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FISHING VESSEL LIVE-BAIT EQUIPMENT

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INTRODUCTION

The pole-and-line fishery for tuna is dependent on adequate supplies of live bait, and the potential range of the tuna fishing vessel depends in part on the vessel's ability to carry large quantities of bait. The equipment used to capture bait and to preserve it alive varies from the simple net and row boat combined with a tank of noncirculating sea water used in the Cuban fishery to the very elaborate system on United States Pacific tuna clippers.

CUBAN FISHERY

The method and equipment for catching and holding live bait in the Cuban fishery (described by Rawlings 1953) consists of a short, shallow fine-mesh net set from a row boat, a receiver for transporting the bait from the shoals to the fishing vessel, scoops for transferring the bait, and live wells. The live wells are fitted with plugs for draining after the bait has been expended, but no provisions are made for the circulation of water. Since the fishing grounds are near the bait grounds, this system is practical for bait caught in the morning and generally expended the same afternoon. However, the availability of bait varies and a circulation system would permit holding larger quantities of bait for an increased period of time. The principle species of bait is the majua (Jenkinsia lamprotaenia). Experiments conducted by Springer (1953), utilizing tanks with circulating seawater, revealed that majua can be kept alive for prolonged periods.

HAWAIIAN FISHERY

More elaborate equipment (described by June 1951) is used in the Hawaiian fishery for capturing and holding bait alive. The bait is quite small and is caught in fine-mesh nets, either at night by using lights to attract the bait to surround nets or lift nets, or during the day by using large encircling nets. The net boats are powered by outboard motors and the transfer of bait to the vessel is made with buckets to avoid injury to the bait through loss of scales. Live-bait wells are built in the hull and are fitted with screened holes below the water line to permit the entrance and exit of sea water. Bait may be kept alive for from one to several weeks in wells of this nature. By plugging the holes and draining the water into the bilge, the wells may be converted to carry tuna. When under way or rolling in a sea, the circulation is adequate to keep the bait alive, but when lying in calm waters the fishermen must periodically rock the boat to encourage circulation. There is a trend toward the installation of power-driven circulation systems. Both the Hawaiian and the Cuban tuna fisheries were pioneered by Japanese immigrants, and the influence of their homeland methods predominates.

PACIFIC ALBACORE FISHERY

The system of capturing and holding bait alive in the United States Pacific albacore fishery was derived from the tuna clippers, but it is less elaborate and the vessels are

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NOTE: THIS PAPER WAS READ AND DISCUSSED, ALONG WITH OTHERS AT THE INTERNATIONAL FISHING BOAT CONGRESS (1953) AT PARIS, FRANCE (OCTOBER 12-16, 1953); AND MIAMI, FLORIDA (NOVEMBER 16-20, 1953). ALL PAPERS AND DISCUSSIONS WILL SHORTLY BE PUBLISHED BY ARTHUR J. HEIGHWAY PUBLICATIONS LTD., 68 VICTORIA ST., LONDON, S.W. 1, ENGLAND.

smaller. Most of the live-bait vessels in this fishery were designed for participation in other fisheries, but they have adequate stability to carry live-bait tanks on deck. Circulating water is supplied by pumps and the bait is caught in large lampara nets set either from a powered boat or from the fishing vessel.

TUNA CLIPPERS

The most elaborate system in the world for capturing and holding bait alive is found on United States Pacific tuna clippers. Essentially, when building a tuna clipper the owner is trading a large sum of money for the maximum amount of refrigerated cargo space, bait and fuel capacity, and other necessary items in a minimum length of vessel. Since the cost of the hull is predicted on the length, all space must be fully utilized for dual purposes where possible.

The equipment required for live bait on a tuna clipper consists of tanks to provide a space for a large quantity of bait to live, a water-circulation system to supply the necessities to sustain life, boats and gear to catch the bait, and facilities for transferring the bait from the nets to the tanks.

BAIT TANK DESIGN: The structure of the tanks must be adequate for the weight of water plus safety factors for service at sea. Hatches at least 18 inches high are required to maintain a head of water to eliminate air pockets and to prevent sloshing. Waterproof lights of at least 100 watts should be installed in the accessible sides of the tanks to permit the bait to mill properly at night. Portable or fixed lights over the hatches are also desirable. Smooth-surface screens with adequate openings to reduce the flow rate to limits which will not injure the bait are essential.

