



Operation and maintenance of machinery and equipment for cold storage plant and canning plant

General

Fish should be chill stored at a temperature between 0° and 2 °C, or sorted frozen in freezers at temperatures below -28 °C. When frozen fish is used, it must be thawed before grading and/or dressing. In the following descriptions of the processing stages for various products, operations which are similar are described below.

Description of canning tuna in brine

The description is related to canning plant with a capacity of 20 tons whole raw fish (bluefin or yellowfin tuna) per 8 hours. The overall yield is approximately 50-55% which gives approximately 10 000 450 g (1 pound) cans or 20 000 225 g (1/2 pound) cans per 8 hours. See Figure 4 "Layout for tuna cannery".

Sequential processing operations for canning tuna are described as follows:

- a. Frozen tuna is thawed, preferably, by means of running water at a temperature of 10-15 °C. Loss during thawing is 0.5-1.0%.

Holding of frozen tuna for long periods before thawing may lead to oxidation of fat resulting in a yellow to orange discolouration on the surface of the cooked loins. Usually this surface discolouration can be removed when the fish is cleaned.

- b. Longitudinal cuts are common with large sized tuna and the viscera are removed from the fish on board fishing vessels prior to freezing. Bonito and skip jack are frozen with

viscera. Once thawed, the tuna is washed and inspected for spoilage. If tuna is not eviscerated on board vessels this must be done in the plant. The splitting and evisceration procedure is the only butchering operation performed on the tuna while it is in the raw condition. All other cleaning is performed after the tuna has been cooked. Loss of weight is approximately 24-27%.

