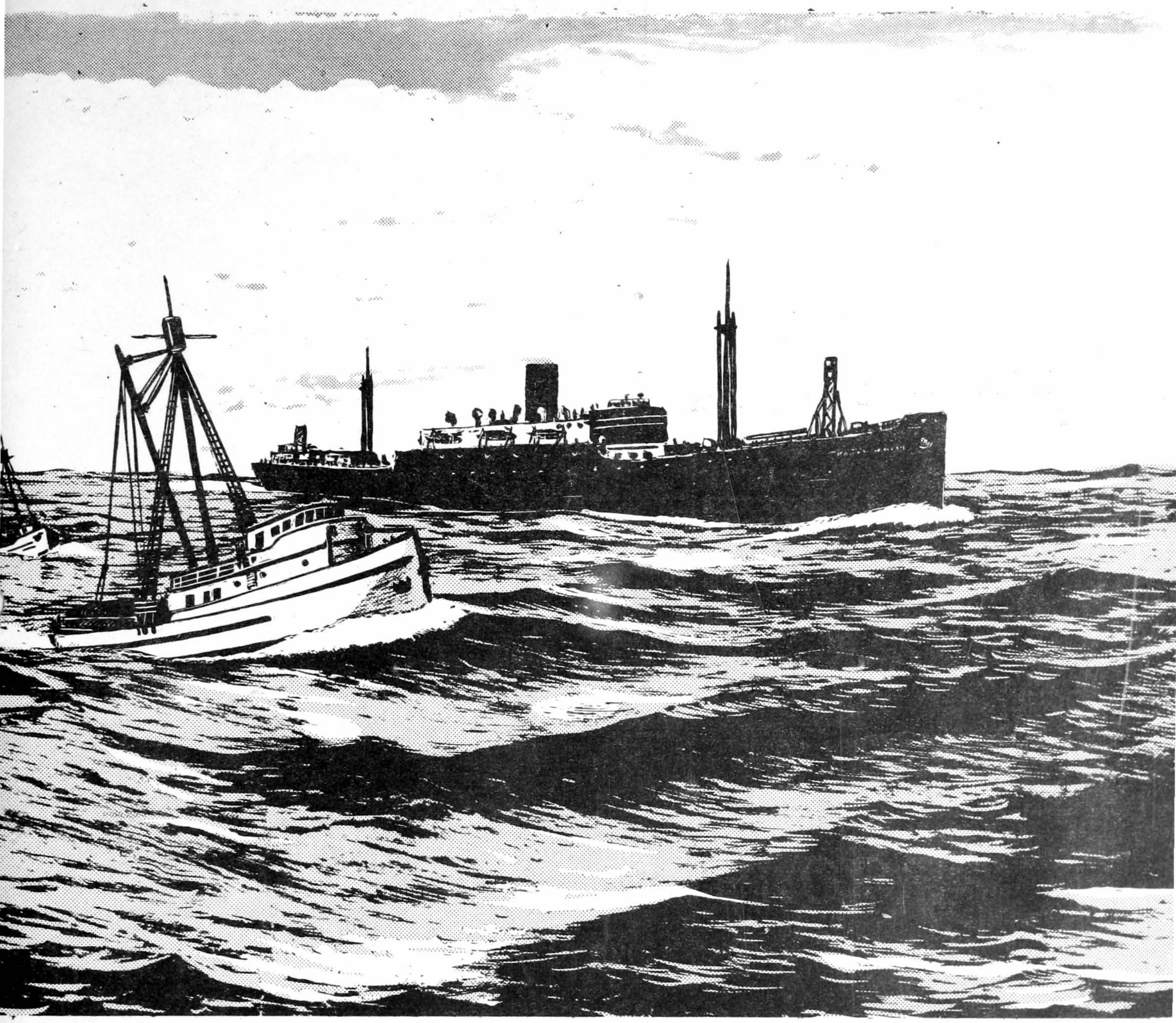
S.S. PACIFIC EXPLORER

ART IV — PERSONNEL AND THE MOVEMENT OF MATERIALS



FISHERY LEAFLET 326

FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

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S. S. PACIFIC EXPLORER
PART IV. PERSONNEL AND THE MOVEMENT OF MATERIALS

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INTRODUCTION

This report, the fourth of a series on the initial tuna operations of the *Pacific Explorer*, discusses the problems encountered with respect to the movement of tuna through the ship, the transfer of miscellaneous supplies to the fishing vessels, and the personnel involved in the transfer of these materials.