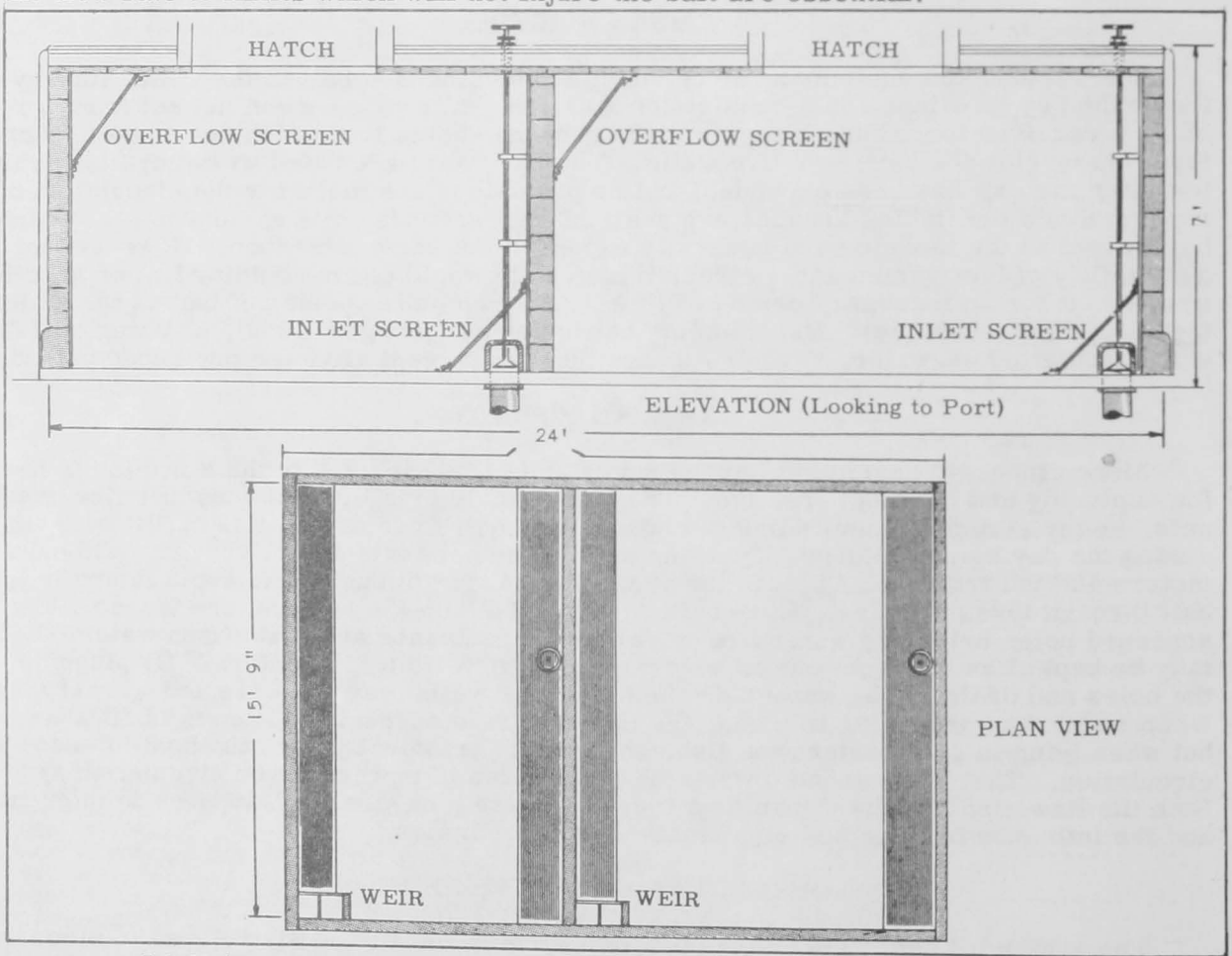

FIGURE 1 - TUNA CLIPPER BAIT TANK (UNEQUAL SCALES, DIMENSIONS APPROXIMATE).

Considerable controversy exists among fishermen as to the amount of live bait which can be carried in a tank of a given volume. The amount of bait is probably dependent on a number of factors, including oxygen content, temperature, and salinity of the water; degree of abuse to which the bait is exposed between capture and deposit in the tanks; variation in the hardiness of the bait because of species, area or season of capture; and the proper design and manipulation of the tanks and circulation system. General practice is to place somewhat more bait in the tanks than is expected to survive and to remove the weaker individuals which die in the "rest period."

