

# OIL & FAT INDUSTRIES

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*Courtesy Canadian Pacific  
Sealing schooners at anchor in harbor of St. John, New Brunswick*

## The Fish Oil Industries

Describing the Production and Utilization of Fish and Marine Animal Oils

BY FREDERICK H. MEISNEST

**F**ISH oils and Marine Animal oils are important because they are relatively cheap oils, and so find a readier market than the higher priced oils and fats. In the United States they

constitute 6% of the supply of inedible oils. The domestic production of fish oils, including whale oil, averages about 100 million pounds.

I have separated the oils into two

groups, or classes;—one group I call non-competitive oils,—sperm, seal, cod, and cod liver oils. These oils are used for special purposes and do not compete with the other fish and whale oils. I have called the other group intra-competitive oils for they can be substituted for one another and for certain animal and vegetable oils and fats under varying conditions. We will first consider briefly the non-competitive oils, and then take up the more important intra-competitive oils.

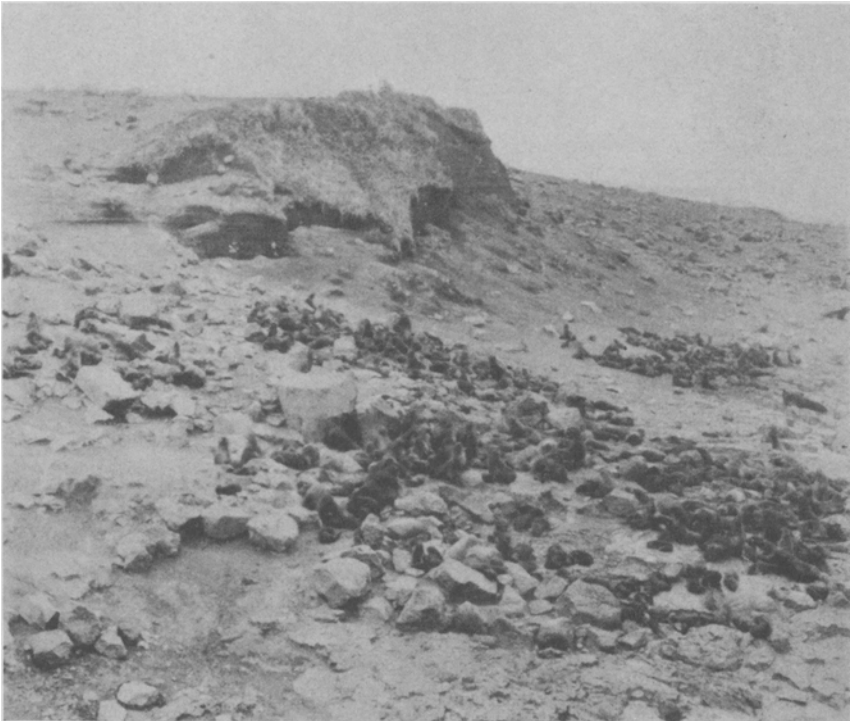
### Non-competitive Oils

*Sperm oil*—There is no separate fishery conducted now for sperm whaling. They are taken only incidentally to the capture of the

other species of whales. Sperm oil, made from the sperm whale, is a liquid wax that is not classified as a fatty oil as are fish, fish liver, and whale oils. Although this species is not extinct they have been hunted and harassed until now sperm oil is a by-product of the whale industry. Other oils, namely, the hydrocarbon oils, have been substituted for sperm oil and have practically driven it off the market.

Sperm whales are hunted in much the same manner as the ordinary whale which I will discuss later. Norway is the World's largest producer of sperm oil.

Sperm oil is produced from the head cavity and from the blubber of



*Ewing Galloway*

*Seal rookeries at Ketavie, Alaska*

the sperm whale. The head and body oils are usually mixed. The chief operation of refining is the separation of the spermaceti from the oil. This is effected by prolonged refrigeration and subsequent pressing of the partially solidified mass. The clear oil obtained in this manner is known as *winter sperm oil*. It is bleached through infusorial earth before it is marketed. *Spring sperm oil* is produced by a similar treatment of winter sperm oil at a higher temperature. The spermaceti solidifies from a third pressing at about 90 to 95 degrees F. This is refined by melting and boiling with a dilute caustic soda solution. It is washed with water and run into molds to permit crystallization. Refined spermaceti is a white, lustrous, translucent, crystalline substance. It is tasteless, colorless, and can be rubbed into powder with the fingers. Our wives find spermaceti in their lipsticks, cold creams, and other cosmetics. It may also be used for candles. Sperm oil is used for lubricating light rapid-running machinery such as spindles of cotton and woolen mills.