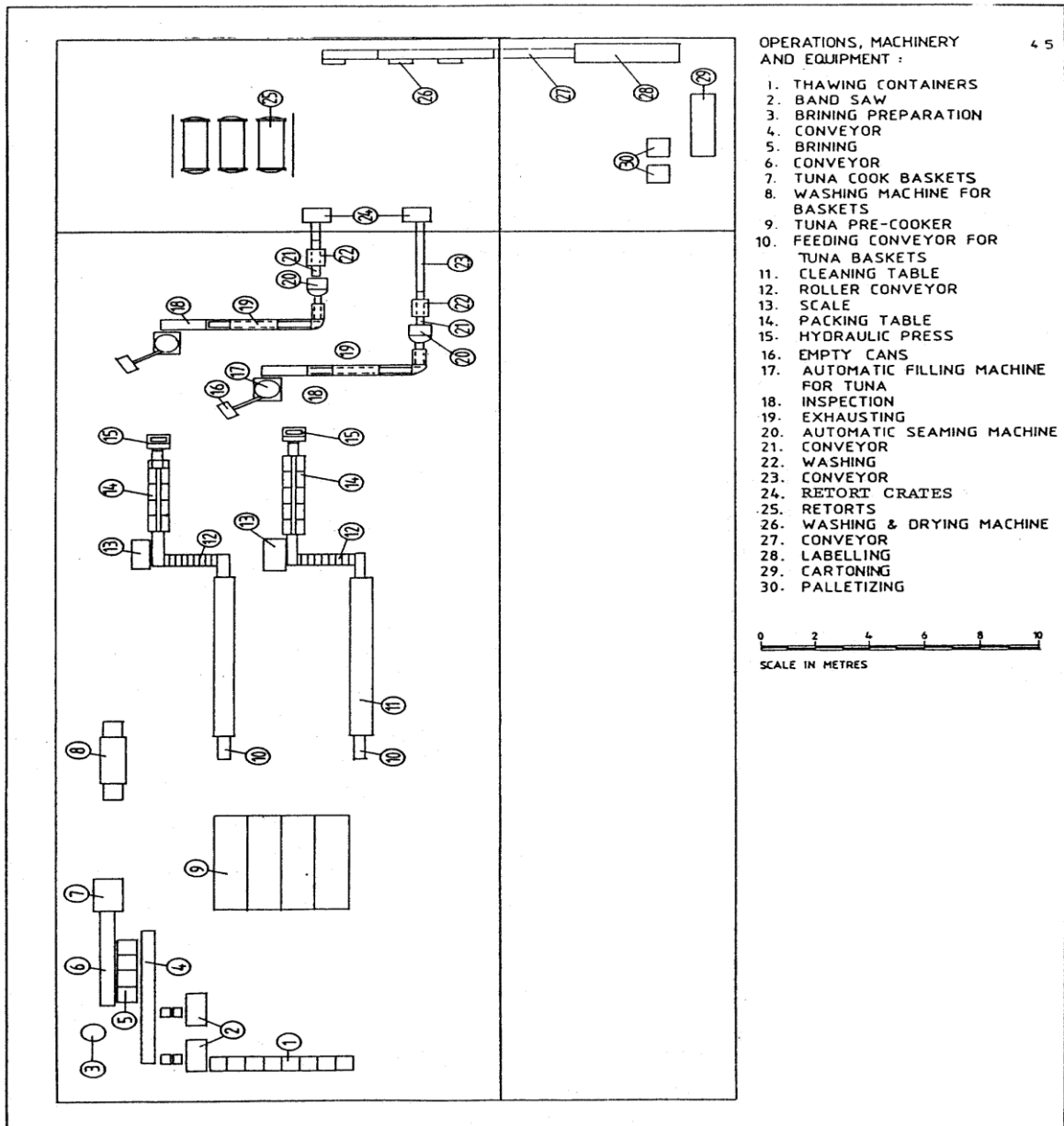


Figure 1 Layout for tuna cannery

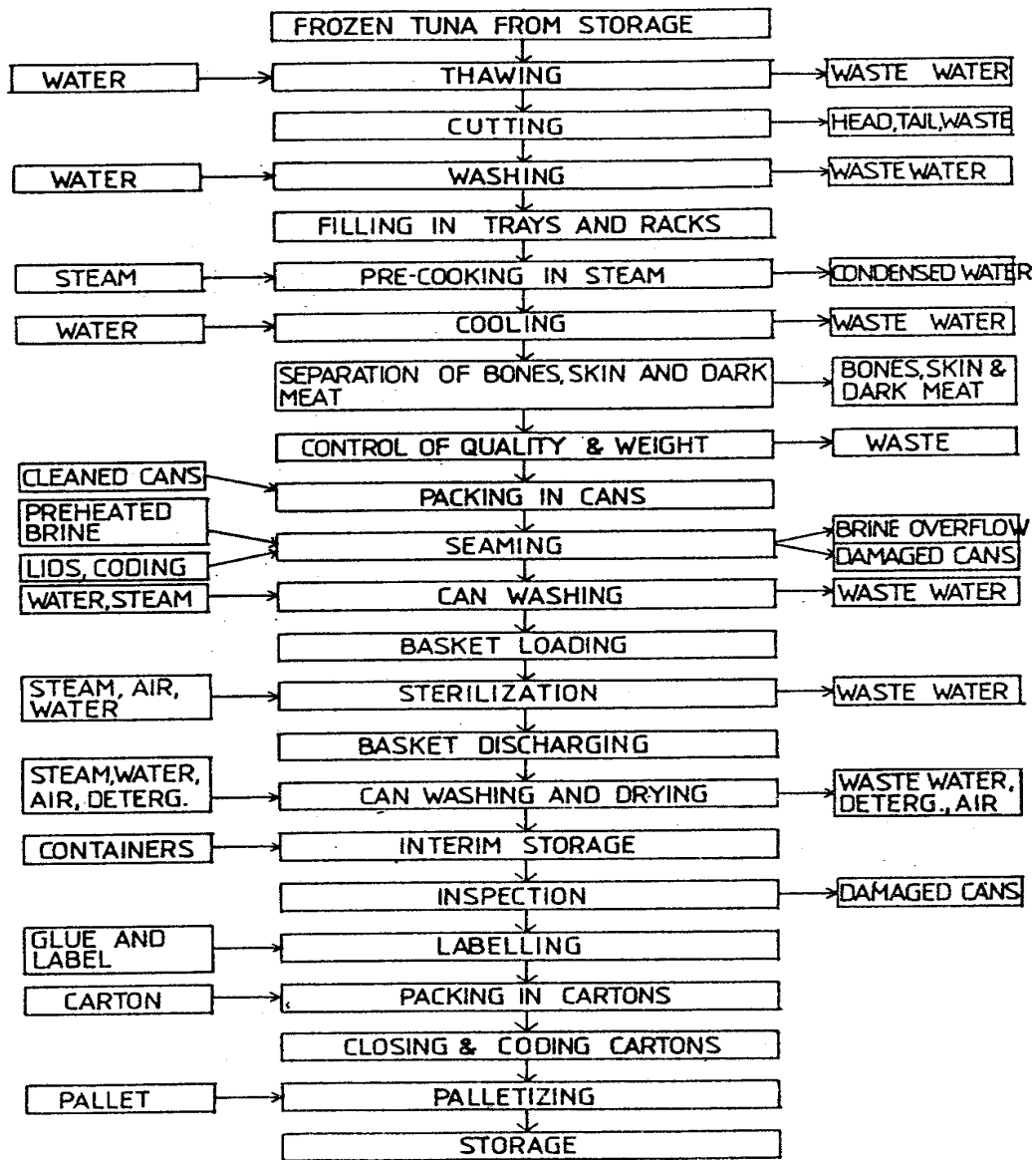


Figure 2 Flow sheet for canning tuna in brine

- c. The tuna is given a pre-cook by heating at a temperature in range of 102 to 104 °C. This operation is necessary to make it possible to hand pick the light meat from the carcass and also to remove some of the oil from oily fish.

The fish is placed in baskets which are placed on racks. The racks of butchered fish are rolled into the cookers which are usually of rectangular cross section and made of reinforced steel plate with a door, or doors, at one or both ends. The pre-cooking is a batch type operation.

Steam is admitted through a steam spreader on the floor of the cooker. Steam vent and drain valves are provided to permit removal of air and condensate. Pre-cooking may also be carried out in boiling brine.

The pre-cooking time for individual batches varies widely according to the size of tuna. For example, the cooking time may vary from 1 1/2 hours for small tuna to 8 to 10 hours, or more, for larger tuna. Loss of weight is approximately 22-26%.

- d. Tuna is cooled thoroughly to firm the flesh before the manual cleaning operation can be performed. Loss of weight is approximately 3-5%.
- e. After the pre-cooking and cooling operations, tuna is individually cleaned. The head is removed and the fish is skinned and split into halves before removing the tail and backbone. The loins are produced by splitting the halves of the fish along the median line. Red meat is then removed from each loin; the blood and dark meat are scraped away and the loins, edible flakes and waste products are separated; of these portions approximately 15% is flake tuna.
- f. The production of solid packs was formerly a hand-packing operation, but is now carried out by machines. This machine produces a cylinder of tuna loins of uniform density from which can be cut can-sized segments of uniform weight.

Chunk packs are produced from loins which are cut on a moving belt by means of reciprocating cutter blades. The cut loins are then filled into cans by tuna filler machines.

Flakes and grated tuna, which is produced from broken loins and flakes, are J packed in the same way as chunk packs.

- g. The open cans next pass the line where additives such as salt, vegetables and finally either water or oil are added. Oil should be added slowly over a sufficient stretch of the line to permit its thorough absorption by the tuna meat. When oil is not added an equivalent amount of water replaces it. The oil temperature is recommended to be 80 °C-90 °C.
- h. Small cans may be closed, without a vacuum, and processed directly, whereas larger ones must be vacuum sealed.

- i. The double seaming method is usually used to seal metal containers. The seam is created in two operations. See Figure 3. "Seaming Operation -Double Seam (CAC/RCP 10-1976).

The sealing compound renders the seam air tight (hermetic). Around its circumference the double seam consists of five layers of metal -three layers of the can end and two layers of the can body, however at the intersection with the side seam there are seven layers of plate, the extra two being due to side seam overlap.

The seaming operation must be monitored throughout the processing and visual inspections should be carried out at least every 30 minutes (Warne, 1993).

Good manufacturing practice indicates that the overlap should be at least 45 % of the internal seam length to ensure that the seam will function correctly and resist to minor abuse.