When the U. S. Fish and Wildlife Service vessel Oregon, now based at Pascagoula, was operated in the commercial tuna fishery off Central America in the Pacific Ocean, 300 and 400 scoops of bait (each containing about 12 pounds) were placed in deck tanks having a capacity of 4,100 and 6,130 gallons, respectively, exclusive of baffle and screen areas. When doing investigational work in the Japanese tuna fishery, Cleaver and Shimada (1950) reported that a sardine $2\frac{3}{4}$ inches long required 0.07 cubic feet of water in tanks having natural circulation; i.e., screened holes in the hull to admit sea water. The amount of water per fish, under forced circulation, could be reduced to 0.05 cubic feet with a water temperature of 64° F. to 68° F. In another instance, approximately 1,000 pounds of bait were held in a tank 8 x 8 x 7 feet without mechanical circulation. The same authors also report 50 buckets, containing from 15 to 20 pounds of bait per bucket, in a tank 6-3/4 x 6-3/4 x 9-5/6 feet without mechanical circulation.

The design of the screens in the bait tanks aboard a clipper is very important. They must have a relatively smooth surface and openings small enough to restrain the bait. But the open area must be adequate to admit and discharge the water at flow rates that will not injure the bait. Too rapid flow on the inlet side will affect the milling of the bait, while an excessive flow rate through the discharge side will draw the live bait or cause dead bait to collect and clog the screen. Typical screens are made of $\frac{3}{4}$-inch waterproof marine plywood with 1/8-inch slots cut by a circular saw on 1-inch centers. Very little, if any, reliable published data is available on the optimum area of the openings, and fishermen may provide additional slots if the bait behaves improperly. One tank having a volume of 910 cubic feet was fitted with inlet and outlet screens having areas of 338 and 494 square inches respectively.

The deck bait tanks are of a general rectangular form to suit the available space, but the below deck tanks (or wells) are vertical on 3 sides while the fourth side and bottom conform to the shape of the hull. Water for the deck tanks is introduced at one corner behind the screen and allowed to overflow through a screen and baffle in an opposite or adjacent corner tending to create circulation in a horizontal plane. Water for the below deck tanks is admitted at the bottom on the shaft alley side and allowed to overflow in the upper outboard side tending to create circulation in a vertical plane. The flow of water to the tanks is throttled by a valve. On the deck tanks the overflow is governed by the height of baffle boards which are set to maintain a constant level of water in the hatch. The rate of discharge and the consequent level of water in the hatch in the below deck wells is controlled by a through-deck valve behind the discharge screen.

PUMPS AND PIPING: The pumps for supplying sea water to the tanks are of the vertical-impeller type designed to deliver large volumes at low head pressures. High head-pressure types are undesirable because of the possibility of churning and separating dissolved gases from the water. The sea chests for the pumps are located near the keel and close to amidship to permit the suction of water that is the least disturbed by the vessel when cruising. It is considered best practice to have pumps with a performance capacity capable of delivering enough water to change the contents of the tanks 5 to 7 times per hour. To achieve this performance, a safety factor of at least 2 should be considered for the water can be throttled by the tank supply line valves. The importance of live bait to the clipper dictates the installation of dual pumps either of which can carry the load for most of the tanks. The pumps discharge to a header on each side with a crossover connection to permit using one or both pumps for the entire system. Each takeoff to a tank is fitted with a valve for governing the flow or for isolation of the tank.

BAIT FISHING BOATS AND GEAR: Most of the bait is taken in sheltered areas along the coasts of Mexico and Central America. Consequently, small boats are suitable and

desirable for the bait is frequently found in water too shallow or too dangerous for the clipper to enter. In this connection it should be mentioned that if the bait-pump intakes are too close to the bottom, mud may be drawn into the tanks causing undue mortality of the bait. Three boats are used to find and capture bait: a power speedboat capable of speeds up to 30 or more miles per hour, a net skiff, and a "dry boat." The power-boat may be fitted with an automatic depth sounder to aid in locating the bait. Power-boats vary from 16 to 18 feet in length, 4 to 5 feet in beam, and are powered with a high-speed gasoline engine from 100 to 150 horsepower. Some are fitted with reduction