*Seal oil*—Seal oil, made from the blubber of several species of seals, is produced in Norway, Canada, and Newfoundland. In Alaska we have a herd of seven hundred and fifty thousand but these are fur seals and are protected by international treaties. Newfoundland, the world's largest producing country manufactured about one million gallons of seal oil in 1925, which they exported mainly to the United States, although some went to the United Kingdom. This industry has been described as the world's greatest hunt, by George Allan England, because the men endure unlimited hardships during the

open season from March 15 to May 1. The sealers cruise northward from Newfoundland into the ice fields off Labrador and Greenland seeking the seals that live on the ice. The crew of a steamer consists of 150 men, who risk their lives to share about \$5,000.00 for the six weeks' period. The highest share any hunter ever received is \$167.00 while some have gotten only \$7.00.

When the captain locates a herd of seal, the hunters armed with clubs and guns crawl over the side of the boat and jump from one cake of ice to another until they get onto the large body of ice where the seals are. The seals are clubbed or shot and dragged back to the ship by the hunters. Skinners remove the skin and blubber and store them in the hold. The boats return to port at the end of the season or when they have secured a full cargo. Each boat tries to get about twenty thousand seals a trip.

There are several methods of rendering the oil. By direct steam is the most common method. Under this method the blubber is put into large tanks and steamed and the oil skimmed off. Several grades of oil are made by this method, according to color. The first oil removed is the finest and lightest in color. The decadence of the seal industry has been gradual and unless the seals are further protected by law the supply will decrease. Other oils are being substituted for seal oil so it does not command the price it used to.

The best qualities of seal oil are used as illuminants in lighthouses. It has been used as an adulterant of cod liver oil, but of course there is no official record of this. Cheap fish oil has sometimes been mixed

with seal oil and the mixture sold as seal oil. Small quantities of the oil are used in currying leather. The cheaper grades are used in the manufacture of soaps, particularly soft soaps.

*Cod and cod liver oil*—Cod liver oil is prepared from the fresh livers and is intended for medicinal purposes while cod oil is prepared from decomposed livers and is intended for industrial purposes. The world production of cod and cod liver oil approximates eight million gallons a year. Norway is the largest producer, with Newfoundland a close second. The United States manufactures 2 per cent of the world production. It is all produced on the Atlantic Coast, principally by pharmaceutical houses. No cod liver oil is produced in Alaska, because the cod livers are too small. Even on the Atlantic Coast only 3½ per cent of the fisherman's gross revenue is derived from the sale of cod livers.

In the early days of the industry the oil was produced by letting the cod livers rot in a barrel until the oil floated to the surface and was skimmed off.

The direct steam process is used almost entirely now. Last August through the courtesy of Dr. Arthur D. Holmes, of the E. L. Patch Co., I had the pleasure of going out on one of the boats operating out of Boston. They have their own representative on the boat who manufactures the oil. They have these representatives on 29 other trawlers in the United States. These men secure the livers as the men dress the fish, and put them into tanks that hold about two barrels. It is cooked by live steam and as the oil rises to the top it is skimmed off, filtered, and run into barrels for shipment to the refining

plant in Gloucester, Massachusetts. They blend the domestic and Newfoundland oil in large tanks to secure a uniform product. This mixture is chilled and pressed. The stearin solidifies and is sold for soap making. The oil is pumped to storage tanks where a flavor is added to give it a more pleasant taste. From this tank it is forced into a small pipe which carries it to the bottling machine. The bottles are filled and sealed automatically. This plant at Gloucester is the cleanest fish plant I have ever seen.

*Cod Oil* is produced because many small boats are engaged in the fishing industry that cannot carry the cod liver oil equipment. It is prepared from decomposed livers in much the same manner as cod liver oil is produced. Large quantities of cod oil are used in the leather trade. In Europe they hydrogenate large quantities of cod oil for margarines. The principal use is for soap.