The total complement of the *Pacific Explorer* upon leaving the United States was 63 men plus 2 technical personnel of the Fish and

Wildlife Service. A personnel list by job classification is given in Table 1. Figure 1 shows the personnel-responsibility arrangement as it appeared to function during the period of buying and freezing the tuna. The captain was in charge of all the normal ship's activities such as navigation, safety, discipline and maintenance, both when the ship was underway and while engaged in receiving fish. All the specialized activities relating to buying and preservation of the tuna, to business relations with the fishing fleet and foreign governments, and to the establishment of policy were the responsibility of the general manager.

Table 1 - Personnel on the Pacific Explorer

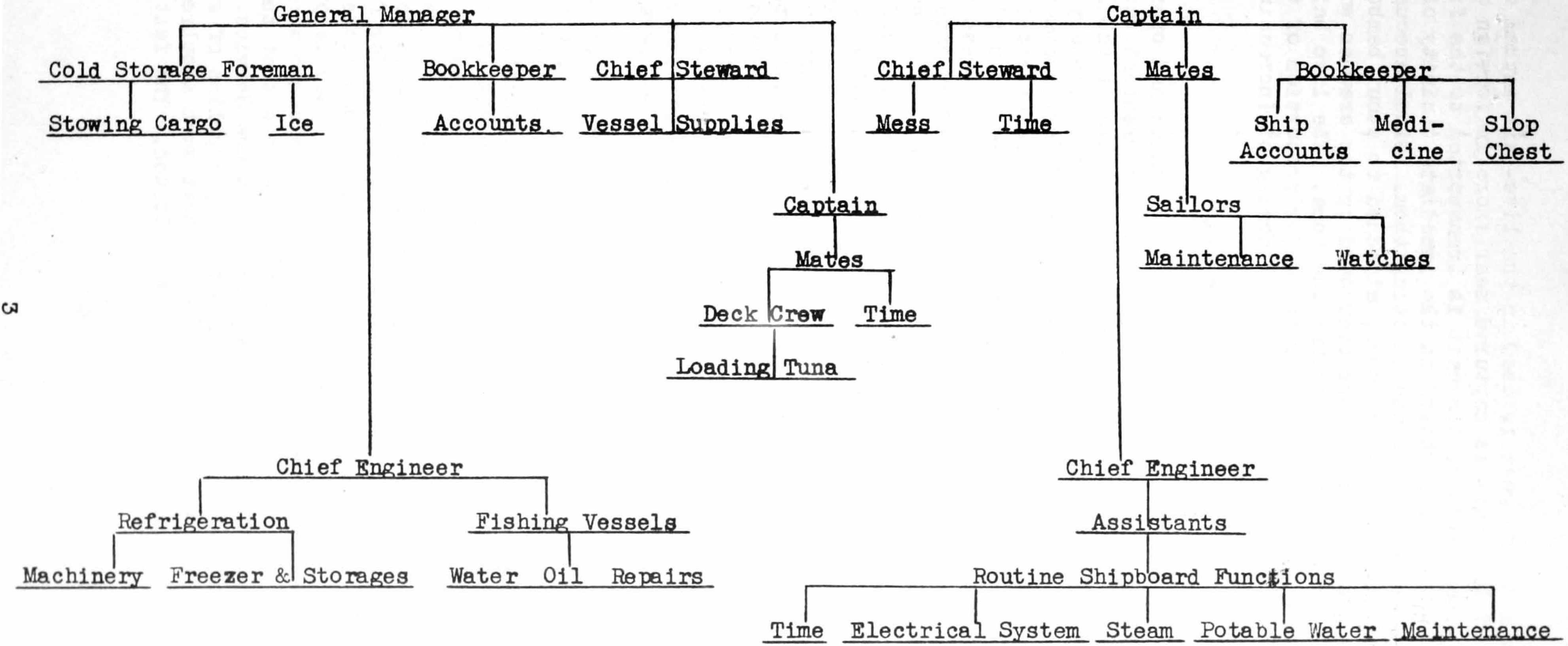
Deck Department	**Engine Room Department**
Captain	Chief engineer
3 mates	4 assistant engineers
Radio operator	3 junior engineers
Boatswain	3 refrigeration engineers
10 A.B. seamen	3 firemen
Total - 16 men	3 water tenders
	3 oilers
Cold Storage Crew	2 wipers
Foreman	Total - 22 men
6 workers	
Total - 7 men	**Steward's Department**
	Chief steward
Specialists	3 cooks
General manager	4 utility men
Purser	4 mess men
Refrigeration technician	Total - 12 men
Electrician	
2 machinists	
Total - 6 men	