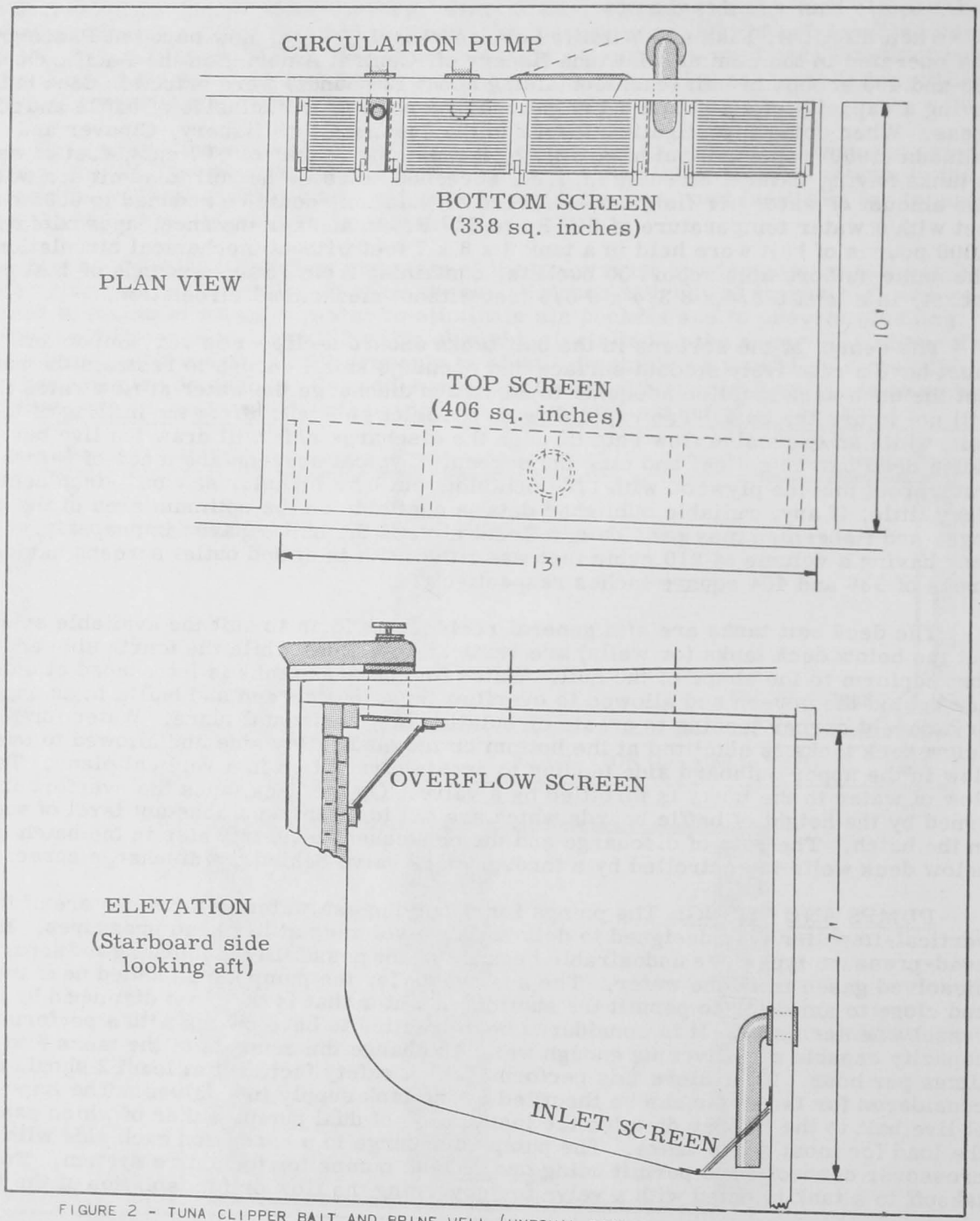

FIGURE 2 - TUNA CLIPPER BAIT AND BRINE WELL (UNEQUAL SCALES, DIMENSIONS APPROXIMATE).

gears permitting the use of larger diameter propellers to reduce slippage when towing the net and dry boat. The net boats are from 16 to 18 feet in length, from 6 to 7 feet in beam, and from 20 to 30 inches in depth. The dry boats are flat-bottom skiffs about 12 feet in length and are used to hold the end of the net while setting and to support the fish bag. Two men are required in the speedboat--one serves as an operator while the other searches for bait and directs the fishing operation. From 6 to 8 men are required to set and haul the net. When not in use the boats are carried in nests aboard the clipper.