### Intra-competitive Oils

In the intra-competitive oils I have classified whale, menhaden sardine, pilchard, herring, and salmon oils. In the United States these fish and marine animal oils compete not only with each other but with certain inedible animal fats and oils, such as tallow and grease. In Europe these fish oils and whale oil compete with certain edible oils and fats as well as with the inedible. There is no foreign competition with respect to menhaden oil since it is made from fish found only off the Eastern shore of the United States. Nevertheless, the similarity between menhaden oil and, for instance, whale oil, and the uses they both serve leads to competition.

The degree of interchangeability

depends upon a number of factors with which the reader is probably familiar. The principal ones are the physical and chemical characteristics, composition, and the price factor. In the manufacture of soap, if fish oils are available at a lower price than tallow or other inedible oils or fats, it may be sub-

equally suitable for every purpose or that interchangeability means complete substitution of one oil for another. Complete substitution may occur but substitution generally means a change in the relative proportions of the constituents. Even the slight difference of  $\frac{1}{8}$  cent a pound on the market price



*Grading, sorting and cleaning cod fish on deck of steam trawler*

stituted for the higher priced fat or oil, but this interchangeability may be limited by standards regarding substitution in certain grades of soap, and unless his plant is equipped with a hydrogenation plant the soap manufacturer is not in a position to use fish oil or whale oil regardless of the price advantage. In certain classes of soaps this substitution may constitute as high as 50 per cent. I do not mean that all animal or vegetable oils are

may cause substitution of one oil for another. This substitution permits economic competition between fish oils and marine animal oils and certain vegetable oils and fats.

The approximate annual world production of the intra-competitive fish and whale oils is about three-quarters of a billion pounds. Norway, the largest producing country, manufactures about 38 per cent of the world's supply, the United Kingdom 19 per cent, the United



*Ewing Galloway*

*General view of a British Columbia whaling station*

States 14 per cent, and Japan 6 per cent.

In the domestic production of these intra-competitive oils more menhaden oil has been produced during the past twenty-five years than of any of the other oils. The combined production of sardine and herring oil approximates the output of menhaden oil. Whale oil, once the leading oil, now ranks fourth. In 1926, the combined production of the intra-competitive oils was eighty million pounds in the United States.

The United States imports of the intra-competitive oils have quadrupled since 1921 because of increased imports of whale oil. It constitutes 84 per cent of the imports of these oils. Pilchard oil imported from Canada constitutes the bulk of the remaining imports. Herring oil and sardine oil imports

have increased since the world war. They come principally from Japan.

The exports of the intra-competitive oils are small, constituting 1 per cent of the domestic production.

#### Processes

There are two processes of rendering fish oils which are known as (1) wet rendering, and (2) dry rendering. The wet rendering method uses steam to cook the fish and extracts the oil by pressure. The various plants of this type on the market are known as the "continuous" reduction plants, and the "batch" type. The dry rendering method removes the moisture from the fish, often by a vacuum process, and extracts the oil by a solvent or by pressure. The solvent method is not used very extensively at the present time, but it is likely that in the future its efficiency will make

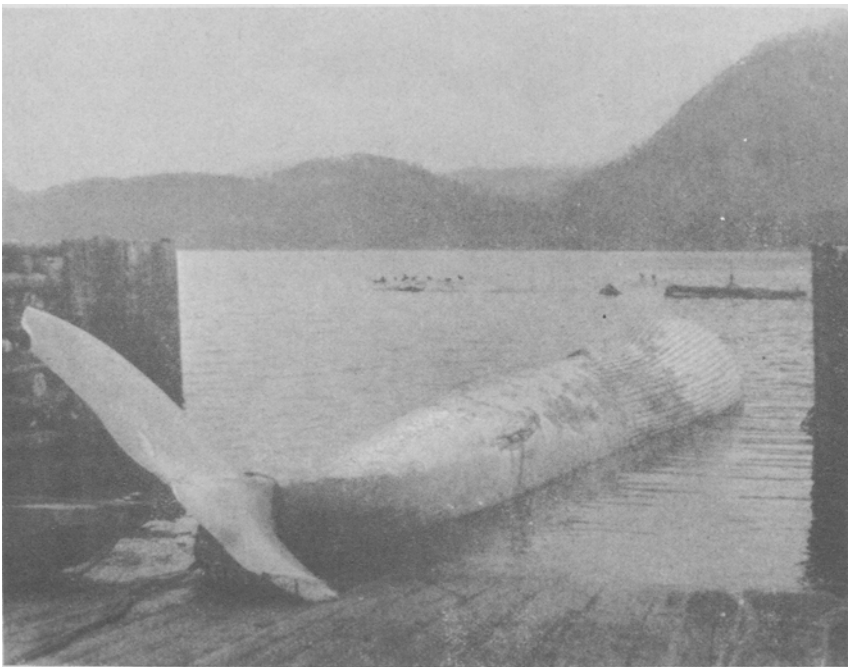
it more popular and its use will become more general.