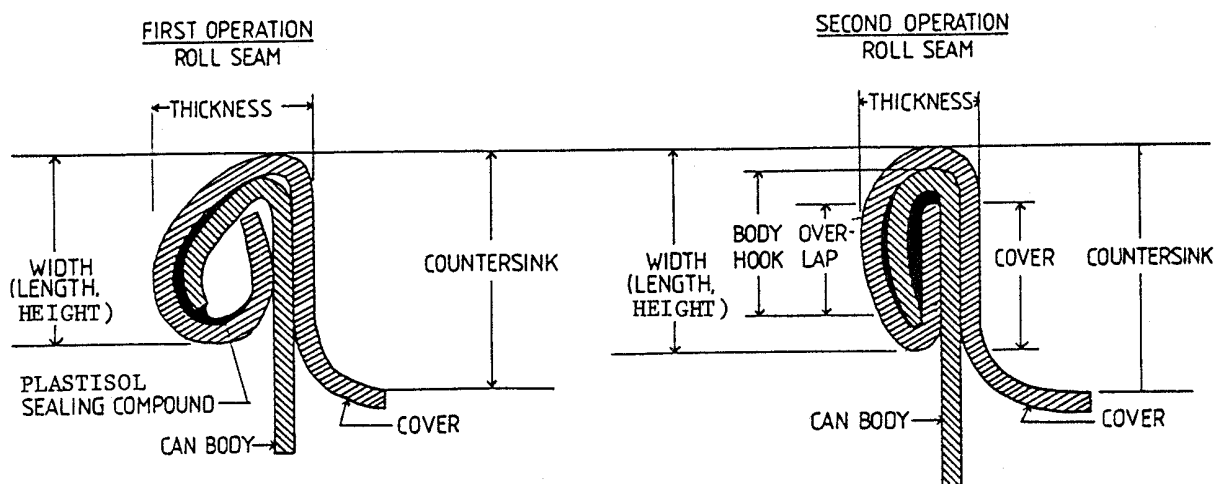


Figure 3 Seaming operation -double seam

- j. The sealed cans are transferred by a conveyor through a can washer which cleans the cans in detergent and water before discharging them into retort baskets. The retort All canned fish products are sterilized at temperatures above 100 °C. Sterilization takes place in retorts, with or without water. Overpressure is between 2-3 kg/cm². Processing conditions shown are suitable for those canneries , operating under conditions of good manufacturing practice. Individual canneries may select different processing times and/or temperatures to suit their manufacturing requirements.

The simplest and most common retorts today are horizontal, or vertical, batch retorts.

The following general description. applies to processing in batch retorts using saturated steam as the heating medium.

After the retort is loaded the door or lid is closed and the seal is checked to confirm that all the lugs are fastened securely. The temperature recorder is checked to ensure that it is working

correctly. Following this the vents and bleeders are opened and the drain and overflow are closed (unless the over flow is used for venting).

The retort is now ready for operation during which the following operational procedures should be adopted:

- Steam is admitted by gradually opening the controller and the steam by pass lines.
 - When the correct venting temperature is reached (≥ 100 °C) and/or the specified, vent time has elapsed, the vents are closed. It is bad practice to vent less than the recommended time; nor should reliance be placed on agreement between the mercury thermometer and pressure gauge readings as a criterion for complete air elimination, as this is not necessarily a true indication of the required condition. If the pressure gauge is reading high while the temperature is reading low, there is still air in the retort and venting should be continued until agreement between pressure reading and the corresponding retort temperature is reached.
 - Gradually close the bypass as the retort approaches the processing temperature. This will prevent a sudden drop in temperature as the steam supply is cut when the retorting temperature is reached.
 - When the retort has reached the processing temperature, check the temperature indicated on the mercury and recording thermometers. While it is not serious if the thermograph indicates a temperature slightly lower (say 1 °C) than the mercury thermometer, it is most important that it never reads higher. At all times the mercury thermometer should be used as the reference, for indicating true retort temperature.
 - At the start of the process, record on the production records the time, the mercury thermometer reading, the pressure, and the temperature indicated by the recording thermometer.
 - Keep a record of the come-up time to make certain it has been long enough to . allow sufficient venting.
 - Maintain the retort temperature at the recommended processing temperature.
 - Throughout the process, check that the specified temperature is being maintained.
 - Leave all bleeders wide open during the entire process.
 - When the recommended processing time has elapsed, turn off the steam and immediately start the cooling cycle.
- k. When processing medium sized or larger cans (say greater than 250 g) in retorts using steam it may be necessary to cool the cans under pressure so that the ends do not peak during cooling. Steam may be used to maintain the pressure but compressed air is more usual. The cooling time depends on the processing temperature, the temperature of the water used for cooling, the can size and the nature of the pack (i.e., liquid to solid ratio).
- l. If necessary the cans should be washed before temporary storage, however under no conditions should the processed cans be manually handled while wet.

Description of canning sardines in oil

The method for canning sardines in oil is often called the raw packaging method which contrasts with the method in which the sardines are thermally treated before packing into cans.

The processing plant related to the description has a capacity of 15 tons raw fish per 8 hours. The overall yields is approximately 50% of the weight of raw fish. See Figure 10 "Layout for sardines in oil, cannery" which shows a plant of this capacity.

One ton of raw sardines is required to produce 5 200 (5 263) 1/4 club cans, packed into 52 cases of 100 cans each or 5 800 (5 882) 1/4 dingley cans packed into 58 cases of 100 cans each.

The operations after the thawing of the frozen fish or after transporting the fresh fish from the chill store are as follows:

1. The sardines are size-graded by an automatic grading machine which selects sardines to suit the size of cans used in the plant.

The number of sardines per can permitted for various can types is given in Table 8

