 hours the dense brine may be removed and the well held dry with the coils. The larger craft are all adopting this system. Only the tuna purse seiners, or smaller "bait boats" continue to use ice. Freezing has resulted in improved quality of raw material and reduced loss in transportation to 4 percent or less.

The fish are not gutted or headed but stowed away "in the round." This is done partly because the fishermen are paid by weight. In addition cleaning the catch before stowing has not been found practical, due to leaching of the flesh by ice, excessive bruising and damage to the flesh during stowage and unloading, and delay in getting the tuna into the hold. It has also been found that dressed fish spoil more quickly and that gutting attracts sharks, making it impossible to fish.

The large "bait boats" may bring in catches of as much as 370 tons of tuna but will average about 200 to 250 tons. The smaller or "local" bait boats, with a comparatively restricted cruising range will bring in catches of from 50 to 125 tons, while the vessels using a purse seine for taking bluefin and skipjack, land catches of approximately 10 to 60 tons.

Equipment and procedure in unloading depend on the location of the cannery. In the Los Angeles area, except at Long Beach, public highways intervene between the factory and the wharf. These plants use iron trucks with deep bodies and three small wheels, holding about 750 pounds each (Fig. 34). The trucks are lowered into the vessel's hold, filled and are then hoisted back to the street by block and tackle operated by the vessel's boom and and winch (Fig. 35). A crew of several men pull and push the loaded truck across the roadway into the cannery. A few plants

unload small albacore boats onto wooden conveyors which run from water level to the cannery, passing underneath the roadway. The load is weighed on scales inside the butchering room and the weight recorded by hand. The fish are dumped on the cannery floor where they are graded according to size and condition (Crooker, 1938).

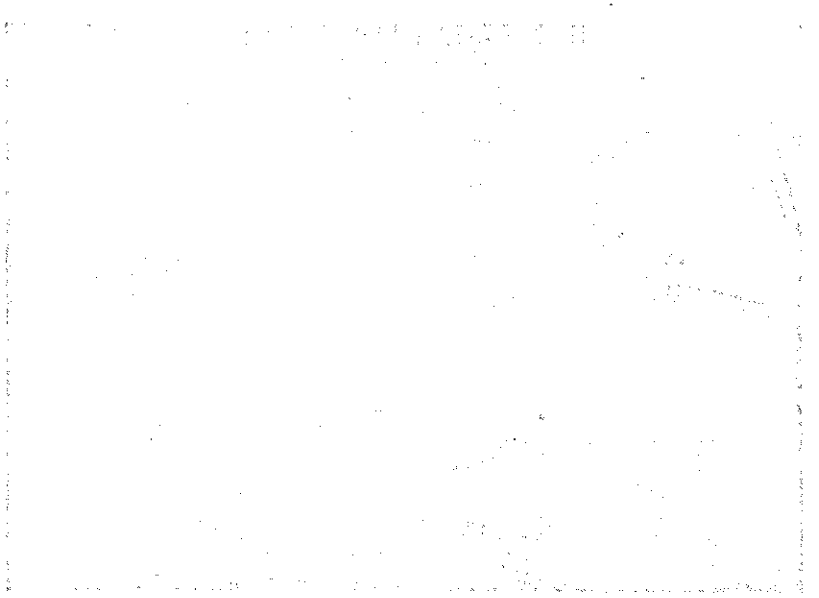

FIGURE 54.—Unloading tuna; preparing to swing a cart of tuna onto the wharf, Terminal Island, California.

In the San Diego area, the canneries extend to the waterfront and maintain their own wharves, with mechanical hoists at the unloading points. The tuna are lifted out of the hold in large iron buckets and are weighed in a weigh house situated by the hoist, or they may be dumped into the apron at the end of a flume, carried a short distance to a weigh house where the weight is taken and recorded by automatic scales, then conveyed by flume to the cannery. In one cannery, trucks running on light rails bring the fish into the cannery while in one or two other instances belt conveyors are used instead of flumes.

THAWING

Tuna stored near the refrigeration coils will be wholly or partially frozen. Imported tuna is always received frozen solid as is fish from the newer clippers. Such fish must be thawed before they can be dressed and precooked. Tuna pre-cooked when frozen will show perforations of the flesh due to the rapid melting of ice crystals formed in the tissues during freezing.

There are two different methods used for thawing tuna. In the Terminal Island (Los Angeles) district, the fish are left to thaw in the open air, where they may be rinsed down from time to time with a water hose. If space is at a premium the fish may be piled in heaps on the floor, rather than in a single layer. At one plant in the Los Angeles area, the frozen tuna are stacked in the racks used in precooking and allowed to thaw.