Most of the bait is caught in hand-operated lampara nets varying from 130 to 160 fathoms in length and from 50 to 75 feet in depth at the bag. The end meshes in the

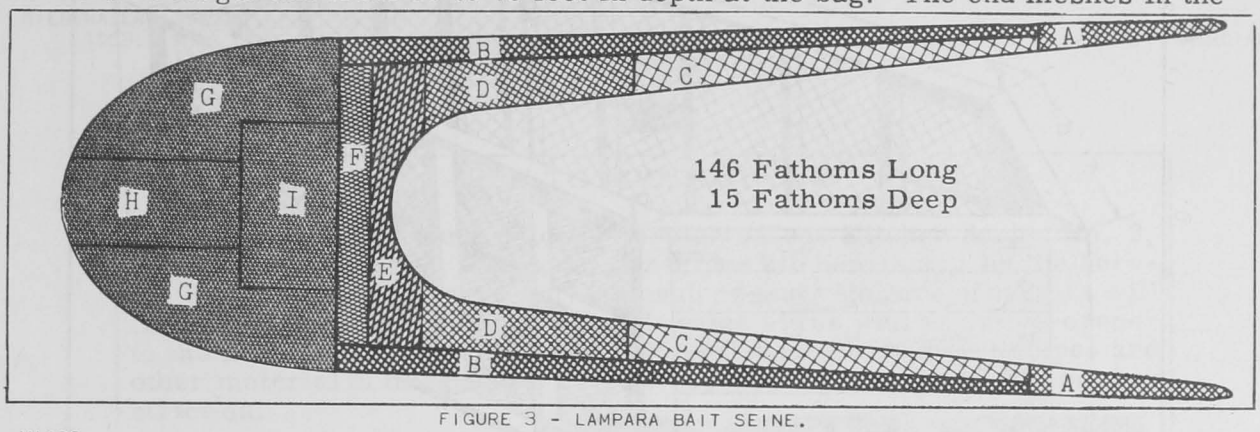

FIGURE 3 - LAMPARA BAIT SEINE.

WINGS
A - ONE FATHOM LONG, 15 MESHES DEEP, 5" MESH, 27-THREAD TWINE.
B - FIFTY-SEVEN FATHOMS LONG, 25 MESHES DEEP, 3-3/8" MESH, 9-THREAD TWINE.
C - FOR 44-1/2 FATHOMS, 144 MESHES DEEP, 8" MESH, 9-THREAD TWINE.
D - FOR 15-1/2 FATHOMS, 205 MESHES DEEP, 6" MESH, 6-THREAD TWINE.

APRON
E - 175 MESHES LONG, 747 MESHES DEEP, 3-3/8" MESH, 9-THREAD TWINE.
F - 133 MESHES LONG, 900 MESHES DEEP, 2" MESH, 6-THREAD TWINE.

SACK
G - 610 MESHES LONG, 600 MESHES DEEP, 1/2" MESH, 20/6 THREAD.
H - 610 MESHES LONG, 300 MESHES DEEP, 1/2" MESH, 20/6 THREAD.
I - 300 MESHES LONG, 900 MESHES WIDE, 1/2" MESH, 20/6 THREAD.

CORKLINE - 9-THREAD MANILLA

LEADLINE - 6-THREAD MANILLA

950 THREE-INCH CORKS

77 LBS. 1-1/2-OUNCE LEADS

wings vary from 5 to 8 inches (stretched measure) and gradually diminish in size to $\frac{1}{2}$-inch (stretched measure) mesh in the bag. The lampara nets are lightly floated and leaded in the wings, about one cork and one lead every 12 to 18 inches; but they are heavily buoyed and leaded in the bags, about 3 corks alternating with a 6-inch space, and the bottom line is almost solidly leaded at the throat. This type of net (described in general in Pacific Fisherman, December 1942) is used along the mainland for day fishing in shallow water or at night in deep water when the bait can be located by phosphorescence.

A smaller fine-mesh net from 125 to 150 feet in length and 20 to 30 feet in depth is used for capturing bait in the clear waters near the rocky shores of the Galapagos Islands. The nets are moderately buoyed and weighted, with about 2 corks and leads per foot, and a mesh size of from 3/4 to 1 inch by stretched measure, depending on the preference of the fishermen. These are used as a surround net and extend from the surface to the bottom. Because of obstructions it is necessary to send divers to the bottom to free the net and to keep the lead line together while hauling. The diving equipment may be either a helmet or a face mask supplied by compressed air from the surface or a face mask and an air tank. Because of the need for bending over while clearing the net and the possible loss of air from a helmet, the trend is toward face masks.