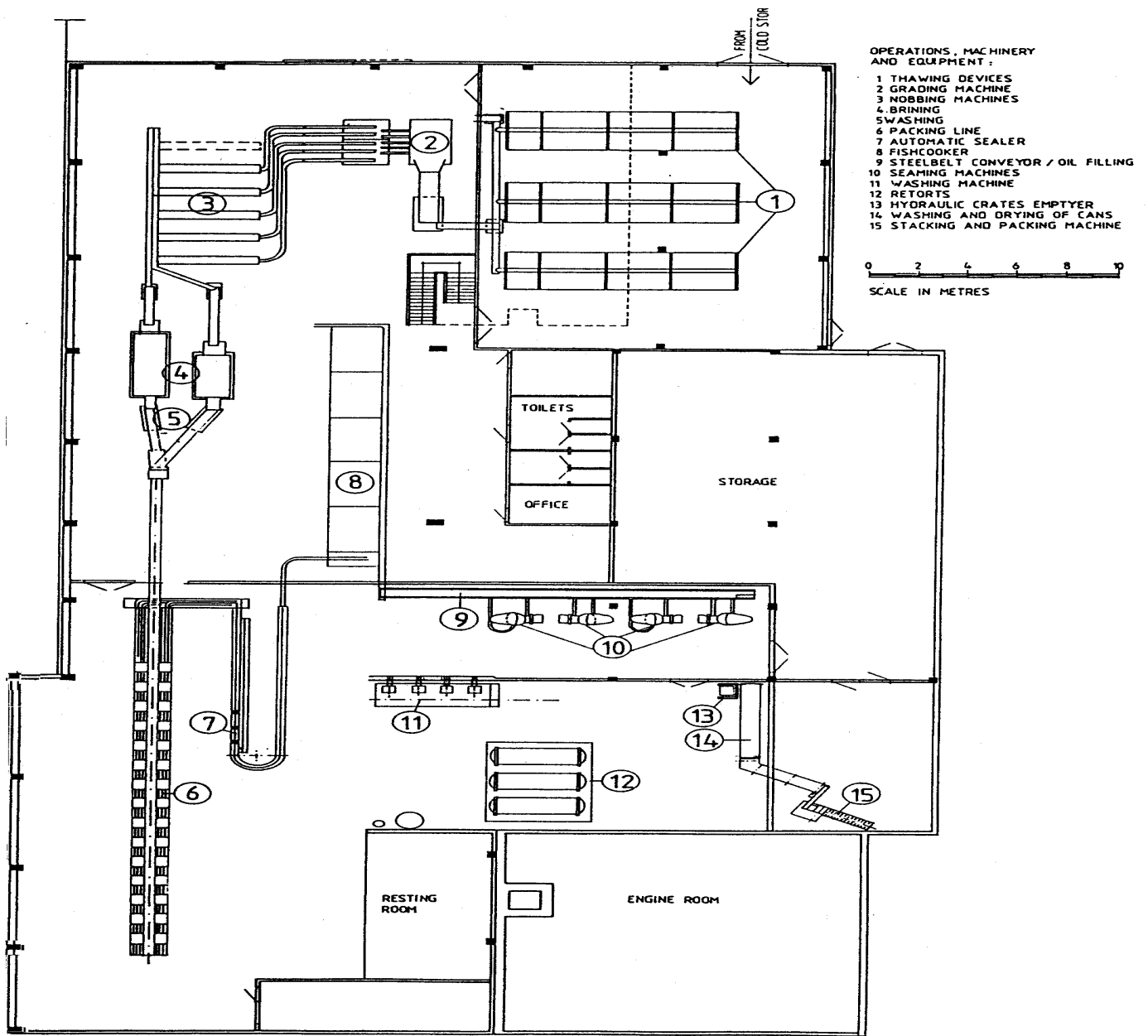


Figure 4 shows "Flow sheet for canning sardines in oil".

Description of canning pre-smoked sardines in tomato sauce or oil

Most of the operations in this process are similar to those described for canning sardines in oil. The description is related to a plant capacity of 5 tons of raw fish per 8 hours. The yield from canning of sardines and other pre-smoked small fishes approximate the yields obtained when canning sardines in oil.

The various operations are described below.

1. Grading is similar to the operation described for canine sardines in oil.
2. Brining is similar to the operation described for canning sardines in oil.
3. The fish are rodded, i.e, hung on rods through the eyes. This operation can be done automatically or manually.

The automatic rodding being a complicated process is only practised in large plants. The rodded fish are placed into frames which are fitted to the smoking racks.

The frames have usually accommodate for 30 rods, each with 30 fish.

4. The fish are smoked for approximately 1 hour at temperatures up to 130 °C. The main purposes of the smoking is to enhance flavour and to lower the water content of the fish.

Usually tunnel type smoking kilns are used in which there is a controlled temperature gradient between 30° and 125-130°C.

The air passes through a heat exchanger while smoke added. The smoke is produced by a smoke generator using sawdust from hard woods (oak or similar). Loss during smoking is approximately 25%.

5. After smoking the bodies of the fish are separated from the heads with an automatic cutting machine. The heads are then removed from the rods with an automatic rod stripping machine. Loss of weight during the deheading operation is approximately 10-12%.
6. The packing, the filling of sauce or oil and the double seaming operations are similar to those described for canning sardines in oil.

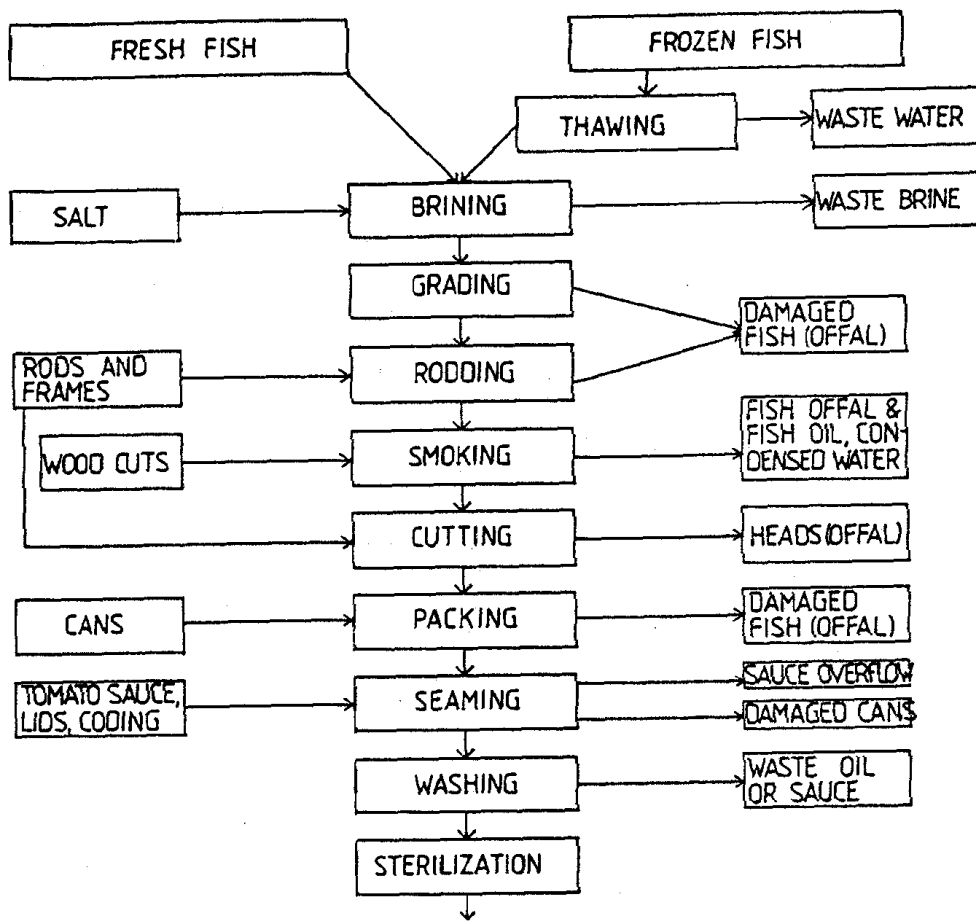
When preparing tomato sauce, puree of good quality must be used and to this is added olive oil or fish oil, etc.