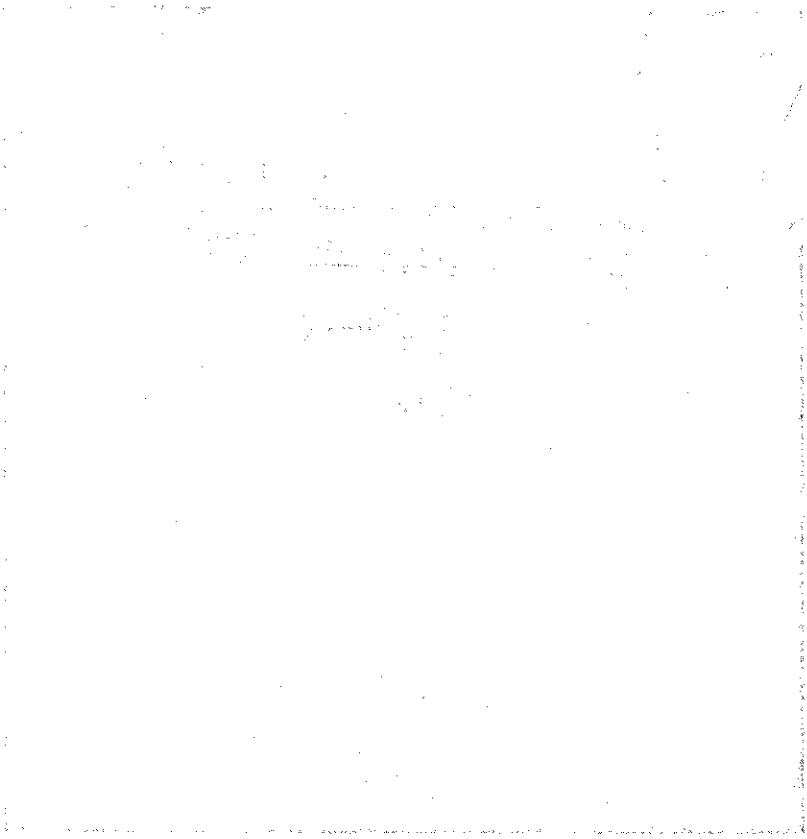

FIGURE 25.—Unloading tuna; unhooking the chains before running cart into the cannery.

In San Diego the usual practice in thawing frozen fish is to hold them in tanks of running water. The tanks may be made of either wood or concrete and are built in varying sizes holding from 1 to 5 tons of tuna. In one large plant an overhead flume conveyor runs between two rows of thawing tanks immediately outside the butchering room. The flume may be blocked so that the fish can be diverted into any particular tank. At the end of the thawing period a sliding door near the bottom of the tank is lifted and the tuna are allowed to flow out into a flume ending in a shallow slanting bin at the head of the butchering table.

The length of time required for thawing varies greatly and depends on whether it is done in air or water-thawed, on the size and condition of the fish, on the packer's judgment as to when the fish are sufficiently thawed, and particularly in air-thawing on the temperature and humidity during the process. If thawed in running water, fish under 10 pounds may be sufficiently soft in 2 to 2½ hours; those weighing from 15 to 30 pounds will require 3

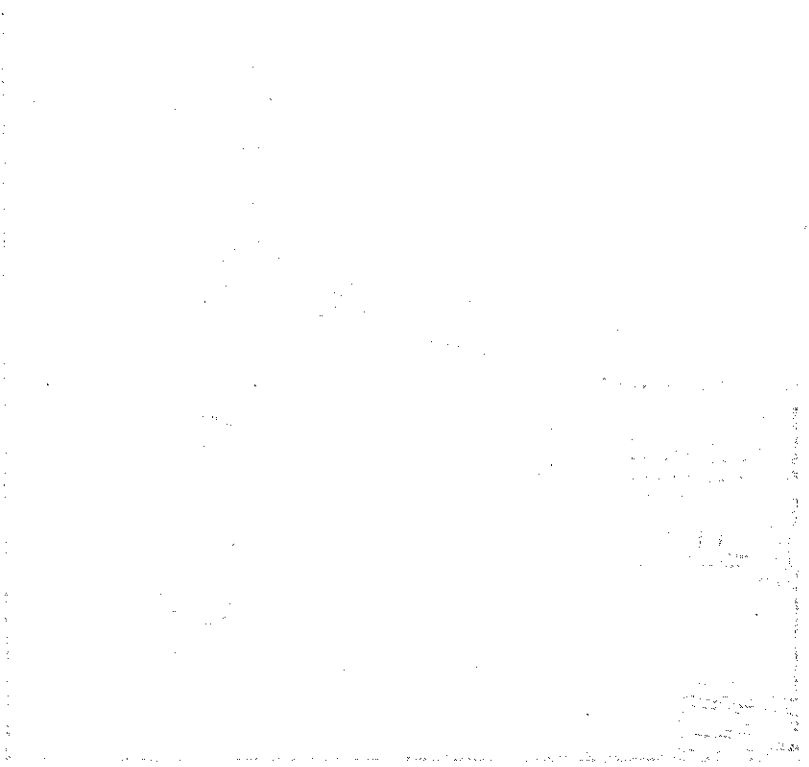

FIGURE 36.—Flume conveyor extending from the wharf into a cannery at San Diego, California. (The tuna are on a slat elevator in transit to the automatic scales.)

to 5 hours, while larger fish will require from 5 to 8 hours. A great variation in the length of time required occurs in air thawing. During warm weather, with the temperature around 80° F., a small skipjack weighing 5 to 10 pounds may thaw in 4 hours, while in cool weather it may require from 12 to 15 hours. A medium-sized fish may be sufficiently air thawed in anywhere from 12 to 36 hours, and a large tuna may require as much as 48 hours. Frozen Japanese albacore, packed principally at Terminal Island, are left on the cannery floor from 24 to 48 hours before they are considered "defrosted."