The various operations for the movement of tuna to and aboard the ship were: removing the tuna from the hold of the fishing vessel; lifting the tuna aboard in boxes; weighing; dumping the boxes; grading the tuna; loading them in the freezers; transporting the frozen tuna to the storage compartments; and finally stacking and glazing the fish. Other materials of consequence which were subject to movement for delivery to the fishing vessels were ice, oil, water, food, fishing gear, and salt.

FISHING METHODS AND PROBLEMS

The tuna in southern waters are taken chiefly by either of two methods, purse seining or live-bait fishing. Purse seines are huge encircling nets varying from 325 to 425 fathoms in length and 450 to 700 meshes ($4\frac{1}{2}$ inch mesh by stretched measure) in depth depending on the size of the vessel. The net is set about a school of tuna and the bottom is closed or "pursed" to surround the fish in a "bowl" of netting. As the seine is hauled aboard, the fish become sufficiently concentrated within a small area to be removed by brailing with power operated dip nets.

FIG. 1 - ADMINISTRATION OF THE S. S. PACIFIC EXPLORER DURING FISH PROCESSING ACTIVITIES



Hook and line gear is used in the live-bait method of fishing. A supply of live bait is captured near shore in foreign or domestic waters. After capture, the bait is transported to the fishing grounds where it is thrown overboard in the immediate vicinity of schools of tuna, thereby attracting and exciting them. Simultaneously, either artificial lures or baited hooks, attached to stout bamboo poles by lines and leaders, are thrown overboard by the crewmen working individually or in teams to capture the tuna. The live bait system of tuna fishing is responsible for the major proportion of the production, but the purse seine method is becoming of increasing importance.

Types of Vessels

The methods of fishing affect the economics and operating conditions of tuna receiving ships and are of consequent concern to the operators of such ships. The captains and crews of the large tuna clipper class of vessels are skilled in the tuna fishery off Central America and have vessels that are designed to transport frozen cargoes to ports in Southern California. The operators of receiving ships can expect to obtain only infrequent loads from the large clippers because a considerable period of time is required to load these vessels and the crews desire to return to their home port after obtaining a cargo. To provide an operating margin for a receiving ship, a substantial price differential must exist between tuna purchased off Central America for transport to the United States and tuna landed directly in the United States. The smaller tuna vessels have a restricted cruising range and cargo capacity which prevents them from working in the year-around tuna fishery off Central America and returning their catches to Southern California. To this class, the receiving ship can offer a real inducement and service. Unfortunately, in the beginning the smaller vessels will be manned with captains and crews of lesser experience in the southern tuna fishery and their initial production will be below the level of the experienced operators.