Typical mixtures comprise one part oil and two parts tomato puree (20% concentration).

7. All subsequent operations are similar to those described for canning sardines in oil.

Description of canning fish paste products

The description is related to a fish paste canning plant with a capacity of 10 tons whole raw fish per 8 hours. The production is based on either deheaded, gutted fish with an average weight of 1.5 kg or smaller industrial fish. Overall yield when manufacturing canned fish paste products depends on species involved, however, approximately 45-65% of raw fish weight could be used for planning purposes. The output from a plant producing meat balls is approximately 25 000/850 ml cans per 8 hours; alternatively 8 000/850 ml cans of fish cakes or 15 000/850 ml cans of meat balls could be produced.



FURTHER OPERATIONS SAME AS FLOW SHEET FOR CANNING TUNA.

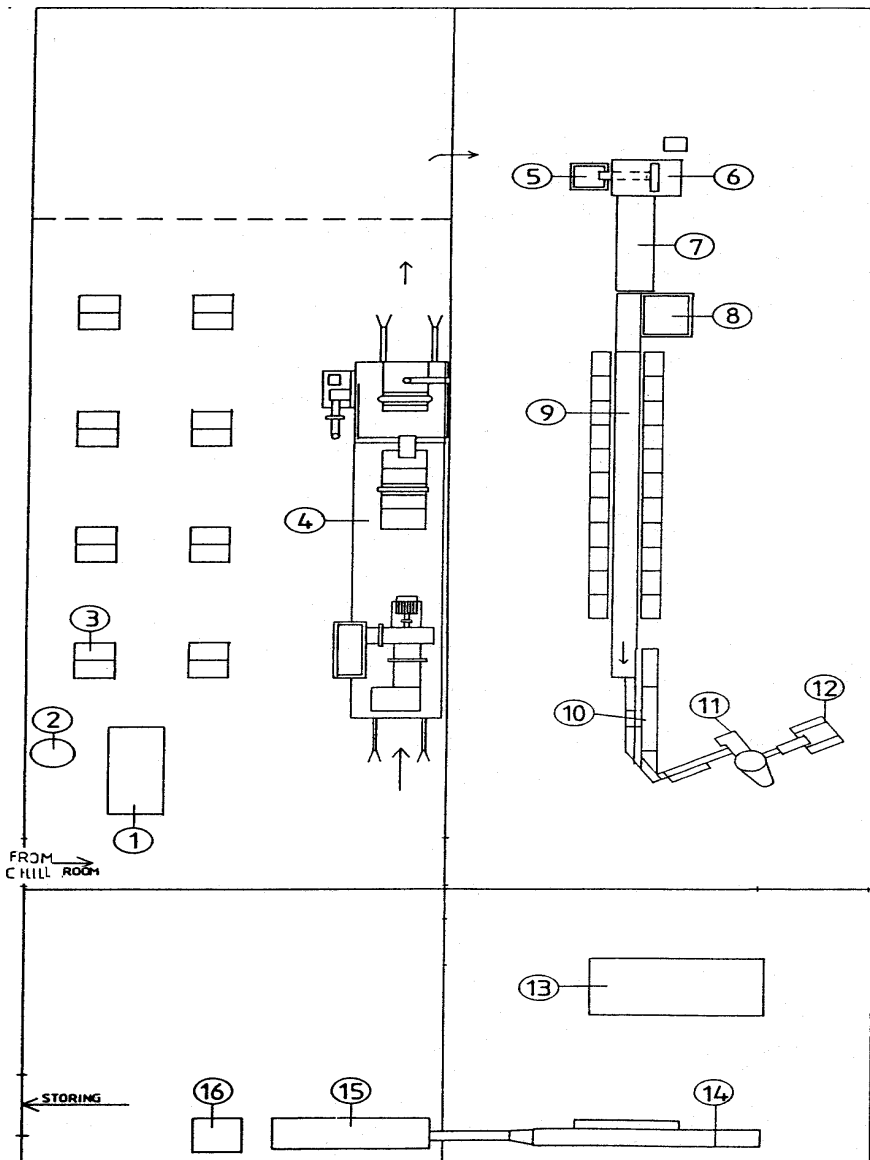
Figure 5 Flow sheet for canning pre-smoked small fish in tomato sauce and oil

The flow sheet for canning fish paste products and various processing operations are summarised as follows.

The raw material has to go through a grinding/chopping and mincing process.

1. The fish are washed, descaled when necessary, eviscerated and deheaded.
2. According to skin thickness and size, the fish will have to be split into halves from head to tail along the backbone.
3. The split and opened fish are washed and cleaned.
4. The washed split fish is separated in a meat-bone separator. According to the type of fish one will get an acceptable minced product, and offal, bones and skin.
5. If the mince is unacceptable, (i.e. ,discoloured because of blood etc.), it may be necessary to have it washed and then dewatered by means of a screwpress
6. The minced fish is mixed in a bowl chopper or mincer with the other ingredients. it is important to add the salt first and to allow the mincer to work for a few minutes before adding the remaining ingredients to the mixture.

This will improve the binding properties of the fish. See Figure 16 "Processing line for fish meat".



OPERATIONS, MACHINERY AND EQUIPMENT :

1. BRINING
2. BRINING TANK
3. RODDING TABLE
4. PRE-SMOKER
5. CONTAINER FOR HEADS
6. ROD STRIPPER
7. CUTTING MACHINE FOR HEADS
8. CAN CONTAINER
9. PACKING LINE
10. TOMATO FILLING MACHINE
11. CAN SEAMING MACHINE WITH CLINCHER
12. RETORT BASKET
13. RETORT
14. CAN WASHING & DRYING MACHINE
15. CARTONING
16. PALLETS

0 2 4 6
SCALE IN METRES

Figure6 Layout for pre-smoked small fish cannery.