The discussion of tuna canning methods refers particularly to California since the industry is at present largely concentrated in

fleet States. (See p. 27.) However, tuna are caught in small quantities on the Atlantic coast at Gloucester and in considerable quantities in a new development in the lower Columbia River area. Some of the newest ideas in cannery construction and layout are incorporated in the Columbia River tuna canneries.

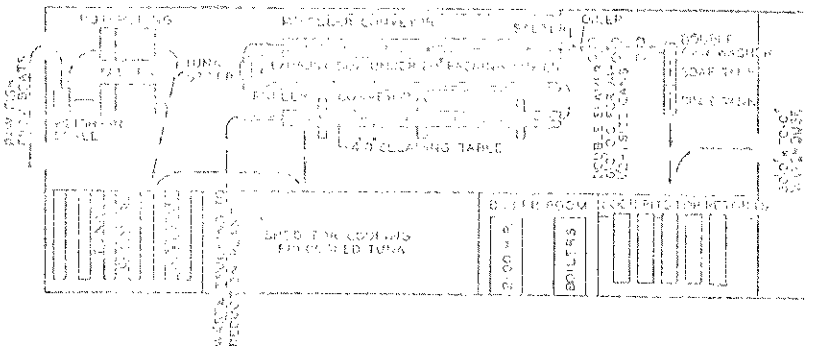

FIGURE 37.—Floor plan of a typical California tuna cannery. (Courtesy, Standard Steel Corporation, Los Angeles, California.)

DRESSING OR BUTCHERING

Two types of tables are used in dressing or butchering tuna. The older type of table, used in plants where fish are dumped on the floor, is portable and built with a small tank in the middle, or at one end. Tuna are washed in this tank after evisceration.

In San Diego plants, the butchering table is a wooden slat conveyor, waist high, running from the end of the flume conveyor inward into the butchering room for a length of approximately 30 feet. The speed of the conveyor is regulated by the rate at which the tuna may be carefully eviscerated and inspected. A man standing by the bin leading from the flume conveyor arranges the fish on the belt conveyor, at a slight angle, bellies toward the operator. The butchers stand next and beside them stands a man who washes out the belly cavities of the eviscerated fish, using a short hose with a spray of water under heavy pressure. At the same time he removes remaining pieces of viscera. He is followed by a State cannery inspector who grades the fish for condition by the odor of the belly cavity. The cannery also has an inspector to cull stale or tainted fish.

One cannery has added a man to the washing and dressing crew. He washes out the gills and mouth of the tuna before they are eviscerated, using a short hose with a long fine nozzle which gives a heavy spray at a force of about 50 pounds per square inch. The tip of the nozzle is inserted under the gill cover, flushing out the gill cavity. This is done so that the odor may be determined more accurately.

In butchering, one worker makes a long slash down the ventral side from the head to the vent, then pushes the viscera free at both ends of the body cavity. Another worker then tears out the viscera. The head and the fins are not removed. The livers are separated from other viscera, since they have been found to contain a high quality medicinal oil, and are packed into 5 gallon cans for sale to drug manufacturers. The remaining offal may be given a short steam cook before it is sent to the reduction plant for manufacture into fish meal.

The dressed and washed fish are placed in wire mesh baskets, which are fitted into wheeled racks of angle iron. Standard dimensions of these baskets are 15 by 30 inches, which will hold 6 small, 3 medium-sized, or one fairly large fish. Sometimes baskets 36 and 42 inches long are used to hold still larger fish. Tuna are stacked in the baskets belly down for better drainage during cooking.

PRECOOKING

The racks of fish are wheeled into horizontal rectangular steam chests where they are precooked in preparation for filling into the cans. The cookers are ranged along one side of the cleaning and packing area, in a separate room, or they may be located in the open air outside. The average tuna cooker is built of sheet iron, is either 13 or 20 feet long, and will hold either 5 or 3 racks, depending on the size.

The chamber must be brought up to cooking temperature gradually if proper cooking is to be obtained. The length of this period varies according to the size and condition of the fish. Tuna brought in fresh usually require less time to reach cooking temperature than fish received frozen, while large sizes must be given more time than small. Length of "come-up" or "lag" time also depends to some extent on the routine practice established by the individual packer. Representative periods are 20 minutes for skipjack and albacore under 15 pounds, 30 minutes for tuna weighing 15 to 30 pounds, 40 minutes for fish 30 to 40 pounds, 60 minutes for tuna 50 pounds weight or larger. The temperature of the precook will average 216° F., though it may be as much as 220° F. The usual custom in cooking is to maintain 1 or 2 pounds of steam pressure in the cooker.

The length of time required for the precook will vary from 1½ to 8, or even 9 hours. Small skipjack may be cooked in 1½ to 2 hours, but the large bluefin tuna should be cooked 8 hours.[11] General precooking times and temperatures for the various weights and species of tuna are as follows:

[11] Continental Can Co. "The Canning of Tuna." Bull. Research Dept. Continental Can Co., Inc., 6 pp. New York.