If the bait is caught in areas too shallow or too hazardous for the clipper to approach, it is transferred to a collapsible receiver which can be towed. The receiver consists of a box stern and midships section (about 10 feet long, $7\frac{1}{2}$ feet wide, and 3 feet deep) and a pointed bow section (about 6 feet long). The bow section is solidly planked on the leading sides to open the water while towing, but the aftersection is covered on the sides and bottom with netting to provide circulation.

The schools of bait may be located either from the clipper or from the speedboat by surface signs during the day or by phosphorescence at night. In making the set, the dry boat is released holding one end of the net, and the circle is completed by the speedboat towing the net skiff. Dumping the bag is a critical operation for considerable differential exists between the length of the float and lead lines. The bag must be specially

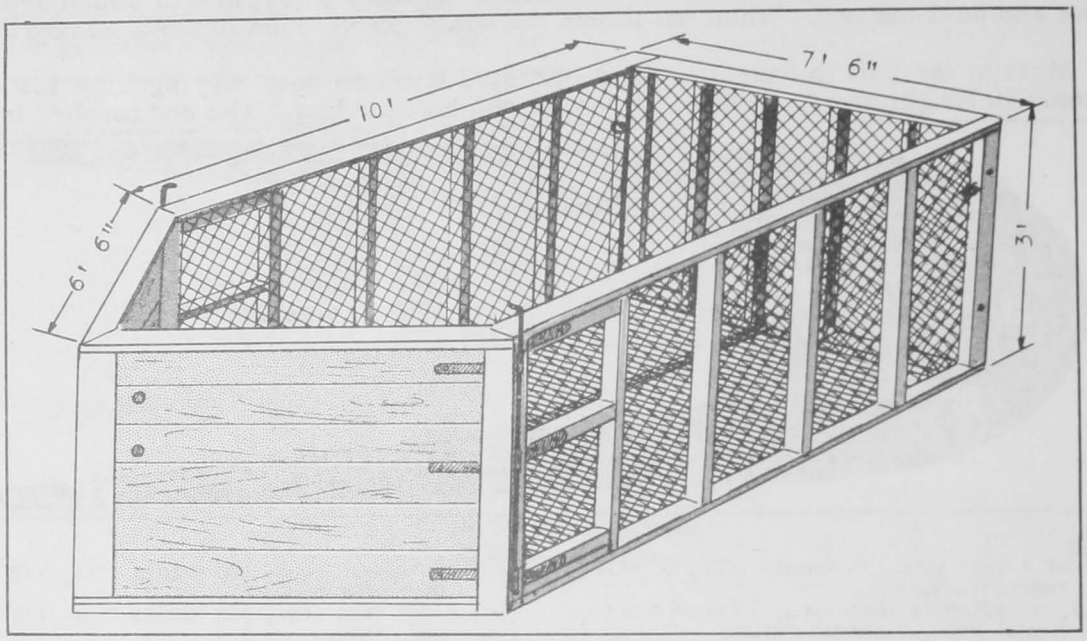

FIGURE 4 - FLOATING BAIT RECEIVER (DIMENSIONS APPROXIMATE).

piled so that it can be set as a unit to avoid tearing. If the length of the circle exceeds the length of the net, a running line is paid out so that both ends may be pulled to the net skiff. The lampara is retrieved by hauling from both ends. Until the lead line is aboard, one man throws a weighted line into the opening to scare the fish into and keep them in the bag. Meanwhile, the dry boat has picked up the cork line at the bag for additional support. After "drying up," the fish may be transferred directly to the clipper if the water is deep enough. Otherwise the bait is transferred to a receiver and towed to the clipper. Transferring is done with scoop nets of $\frac{1}{2}$-inch mesh holding from 10 to 15 pounds of bait. After making bait the clipper generally remains from one to several days in quiet water to acclimate the fish to life in the tanks (a "rest period").

A new method of using pumps to transfer the live bait is described in Pacific Fisherman July 1953.

Recently a new-type trap lift net for catching tuna bait fishes has been developed by the technical staff of the U. S. Fish and Wildlife Service exploratory fishing vessel Oregon (Siebenaler 1953). This net is operated from the fishing vessel, using lights to attract the schools of bait at night. To date, it has been extremely successful in catching anchovies and other small bait species in the Gulf of Mexico. It eliminates the need for special bait boats and large bait seines, and appears promising for use by the commercial tuna fleet. It differs from ordinary lift nets in that it has the advantage of quick lift of the sides independent of lift of the bottom and frame of the net.

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HOW TO COOK OYSTERS

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