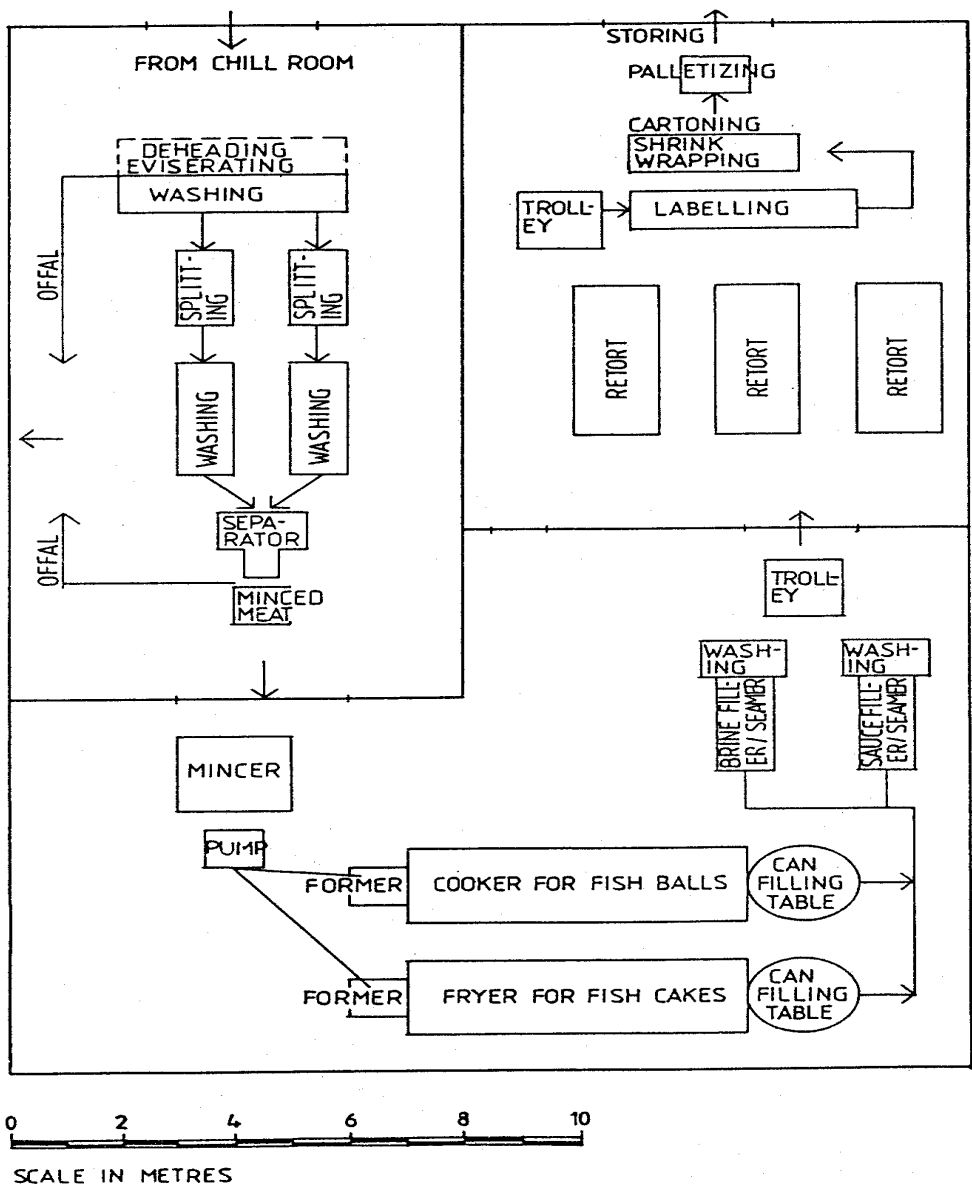
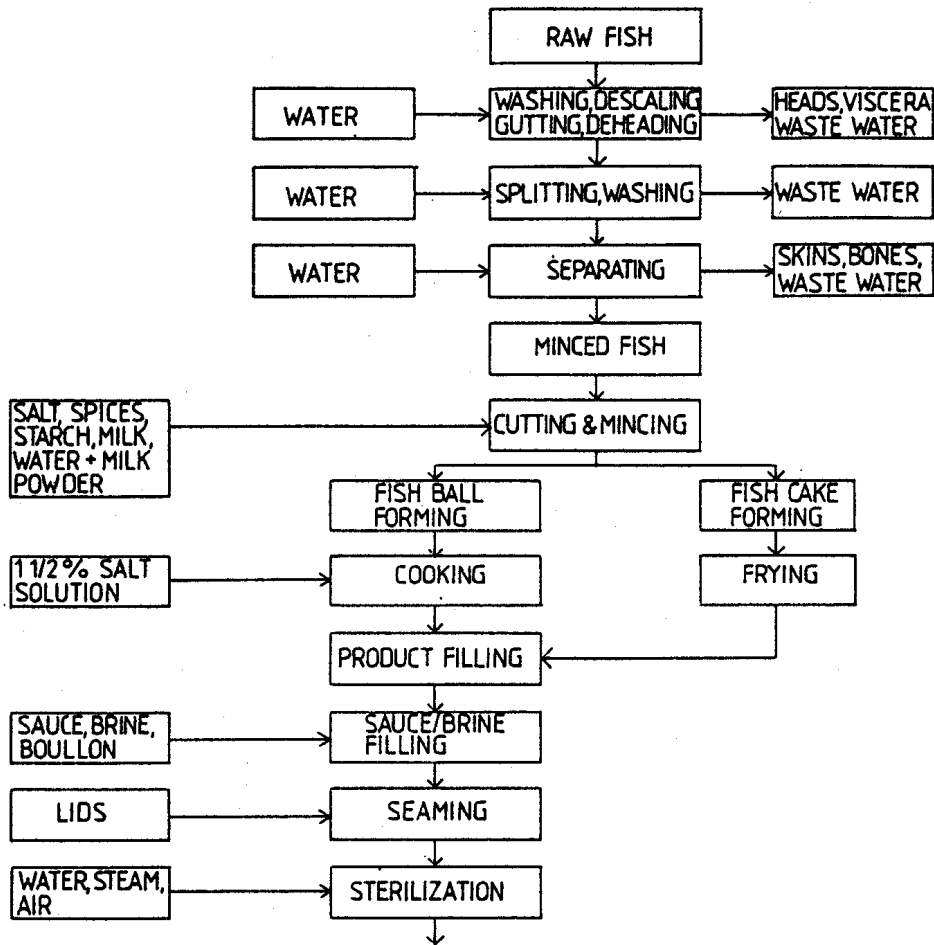


Figure 7 Layout for fish paste products cannery.



FURTHER OPERATIONS SAME AS FLOW SHEET FOR CANNING TUNA.

Figure 8 Flow sheet for canning fish paste product.

7. Starch, spices and, if necessary, onions, fat, etc., are added.
8. Liquid milk is added and according to the type of mincer, it will take 10-12 min for the materials to reach a soft and formable conditions.
9. The fish balls can be formed in machines, by hand with spoon, or by hands only, and dropped into a 1 1/2% solutions of salt water at approximately 90 °C.
10. After cooking in the salt solution for approximately 5-8 min the fish balls are filled into cans.
11. Hot brine or fish bouillon is added.
12. After seaming the product goes immediately to retorting.