Species	Weight	Time of precook at 210° F.
	pounds	*hours*
Albacore	10 - 14	3 - 3½
Albacore	15 - 17	3½ - 4½
Bluefin or yellowfin	8 - 14	2
Bluefin or yellowfin	15 - 50	3
Bluefin or yellowfin	50 - 65	4
Bluefin or yellowfin	66 - 200	5 - 9
Skipjack or striped tuna	5 - 12	2 - 2½
Bonito and yellowtail	5 - 12	2 - 2½

Commercial fishery regulations of the State of California prohibit the canning of tuna weighing more than 150 pounds, but in actual practice the canner usually refuses to accept fish weighing more than 100 pounds, and may even establish 50 pounds as the maximum weight. The reason for this is that the flesh of the larger fish is usually darker in color and stronger in flavor than is desirable for a fancy pack.

When the fish have been sufficiently cooked they are run out into a cooling room where they are held until the flesh is cold and firm enough to handle. If attempts are made to pack precooked tuna before it is sufficiently cool, the flesh will crumble and the separation of skin, dark meat and other waste, is incomplete. The cooling room is often a cross-ventilated area, with screens taking the place of walls but mechanical aids, such as blower fans, are only used occasionally for cooling in hot weather. Length of cooling is regulated by the size of the fish and atmospheric temperature. An average cooling period for most sizes of tuna is 12 hours.[14] Large bluefin tuna are preferably cooled for 24 to 36 hours, as this is believed to give a better texture and color because of longer drainage. The maximum length of time precooked tuna may be allowed to stand without spoilage is 24 hours during warm summer weather. The average loss of weight from precooking runs from 25 to 30 percent. The tuna oil cooked out is sometimes recovered from the steam chests and sold as a by-product.

CLEANING

Cleaning tables may be of several types—including makeshift tables used during rush periods when extra cleaners are required. These are simply flat table tops laid on saw horses and set up in any empty corner. Waste is shoved down holes in the center to fall into containers below. Other permanent tables require waste containers for every two packers. One type is equipped with wide conveyors which run under the cleaning table, carrying all the waste outside the packing room. Comparatively little waste accumulates around this type of cleaning table. Cleaning may be

[14] American Can Co. "The Canning of Tuna." Research Dept., American Can Company, Inc. San Mateo, Calif.

done in a separate room or the tables may be set up close by and connected to the packing line.

Cleaning methods do not vary between canneries or with different species of tuna. The heads are broken off, tails and fins are removed and the skin is scraped away, after which the body is separated into two halves, exposing the backbone, which is removed, together with the adhering rib bones (Fig. 38). The halves are split longitudinally and the dark meat, which is located in a V-shaped layer along the lateral line is scraped away quickly

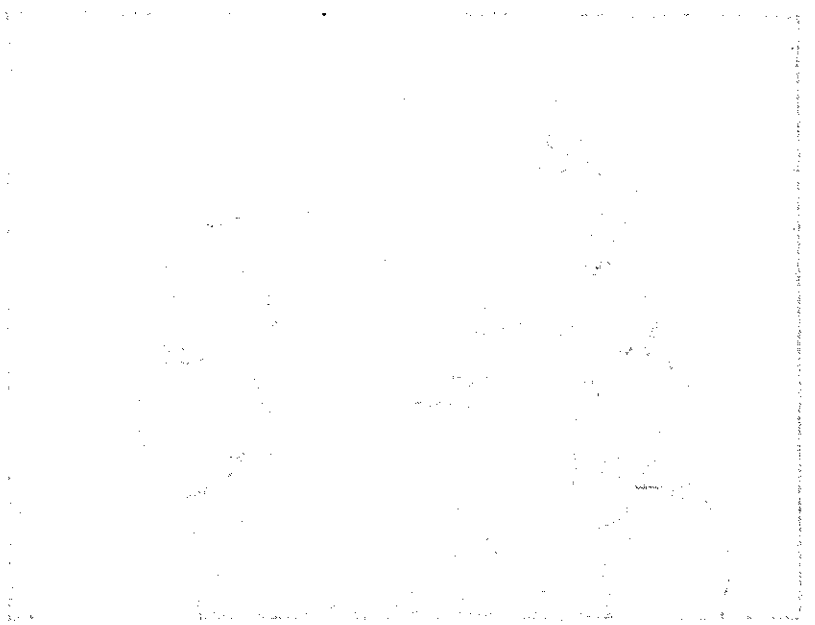

FIGURE 38.—Cleaning cooked tuna. (The light meat used in canning is separated from the bones, skin, dark meat and other refuse.)

and thoroughly with the blade of a small paring knife. The chunks or strips of light meat are placed on wooden trays 16 by 24 inches in size with two metal strips on the bottom, one near each side. These trays are scalded frequently in a hot alkaline cleansing solution. One packer treats new trays with a liquid synthetic resinous compound to give them an impervious surface.

The cleaned meat is checked for condition before it is sliced. Inspection includes an examination to determine the adequacy of cleaning, that is, that all dark meat is removed and that no meat unfit for canning because of discoloration, staleness or "honeycombing" is included. The waste may also be inspected before it is discarded to determine that the cleaner is not throwing away light meat. Cleaners are paid on a piece-work basis or they may be assured a minimum hourly wage, with piece-work rates for

production over a certain amount. Inspection is very close in some plants, with the checkers making an inspection as they remove the trays, another inspection by the forewoman and a third by a woman stationed by the conveyor taking the sliced meat toward the packing tables.