### Whaling

Whales are in many respects the most interesting and most wonderful of all living creatures. The United States was once the world's largest producer of whale products. During the golden era of whaling, 1815 to 1860, many fortunes were made in this industry and the American whaler hunted all of the oceans and seas for whales. The decline of the whaling industry in the United States is one of the outstanding features of the fisheries history of the world. The decline is attributed primarily to the Civil War which destroyed the fleet; the financial crisis of 1857 that caused many whaling companies to fail;

the discovery of petroleum which led to substitution; and the invention of the harpoon gun which increased whaling efficiency and decreased the number of whales. Contributing factors were the discovery of gold in California which drew the adventurous whalers, and the uncertainty of financial return from the business.

The domestic industry is pursued along the Pacific Coast and in Alaska. Small steamers about 100 feet in length, mounted with a harpoon gun, are used to capture the whale. At the shore stations in California, British Columbia, and Alaska, the whales are drawn into landing platforms where they are flensed; that is, the blubber cut off. The blubber varies from 6 to 12 inches in thickness. This



*Ewing Galloway*

*Whale being hauled ashore at whaling station. Note two others in background*

is rendered to produce the better grades of oil. The flesh is then removed and cooked to produce the cheaper grades of oil. Finally, the bones are cut into small pieces and dumped into boilers to make bone meal. The blubber is cooked by steam and pressed in hydraulic presses to obtain the oil.

The Norwegians have inaugurated a new system that eliminates the shore rendering station. They use a large ship of about ten thousand to fifteen thousand tons as a floating factory, and for each floating factory there are about five whaling boats.

The operators of this invention haul the whale up on the deck through a trap cut in the bow or the stern of the floating factory. A winch is used to haul the whale up the incline and the trap door is closed. The whale is then rendered in the same manner as on the shore.

The Norwegians, British, and Argentine Companies use these ships to avoid payment of license fees and export duties, and to enable them to utilize the entire portion of the whale. The old whaling method allowed the boats to flense the whale alongside the factory and then cast the carcass adrift because they could not haul it aboard. Only one floating factory of this kind is used by the five companies on the Pacific coast.

The world production of whale oil approximates half a billion

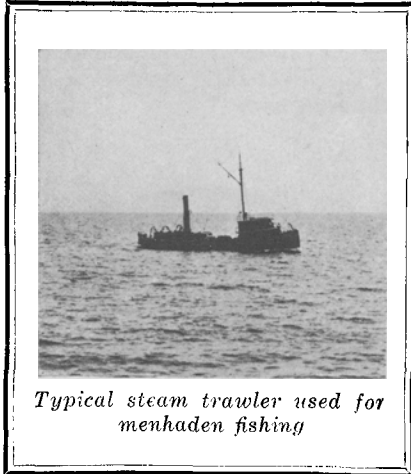
pounds annually, the bulk of which, 62 per cent, is produced by Norway and Great Britain in the Falkland Islands. The United States produces now only an insignificant amount, about 2 per cent of the world production. Since 1922 imports of whale oil into the United States have quadrupled in comparison to the previous 14 year period. Of the half billion pounds of whale oil produced the United States consumes about sixty million pounds and produces less than ten million. I understand that 95 per cent of the whale oil consumed in the

United States is utilized in the manufacture of soap. Less than 2 per cent is used for edible purposes, according to my information. A different situation is to be found in Europe. They utilize large quantities for edible purposes. All the fish oil used in the United States is for soap, and so far

as I can find out in Europe it is hydrogenated and used for margarines and lard substitutes. It is interesting to note that Holland and Denmark, large producers of butter, export the high priced butter and eat margarine.