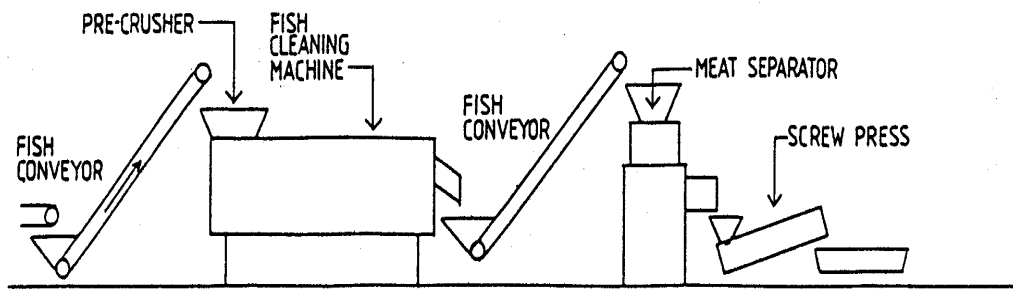


Figure 9 Processing line for fish meat

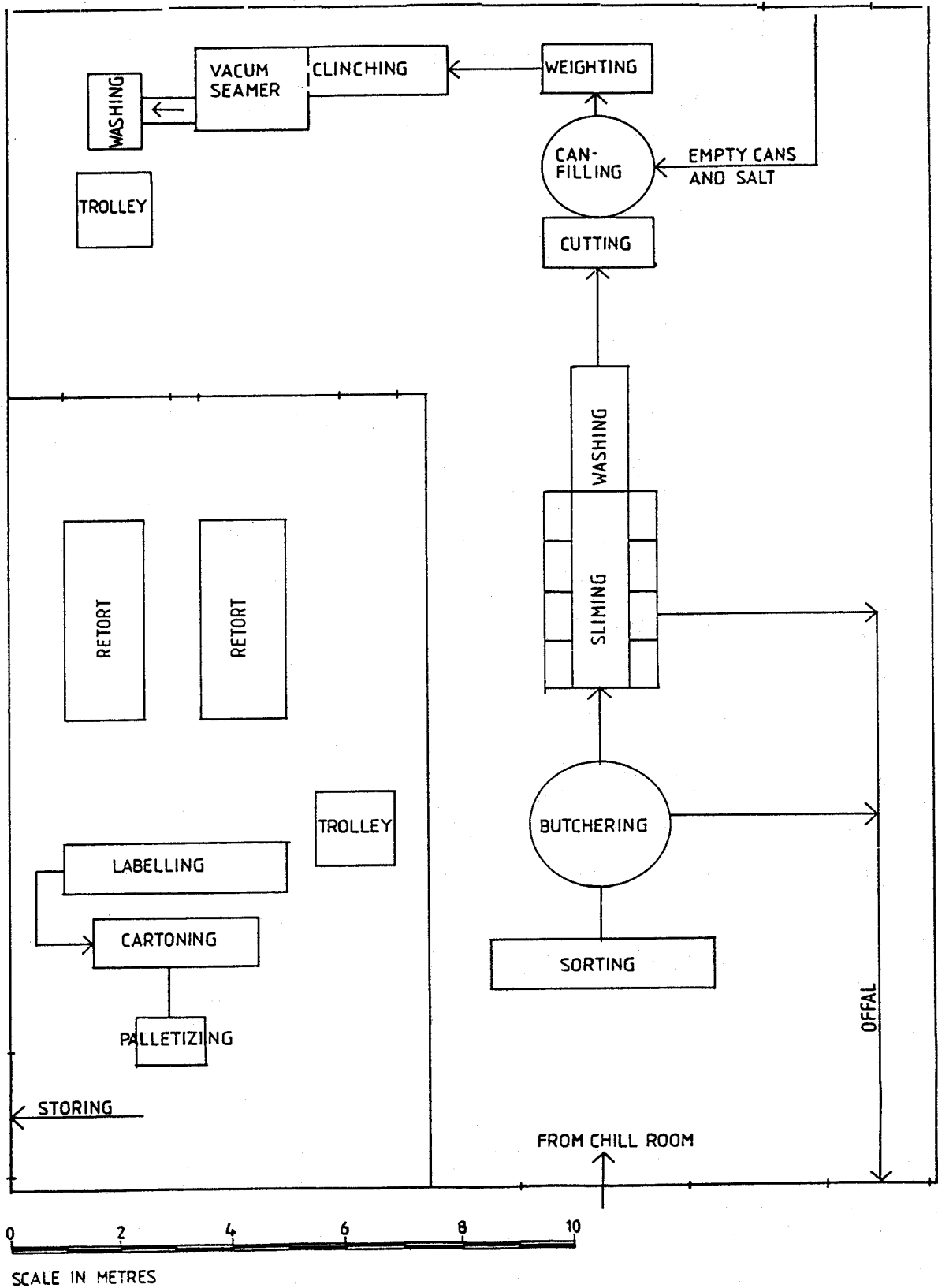


Figure 10 Layout for salmon cannery

Description of canning shrimps

Headless, peeled shrimps are graded according to number of shrimps per 100 g of drained product.