Cleaning requires more labor than any other operation in tuna canning. If the fish are of average size, cleaning will require two and a half workers for every packer engaged in filling cans; if the tuna are large, the number of cleaners and packers will be more nearly equal, but if the tuna are small the ratio may be four cleaners to each packer.

PACKING

CUTTING

Various types of slicing machines have been used but an automatic cutter of the guillotine type is favored at present (Fig. 39). The trays of cooked meat are carried along a chain conveyer, passing under a blade moving between uprights on each side. A ratchet bar arrangement moves the conveyor forward. Adjustment of the bar, altering the angle at which it engages the ratchet determines the width of the slice. In packing ½-pound cans of tuna, the slices should be approximately ⅞ inch wide; ½-pound cans, 1 inch to 1⅛ inches, while for 1-pound cans, the width must be 1⅝ inches. Some packers cut the large fish only for 1-pound cans. The meat is always cut across the grain.

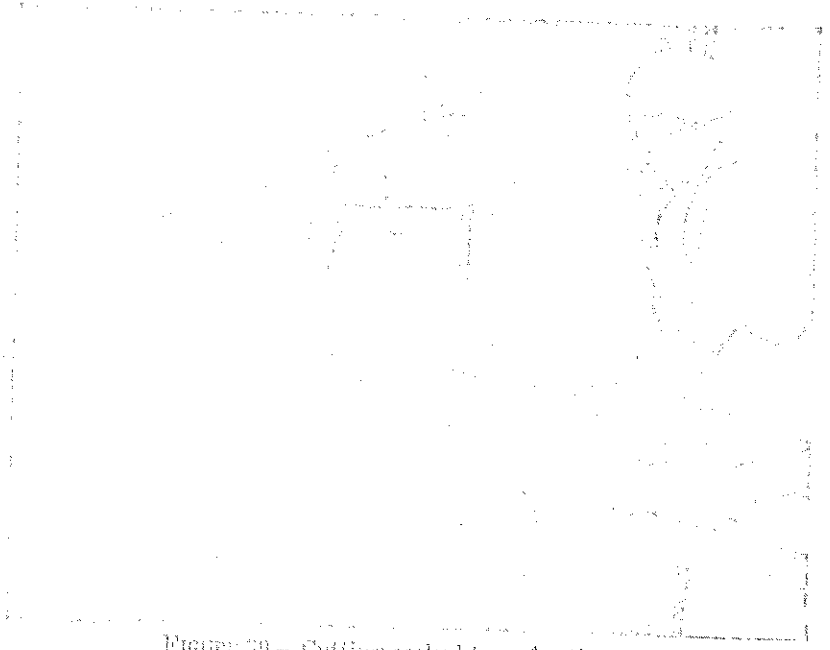

FIGURE 39.—Cutting cooked tuna for the can.

GRADING

Three grades of tuna are packed, namely, "fancy," "standard," and "flakes" or "salad." The "fancy" pack usually consists of large pieces of solid meat with no small fragments. In a "standard" pack, 3 pieces of solid meat are placed in each can, with sufficient small fragments to give the desired net weight. The common practice in packing "standard" tuna is to fill in 25 percent flakes but some packers use no more than 15 percent. "Flake" tuna consists entirely of small crumbs or finely divided meat, packed down into a more or less solid cylinder. (Federal Trade Commission, 1940). If a "standard" pack is being canned, it will use practically all the flake material. "Flake" tuna is usually packed when "fancy" tuna is being canned. Meat going into the flake pack is of the same quality as in "fancy" or "solid-pack" tuna and is by no means a secondary grade product. If the meat is tender and brittle, the amount of flakes will be greater than if the tuna is firm and dry. More flakes are obtained when the tuna are of the smallest sizes.

Species is a factor in establishing the quality of a pack. Albacore has been considered the finest tuna and is the only variety which can be marketed as "white-meat tuna." With the decrease in the catch of albacore, more attention has been paid to developing fancy packs from other species of tuna. Much of the "fancy" pack is now prepared from yellowfin tuna. The catch of this species is larger and more consistent than that of albacore.

FILLING

Details in the setup of the packing table differ among individual canneries. In some plants the exhaust box is built into the center of the packing table, in others it is separate. In some canneries a roller conveyor runs along the top center of the table. Filled trays of meat are placed on this conveyor at one end, to be removed by the packers as needed. In other plants, the cleaned meat is left stacked in the racks which are wheeled around near the tables and a man brings trays from the rack to each packer as she needs fish. This method is slower and it is claimed to cause delays in filling the containers.

The container which is most used in tuna canning is the ½-pound tuna (307 x 113) can. An average of 80 percent of the total tuna pack is packed in this container. (Roedel, 1938.) Other containers used are the ½ tuna (211 x 109) can, and the 1-pound tuna (401 x 206) can. A small amount is packed in 4-pound cans, mostly flakes for hotel and institutional trade. Most of the packers use plain cans, but as some trouble has been experienced with

sulfide discoloration, especially with albacore and catches brought in from the more distant fishing grounds, a number of packers are now using cans with an inside lining of C-enamel, seafood formula.