### Menhaden Oil

At the present time the center of the menhaden industry is in Reedville, Virginia, where over \$5,000,000 is invested in equipment. I would not say however that the plants are the most up-to-date, since



*Typical steam trawler used for menhaden fishing*



a large number of them have not made any material change in their procedure of operation for 25 years. The expansion of the menhaden industry continued until in 1920 there were about 60 factories operating, which employed a fleet of 150 steamers and about 7,000 men.

*With the fishing boats.*—The fish are located by the captain and first mate who scan the waters from the top of the mast of the vessel. Then two purse seine boats, each carrying half the net, surround the school of fish and purse the net before the fish can escape. The steamer then comes along side and the fish are dipped into its hold.

The steamers leave their berths

*Reduction.*—The cooking is done in a long cylinder about two feet in diameter equipped with a screw conveyor that slowly forces the mass through the cylinder to which the heat is applied by means of steam jets in the bottom. This treatment breaks up the fish so that the oil will flow readily when the pressure is applied and the soft wet mass is then conveyed to the press, which consists of a tapered screw fixed on a hollow shaft, rotating inside of a similar and parallel shaft called the curb. The mass moves forward and is pressed by the decreasing size of the screw and curb.

Oil and water are caught in con-



*Menhaden seine closed, ready for the haul*

in the early morning, spend the day cruising and put back to their home factories or into the nearest harbor at dusk. They are limited in fishing range only by the necessity of discharging their cargo promptly so that the fish may be cooked before they deteriorate.

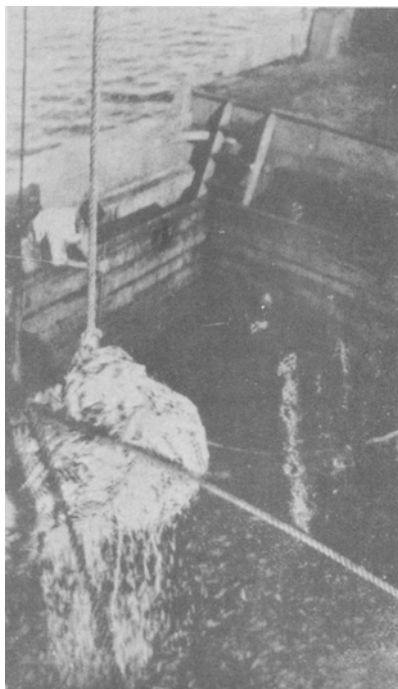
The transfer of the fish from the steamer's hold is accomplished by means of a bucket elevator into which the fish are fed and carried through a weighing device before discharge into cooking machines or storage bins.

crete basins beneath the presses and carried to receiving tanks for further treatment while the remaining solid matter or scrap is deposited separately, dried or treated with acid and sold as meal or fertilizer. In each hundred pounds of material leaving the presses there are approximately four pounds of oil, forty-six pounds of water, and fifty pounds of scrap.

The separation of the oil from the water is accomplished by means of a series of open tanks each connected to take the overflow or skim-

mings from the preceding tank in the series so that when the fluid has reached the last tank it is practically free from water. After separation has been accomplished the oil is heated to the boiling point for about 30 minutes, and then, after being allowed to stand for a day exposed to the sun, it is run into storage tanks and held ready for shipment to the refiner.

Both the quality and yield of the oil depend primarily on the quality of the fish, which varies with the locality in which the catch was made, the season of the year, and



*Dipping menhaden aboard ship  
from the seine*

the kind of a fishing year it may happen to be. The best oil is obtained from the large fat fish which are found usually in northern waters toward the end of the fish-

ing season, and a yield of eight gallons of oil per thousand fish is a fair average. This figure may be exceeded under favorable conditions during the late summer. The quality of oil also depends on the skill of the workers at the factory and the promptness and thoroughness with which the cooking and pressing are accomplished.