The catching of tuna by live-bait boats is apt to be erratic. These boats perform two distinct fishing operations, one for bait and the other for tuna. If bait and tuna are plentiful and the tuna are in a mood to bite, regular and sustained production can be maintained. If the opposite of these conditions prevails, the rate of production will be low. Further, since the supplies of suitable bait are most frequently taken in the territorial waters of one of the Latin American countries, a receiving ship, which depends on live bait boats, may be forced indirectly to buy fish under foreign jurisdiction. It will then be subject to local customs duties and various other demands such as increased employment of local labor, social security taxes, and vacations with pay. If the cargoes of tuna are purchased in foreign ports, a probability exists that these may be classed as imports by the United States Customs Service. No method has been developed, to date, for obtaining supplies of suitable live bait on the high seas, nor is it known that such supplies exist in the tuna fishing areas that are now exploited. The fact that the

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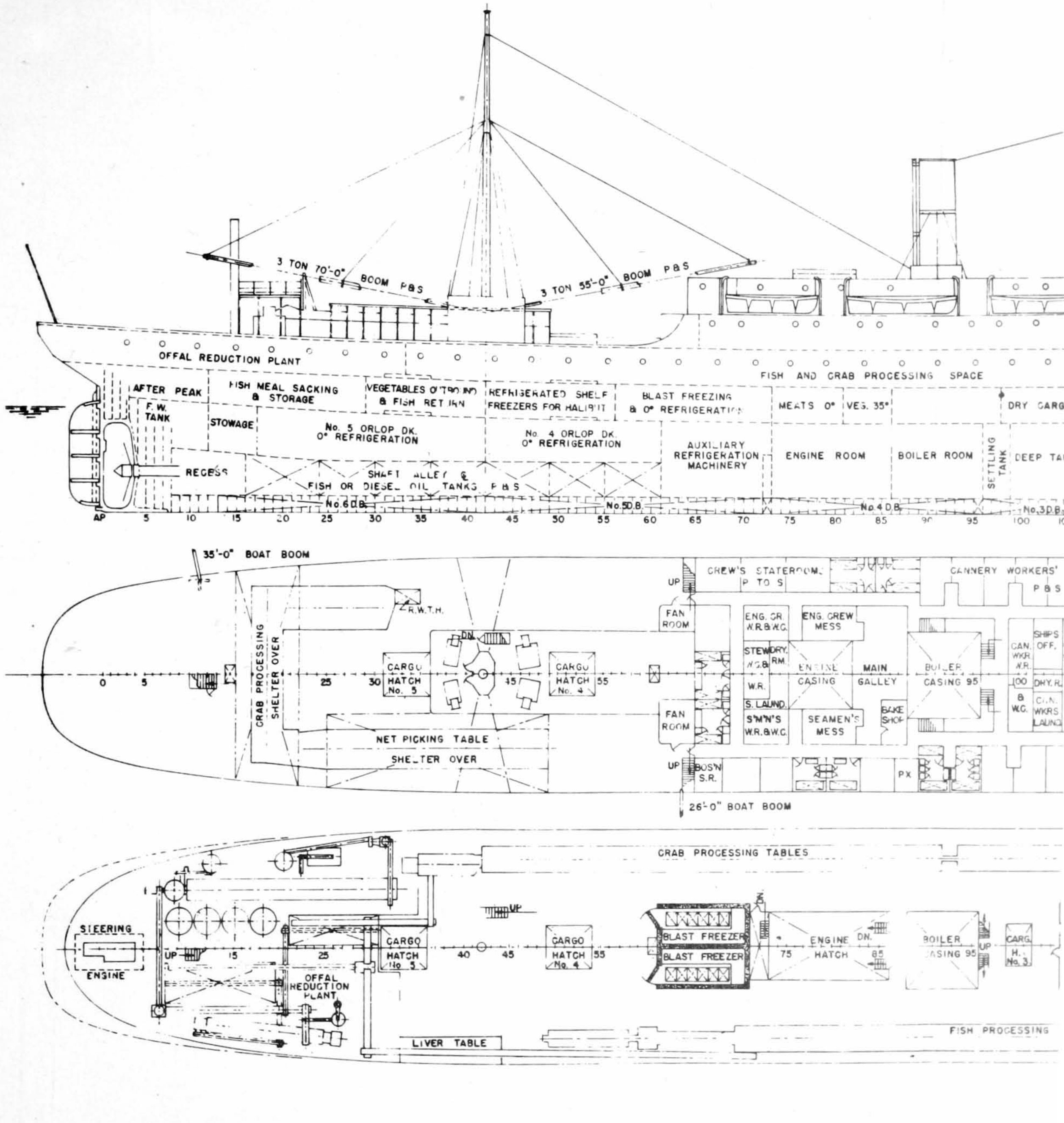