All tuna are filled into the cans by hand but one packer is preparing to use a filling machine for his flake pack. In filling the can by hand, pieces are selected to fit well into the cans, leaving no spaces around the sides or in the center. As each can is filled with meat, the worker tamps it down quickly with the heel of her hand and places it on the conveyor for filled cans. Balance scales are placed beside each packer but these are rarely used by the more experienced women who have learned to estimate the right amount of fish needed for each can.

Some plants have an inspector on the line to see that cans are properly filled. A 3/16-inch space is left in the top of each can after the meat has been filled in but when the oil is added and the top sealed on, the headspace will not be more than 1/8 inch after processing. Fill-in weights of meat depend on the moisture content of the fish and are approximately as follows: 1/4-pound tuna can, 2½ ounces; ½-pound, 5½ to 5¾ ounces; 1-pound, 11 to 11½ ounces, and 4-pound, 46 ounces.

The filled cans pass along a conveyor to an automatic salt dispenser. The salt used is "three-quarters ground" or "dairy fine." The salt must be handled carefully to prevent clogging, which would cause an uneven distribution of salt in the containers. One packer keeps canning salt in a constantly heated dry kiln, removing a sack only when it is to be used immediately. The approximate amounts of salt used per can are: 1/4-pound can, 1/14 ounce; ½-pound, 1/7 to 3/14 ounce; 1-pound, 3/14 ounce, and 4-pound, 6/7 ounce. Salt may be added to the empty can in some instances, but this is not the general practice.

The oil-dispensing apparatus is located on the canning line immediately following the salting machine. The usual type consists essentially of a tank with a single spigot. The flow of oil is constant, falling into a drip pan below when cans are not moving along the conveyor. This excess oil is piped off, filtered and re-used. In some canneries the oil-dispensing machine is equipped with a horizontal length of pipe a few inches above the conveyor. Oil falls into the cans in a series of small jets from holes bored in the bottom of the pipe (Fig. 40).

Winter-pressed cottonseed oil is used, although olive oil is required in at least one specialty pack. The oil is usually added hot at temperatures varying from 180° to 200° F. principally to facilitate handling, but it is claimed that warm oil permeates the flesh more rapidly. The amount of oil filled into each can is supposed

to average for ¼-pound cans, ¾ ounce; ½-pound, 1⅔ ounces; 1-pound, 3 ounces; and 4-pound, 9 ounces.

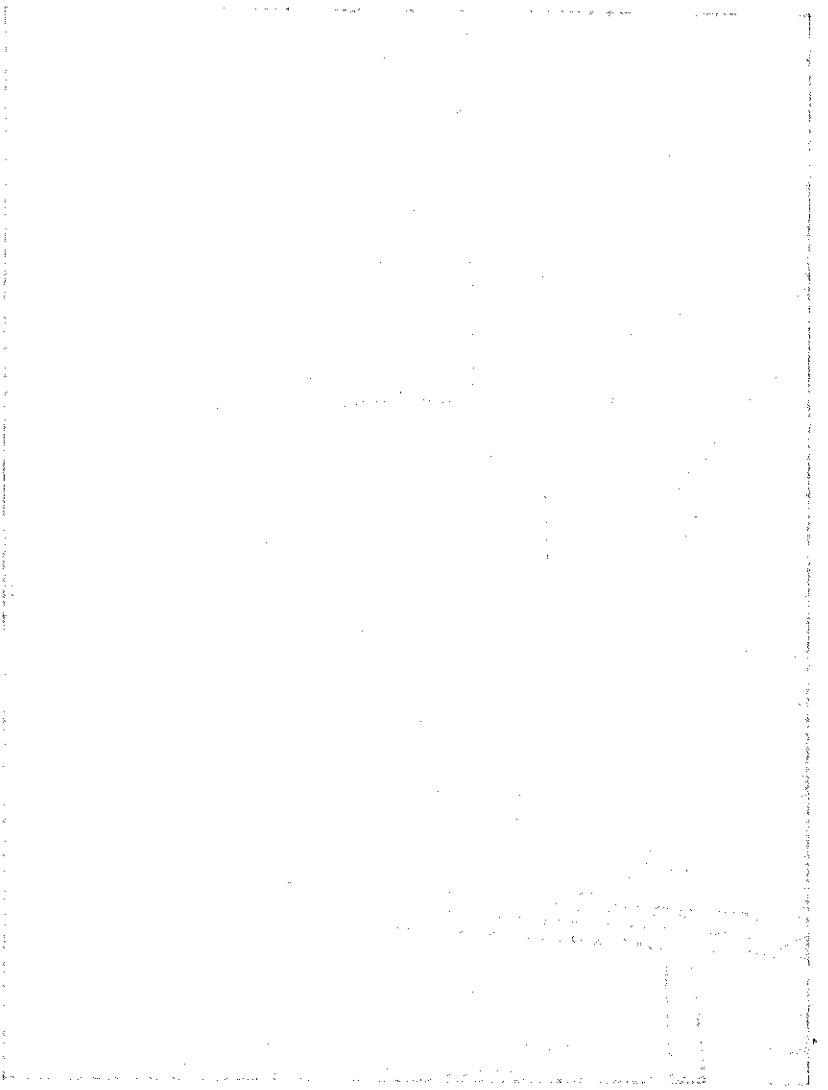

FIGURE 50.—Oil-dispensing apparatus used in tuna canning.