The menhaden plants generally cover several acres and employ from 125 to 160 men. On the Pacific Coast less than one-half this number are employed per plant. They have the mistaken idea on the Atlantic Coast that their plants must be equipped to handle enormous catches of fish which must be handled immediately. It is my idea that if these plants were equipped to handle the average quantity of fish, they could operate steadily during the producing season, and during the slack periods they could catch up. Producers tell everyone that they must be equipped to handle a million and one-half fish a day, but it is only one day or possibly several days a season that such a catch occurs. They will, however, not make any changes that cost any money because their fathers made money under these methods, and they have made enough money at times to make them think the methods suitable for this day and age.

It is the custom at Reedville to cook and press the fish at night, after the steamers have returned with the catch. The next morning the pressed fish is shoveled into a conveyor and carried to the drier, which dries it to 8% moisture. The meal is then conveyed to the warehouse and dumped on the floor. Some plants, however, produce green scrap, and sell it as it comes from the press without further

treatment. This material contains 40% moisture. Some plants add sulphuric acid to this material to prevent it from decomposing too rapidly. Other plants just sell the dried material as scrap.

soap is hydrogenated. Refined menhaden oil and sardine and herring oil are the best materials that can be used in the preparation of certain heat-resisting paints, that is, for surfaces that become hot,



*Typical menhaden oil and fertilizer factory at Reedville, Virginia. Note piles of fish meal*

Even in the handling of the oil their process lacks efficiency. They allow the oil to stand out in open tanks, believing the sun's rays will help clarify it. Rain often damages it. Any chemist knows what water will do to oil, but it is difficult to convert the menhaden producers to new practices.

The domestic production of menhaden oil averages about forty million pounds, but the migratory habits of the fish cause the yearly production to vary considerably. Production of this oil, therefore, depends upon the abundance or scarcity of the fish, the weather conditions playing a considerable part in their migrations.

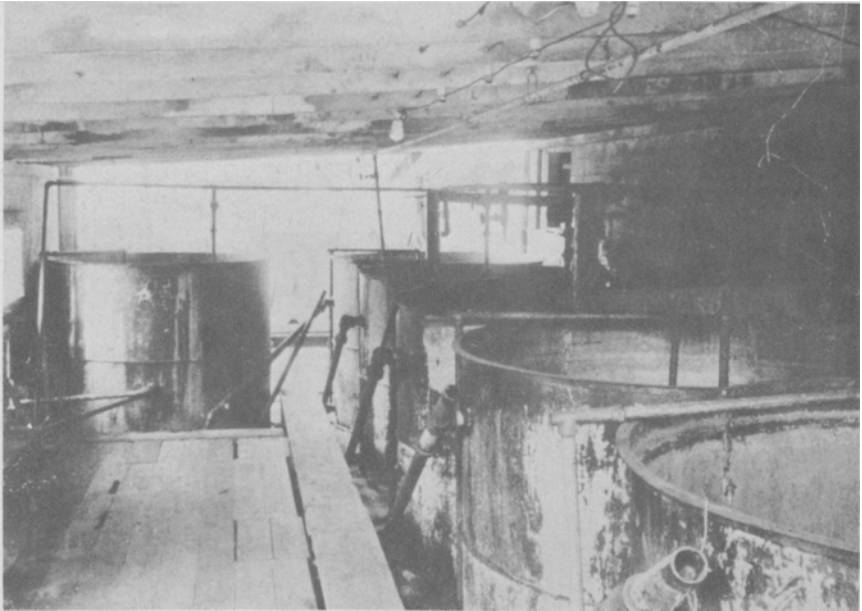
Crude and refined menhaden oil is used in the manufacture of soap, paint, linoleum, oilcloth, in tanning and in tempering steel. It is estimated that 40% of the production is used in soap, while the next largest use is for paint. I understand that all the menhaden oil used in

such as boilers and smoke-stacks, etc. According to experiments conducted, it does not make a good oil for white paint, and it is a strictly out-door paint. Large quantities of menhaden oil were formerly used in tempering steel, but this market has lost to lower priced oils. The future of the industry depends upon the perpetuation of the supply of fish and its ability to compete with the other intra-competitive oils.

### Sardine Oil

Let us now make a transcontinental trip to the Pacific Coast and consider the various fish oils produced there.

*Sardine Oil*—The sardine reduction plants are similar to the ones used in the menhaden industry but have a smaller capacity, and I believe are more efficient. The meal and oil plants are all operated as an adjunct to the sardine cannery and not as a separate industry like the menhaden plants.