FIGURE 2 - OUTBOARD PROFILE AND UPPER DECKS OF S.S. PACIFIC E

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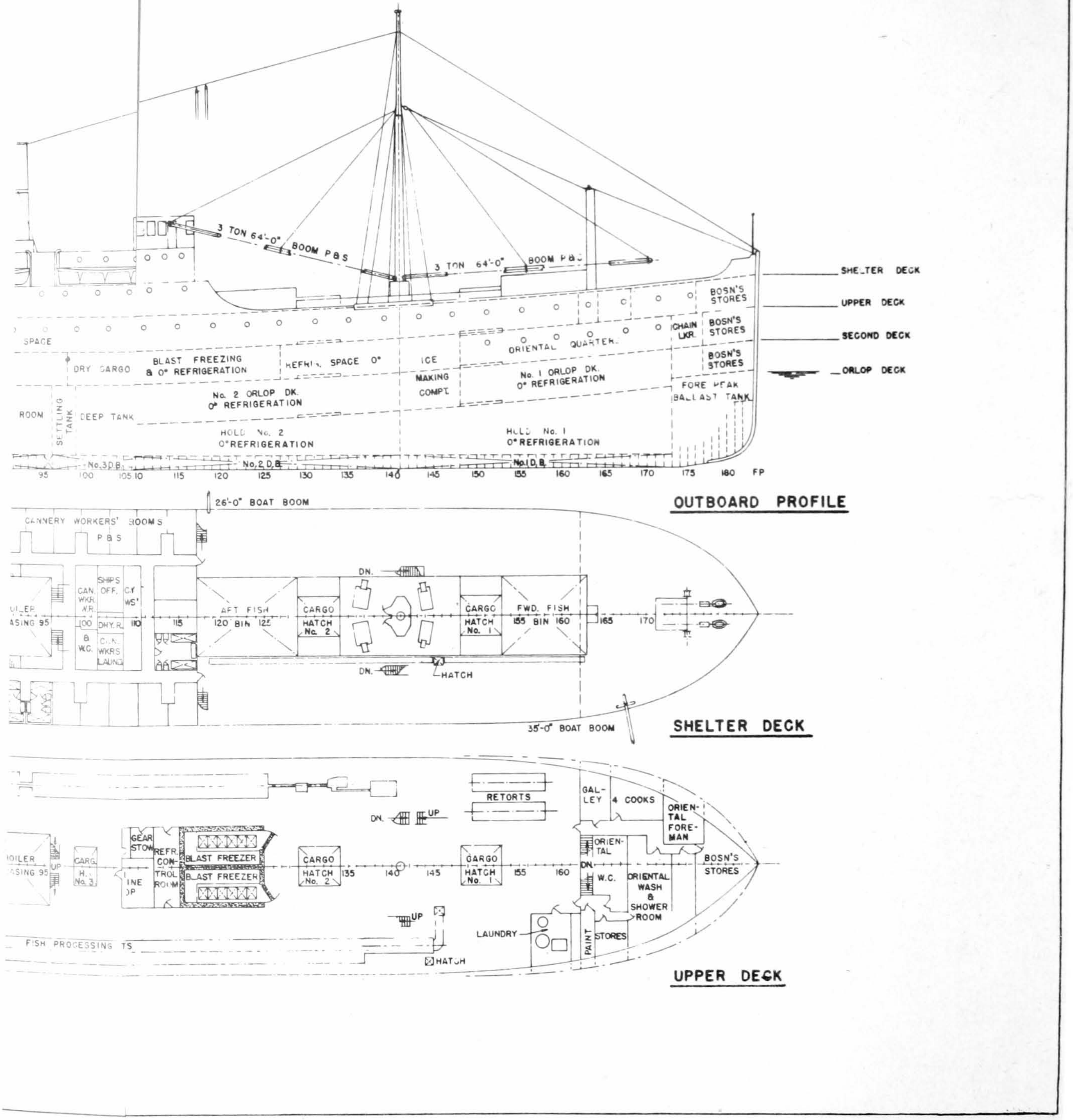