EXHAUST OR VACUUM AND SEALING

The greater part of the tuna pack is still given a heat exhaust in a steam exhaust box, although about one-third of the plants use vacuum closing machines. Covers are not clinched on the cans before exhausting, in most canneries. The exhaust box used has but a single "run," that is cans pass through the box but once. The exhaust is very short, averaging 3 minutes, although an exhaust

of 5 to 10 minutes is recommended. The vacuum obtained is very high, not more than 1 and often 2 inches or less. There is a tendency on the part of canners to under exhaust as water condensing in the can will flood the oil.

Where vacuum closing machines are used, oil is not heated before it is added to the can. After salting and oiling, the cans pass under a machine equipped with a series of plungers. These force the contents into the can so that air spaces are not left on the bottom, which would make it difficult to secure a good vacuum. The cans are then conveyed through a "clinching" machine which drops a lid on each can and crimps it loosely, after which they are carried to the vacuum closing machine, where each can is enclosed in an airtight chamber and the air sucked out by a pump, while the top seam of the can is completely sealed. The vacuum obtained in the cans averages 9 inches. This machine operates at a speed of from 100 to 120 cans per minute. Auxiliary machines may be set up on the line, greatly increasing the speed of operation.

WASHING

The sealed cans roll down a conveyor into the washing machine. Details of these machines differ between canneries but in the usual form the cans pass through a bath of hot alkaline cleansing solution such as tri-sodium phosphate, then through a second bath of hot fresh water and out onto a conveyor, down which they roll into wheeled retort baskets. A baffle of wire mesh or belting at the end of the conveyor breaks the fall of the cans so that they will not be badly dented in dropping into the basket. The baskets are oval in shape to reduce the amount of lost space in the retort and are usually made of sheet metal. State cannery inspection regulations require that the devices, pans, trays, or cages used to hold cans, glass jars, or other containers in retorts should be perforated or made of strap iron so as to insure proper circulation in the retort.

PROCESSING

Horizontal retorts are used in all tuna canneries, but they differ widely in size and capacity (Fig. 41). In California all retorts must be equipped according to the specifications of the State Board of Health. When the retort is loaded and steam is admitted, a period of 7 to 10 minutes is required to bring the temperature and pressure to the required point where the cook actually begins. This is known as the "come-up" or lag time and is not included in the processing time. Official processing times and temperatures are specified by the State Board of Health, and are given in the following schedule:

Can	Size	Initial temperature of product	Process for temperature of—		
			250° F.	240° F.	230° F.
¼ lb. tuna	211 × 109	70	130	65	30
½ lb. tuna	307 × 113	70	140	75	35
1 lb. tuna	401 × 206	70	170	95	80
4 lb. tuna	603 × 7	70	320	250	190

Although "equivalent" processes at 230° F. are permitted, no commercial pack is processed at this temperature. Most canners process at 240° F. as an additional safety factor. The shorter process at the higher temperature of 250° F. is employed in a few canneries.

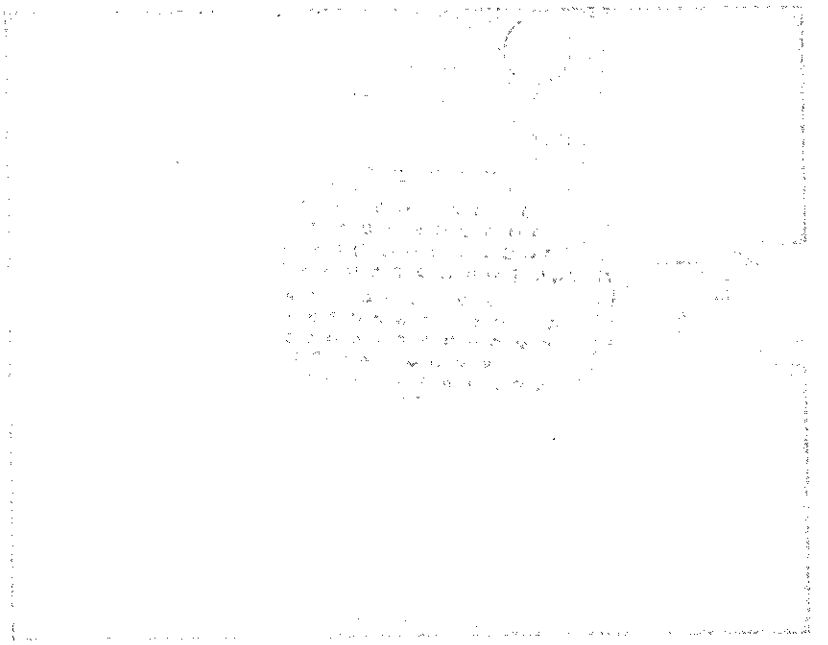

FIGURE 31.—Horizontal retort used in processing tuna, showing the metal basket and arrangement of cans.

COOLING

At the end of the processing time, the steam is shut off and air under pressure is admitted so that the pressure in the retort will be equal to or slightly greater than that during the cook. A spray of water is turned on through a perforated pipe running along the top of the retort. The air pressure is gradually reduced as the temperature decreases. After a period of about 30 minutes the cans have been cooled and the retort may be opened. The cans are

still warm to the touch so that the retort crates are wheeled to the warehouse where the pack is held at least 24 hours before labeling.