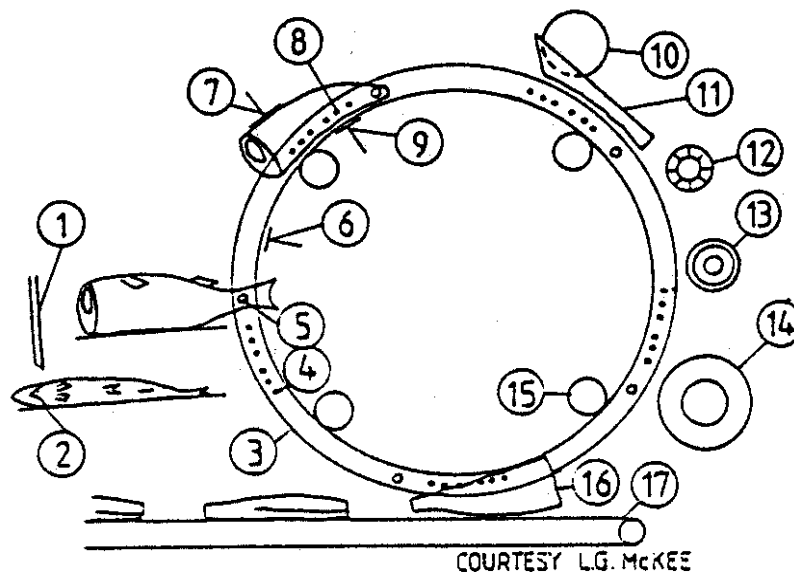


Figure 11 Iron chink for dressing salmon

1. HEADER KNIFE
2. FISH IN POSITION FOR HEADING
3. BULL RING WHICH CARRIES FISH THROUGH THE MACHINE
4. BACK PINCERS
5. TAIL PINCERS ADVANCED AND GRASPING FISH
6. TAIL CUA OFF SAW
7. BELLY FINNING KNIFE
8. BACK PINCERS ADVANCED AND GRASPING FISH
9. BACK FINNING KNIFE
10. BELLY SLITTING SAW
11. GUIDE TO OPEN BELLY FLAPS FOR GUTTING REEL
12. GUTTING REEL TO REMOVE VICERA
13. KNIFE AND REEL TO SLIT KIDNEY MEMBRANE AND TO REMOVE KIDNEY
14. BRUSH TO REMOVE BLOOD AND MEMBRANES
15. ROLLER TO SUPPORT BULL RING
16. FISH RELEASED AS BACK AND TAIL PINCERS RETRACT
17. CONVEYOR TO REMOVE BUTCHERED FISH

It is usual to can only those shrimp which fall in the medium to very small size range.

The description is based on a processing plant capacity of 3.6 tons raw shrimp per 8 hours. This corresponds to production of 12 000-14 000 cans, each containing 75 g shrimp, in 8 hours.

The overall yield from canning shrimp is between 25 to 30% of raw weight. See Figure 20 "Layout for shrimp cannery " which shows a plant of the capacity mentioned above. The description is based on using iced raw shrimp as the raw material. The shrimps are usually graded before delivery to the cannery. See Figure 21 "Flow sheet for canning shrimps" .

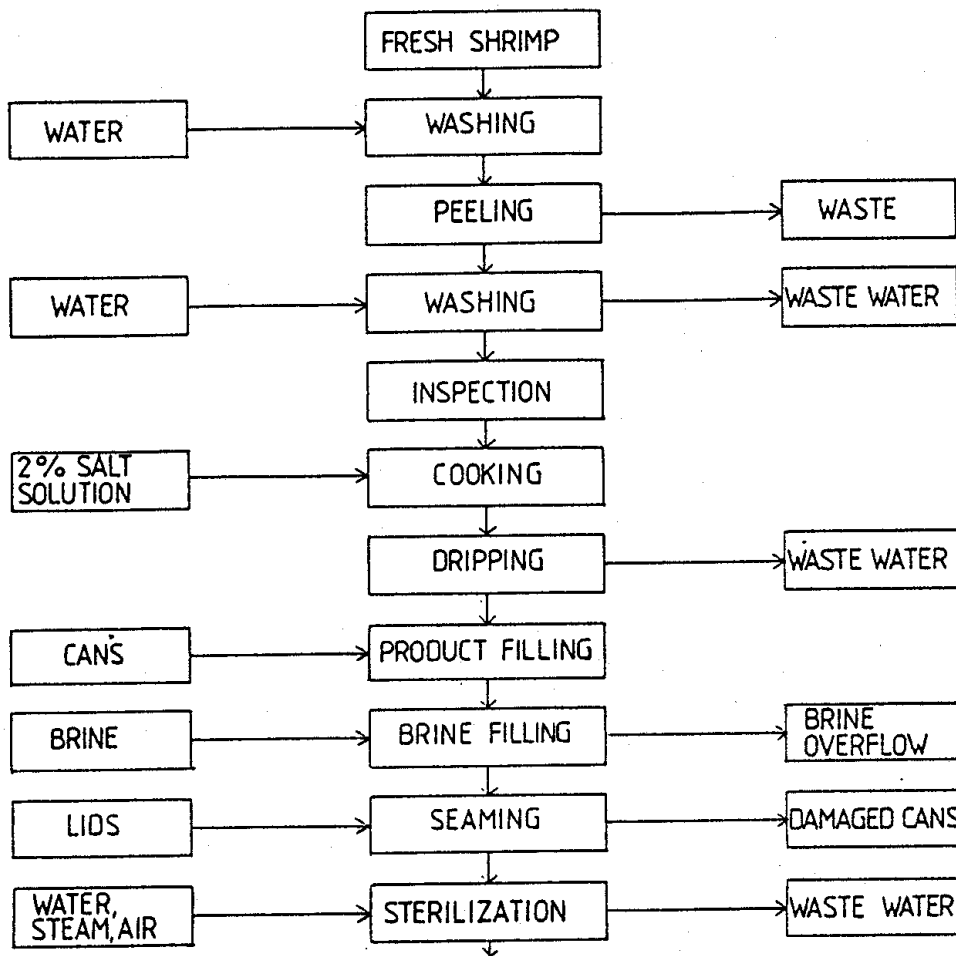
The operations in the canning process are summarized below:

- a. On arrival at the cannery, ice is removed before washing the shrimps.
- b. The shrimps are thoroughly washed while being conveyed into the plant.
- c. After washing the shrimps are inspected and foreign debris removed.
- d. The shrimps are then conveyed to a peeling machine, which separates the shells and heads from the body. This operation can also be done manually. Approximately 46% of the total weight is lost during this process.
- e. After peeling, the shrimps pass through to a waste separator, which removes fragments left after peeling.
- f. The cleaned shrimps are loaded into baskets and placed into a boiling salt solution for cooking. Average salt concentration in the solution is 11-13%. The cooking time varies from 6-10 minutes depending on the size of the shrimps.
- g. After cooking the shrimps are inspected and any broken ones and/or pieces are removed. The shrimps are then dried by fans.
- h. The shrimps are weighed and hand-filled into cans. The weight of the shrimps . should be 64% of the content of the can. Aluminium cans are preferably used for shrimp canning, however if tin plate cans are used, layers of parchment paper should be placed between the shrimps and the can to prevent corrosion. Hot or cold brine is filled into the cans.

Table 2 Example of mixture for brine

Salt	2 kg
Sugar	1 kg
Citric acid	0.9 l
Water	100 l

- i. The cans are automatically closed and transferred to retorts for processing.



FURTHER OPERATIONS SAME AS FLOW SHEET FOR CANNING TUNA.

Figure 12 Layout for shrimp cannery