*Tanks for separating fish oil from emulsions, fish oil and fertilizer plant*

The canning process is almost a by-product oil now and the meal and oil the main products. In 1922 one packer I know lost \$13,000 packing about 100,000 cases of sardines but made \$30,000 from his reduction unit. The canners can probably make more money from the meal and oil than from canning sardines but the California law requires that 75% of the fish be canned. It has cost the packers a large amount of money to find out through the courts that this law is valid. The State has even confiscated several ships equipped as floating reduction units, so there are some that know the law is valid.

There are three important centers of the industry in California; namely:—Monterey, San Pedro and San Diego. I will describe the methods employed at Monterey, since they are typical of the industry, on the Pacific Coast.

The most profitable time for fishing is during the dark phases of the moon, since during full moon no fish at all can be caught. This sounds fishy, but the fishermen locate the schools of fish at night by the phosphorescent light produced by the movement of the fish in swimming. This explains the dependence of the fishermen upon absolute darkness, since it is almost impossible to see the fish in the water during full moon. A few fish are sometimes caught in the daytime by watching the gulls, as they feed upon the splashing fish.

Several hauls may be necessary to secure a load of fish, since water hauls are often made,—that is the fish swim down and out of the net, and all the fishermen have is a bag full of water.

On returning to port with a load, the boats unload the fish into me-

chanical elevators that convey them into storage bins in the cannery. Cutters remove the heads, entrails, and tails, which are sent to the reduction plant. The body portion is canned. A large percentage of the sardines are from 6 to 8 inches long and must be cut so they will fit the cans.

The most popular method in the reduction is erroneously known as the "continuous" machine or unit. It is in reality the wet rendering process. The plants have a capacity for from two to ten tons of fish per hour.

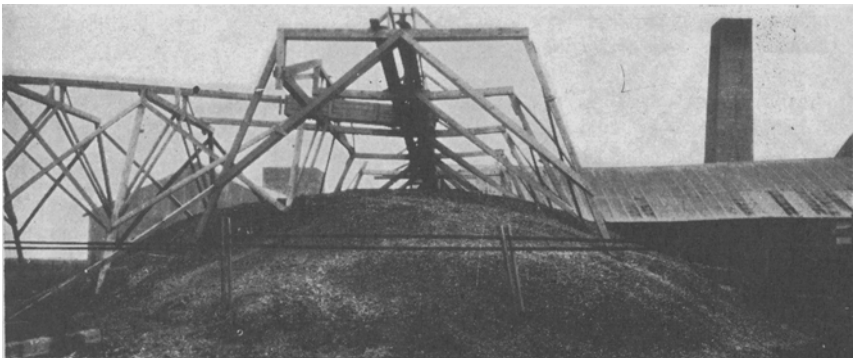
In order to secure the manufactured meal and oil it is necessary to cook, press, and dry the fish and separate the oil from the emulsion as it comes from the press. The raw fish are carried by an elevator into a continuous screw conveyor and steam is injected at various intervals so that the fish will be thoroughly cooked. The cookers used maintain a steam pressure of from 5 to 10 pounds, while those employed on the Atlantic coast cook the fish at atmospheric pressure. From the cooker the fish drop into a continuous press which is said to be a modification of the type used

for pressing olives. The oil and water is pressed out as the auger shaped screw works in a metal jacket which is lined with a perforated screen. The emulsion then flows to settling tanks.

The pressed fish is dried in a direct heat rotary dryer. This material is ground and sacked and sold as fish meal for feeding poultry, cattle, hogs, and for fertilizer.

The gravity flotation method is employed in separating the emulsion. It is run into a series of tanks, generally four in number, of about 500 to 1,000 gallons each, and is allowed to overflow from one tank to the other. It is then cooked by means of steam coils in each tank, which maintain a constant temperature from 180 degrees to 210 degrees F. The superfluous water is drawn off the bottom of each tank to permit a continuous flow from one tank to the other. Almost pure oil will separate out in the fourth tank and it is then cooked in a fifth tank to get rid of as much water in the oil as possible. A great deal of care has to be exercised in cooking the oil so that it will not be overcooked, which would darken it.

*(To be continued)*



*Atlantic*

*Menhaden fish meal fertilizer stock-pile*