STORAGE AND LABELING

In California all cans are embossed with a code registered in the State Canners Inspection Service, stamped into the can lids when they are seamed. All lots are kept separate according to codes, at least until they have been released for labeling and distribution. It is claimed that tuna should be held in storage for at least 3 months as oil and salt will not have penetrated evenly in a shorter time, but in practice some canners do not hold the pack in storage any longer than is necessary to find a buyer. Details of labeling and storage do not differ from methods followed with other fishery products. A standard case of tuna is 48 1-pound cans though it may be packed in ½-pound cans to the case; quarters may be packed 48 to the case but in many instances are packed 100 to the case, while 1-pound cans are packed 12 to the case.

SPECIALTY PACKS

TONNO

Tonno is solid tuna meat packed in olive oil and with about double the quantity of salt used for the regular pack. The meat is darker and stronger, as a more pronounced flavor is demanded in this style of pack. Bluefin and skipjack or striped tuna are packed as tonno, with skipjack preferred. Tonno is usually packed in quarter-pound cans although small amounts are canned in larger size containers. A special type of can is often used differing from the ordinary type in that the top end is closed by a crimped sheeting instead of the usual rolled seam. This can be readily removed and the can opened by inserting a sharp instrument under the edge. Tonno is sold principally to the Italian-American trade.

TUNA IN GLASS

Glass containers are sometimes used in packing tuna, particularly tumblers of 3 ½-, 7- and 8-ounce sizes. The method of preparation does not differ from that previously described. Special care is required in filling, as appearance in the containers is a selling feature of this pack. It is prepared only on special order by a few firms.

TUNA IN ALUMINUM CANS

One firm packs a few thousand cases of fancy yellowfin tuna using aluminum cans in ½- and ½-pound sizes. The method of

preparation, the amount of salt and oil, and other packing details do not differ from the usual style of pack. Tuna makes a very good appearance in aluminum cans, with no sulfide discoloration. The container has a re-use value since it is adaptable for use as a salad mould or small refrigerator dish when empty. The cannery preparing this pack has installed brass conveyor belts from the filling table to the seamers, as iron conveyor belts mar and stain the aluminum can. Sealing aluminum cans requires much more careful control than for tin cans because the metal is so soft. The top seam is wider and thicker than in the ordinary can. Because aluminum cans are much higher in cost than tin containers, the pack is limited to the quantity of advance orders.

CREAMED TUNA

Canned creamed tuna is a novelty pack prepared by a single firm. This pack is canned in No. 1 Eastern Oyster, or 12-ounce tall cans. The method of preparation is much like that used in the canning of New England fish chowder. Cooked tuna meat of strictly fancy quality is diced into cubes and filled into the containers, about 4½ ounces to a No. 1 Eastern Oyster can and 5 ounces in the 12-ounce can. The cans are mechanically filled with a hot cream sauce and the covers are sealed on immediately. A standard cream sauce formula, such as is used by the housewife in preparing creamed chicken or tuna is employed, but the consistency of the sauce when added must be thinner than in home cooking since the heavy process thickens the sauce. The process used is 75 minutes at 240° F.

GARLIC FLAVORED TUNA

A pack of fancy yellowfin tuna is now on the market, with just enough garlic added to each can to give the meat a piquant but not obtrusive flavor. There is no change in packing methods, other than the addition of the garlic.

VENTRESCA

Ventresca is a specialty tuna product following the Mediterranean rather than American method of precooking. The belly strips of large fat bluefin weighing 50 pounds or more, are cut into pieces that may be filled into ½-pound cans. The skin is not removed. The chunks of tuna are boiled in a strong salt brine until cooked. After cooling and draining a single piece is packed in a ½-pound tuna can, together with an extra quantity of olive oil. The regular cook for this size can is used in processing.

INSPECTION AND EXAMINATION

In California the inspector assigned to each tuna cannery boards a fishing vessel when it arrives, examines the catch and records the source of the tuna (where caught), the length of the voyage, approximate quantity of different species, the condition of the fish and whether it has been preserved by ice or mechanical refrigeration. The odor is noted and sample fish are thoroughly examined after which permission is given to unload.

The inspector observes the fish through the various stages in packing. In addition to inspection at time of butchering, already described, he inspects the cooked fish when it is being cleaned in preparation for the can. Fish showing discoloration or honeycombing are discarded by the inspector if this has not already been done by the worker. The odor is determined if the condition is at all doubtful. The meat is again inspected for texture, odor and color after it goes through the slicing machine. Meat rejected after cooking is weighed, the amount multiplied by a standard factor of 3 if the meat is cleaned; by a factor of 2 if head, skin and bones are included, and the total is deducted from the amount delivered by the fishing vessel.

The inspector notes all codes used in the daily pack, and close control is maintained over details of processing. At the end of the day, an inspector draws a representative sample of each code packed. If the condition of any lot is doubtful, additional samples are drawn to determine the extent of the defect and the pack is restrained until official instructions based on laboratory examination are issued for final disposal. Samples are cut by a trained examiner who makes out a cutting report covering the sample. The examination is not as detailed as for sardines. Odor only is noted. Most examiners empty the contents of the can and determine the odor at the bottom of the container. A certificate is issued releasing the code or codes for shipment, if production records and processing temperature curves are satisfactory and no stale or off-odors are noted.