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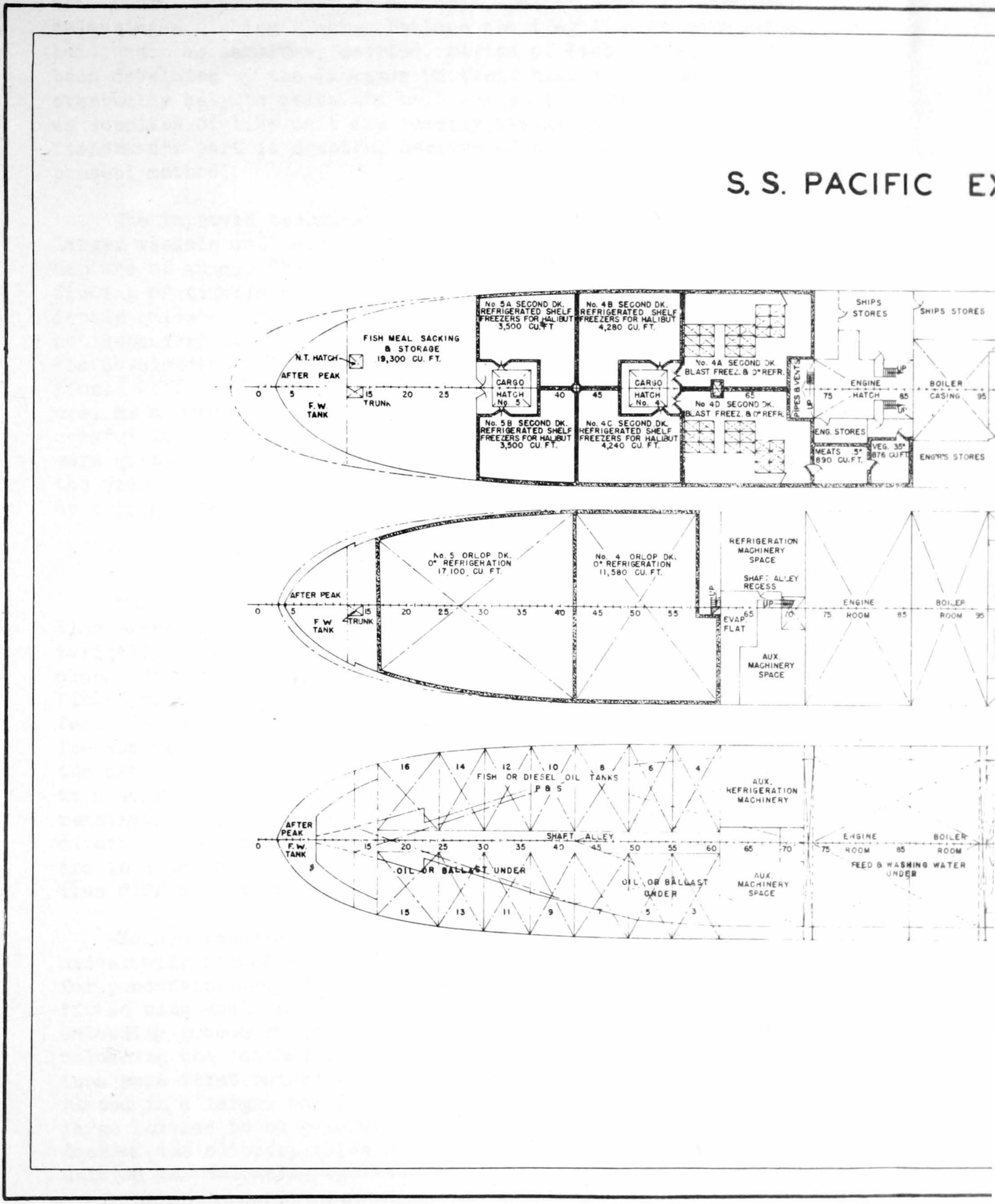

FIGURE 3 - LOWER DECKS OF S.S. PACIFIC EXPLOR

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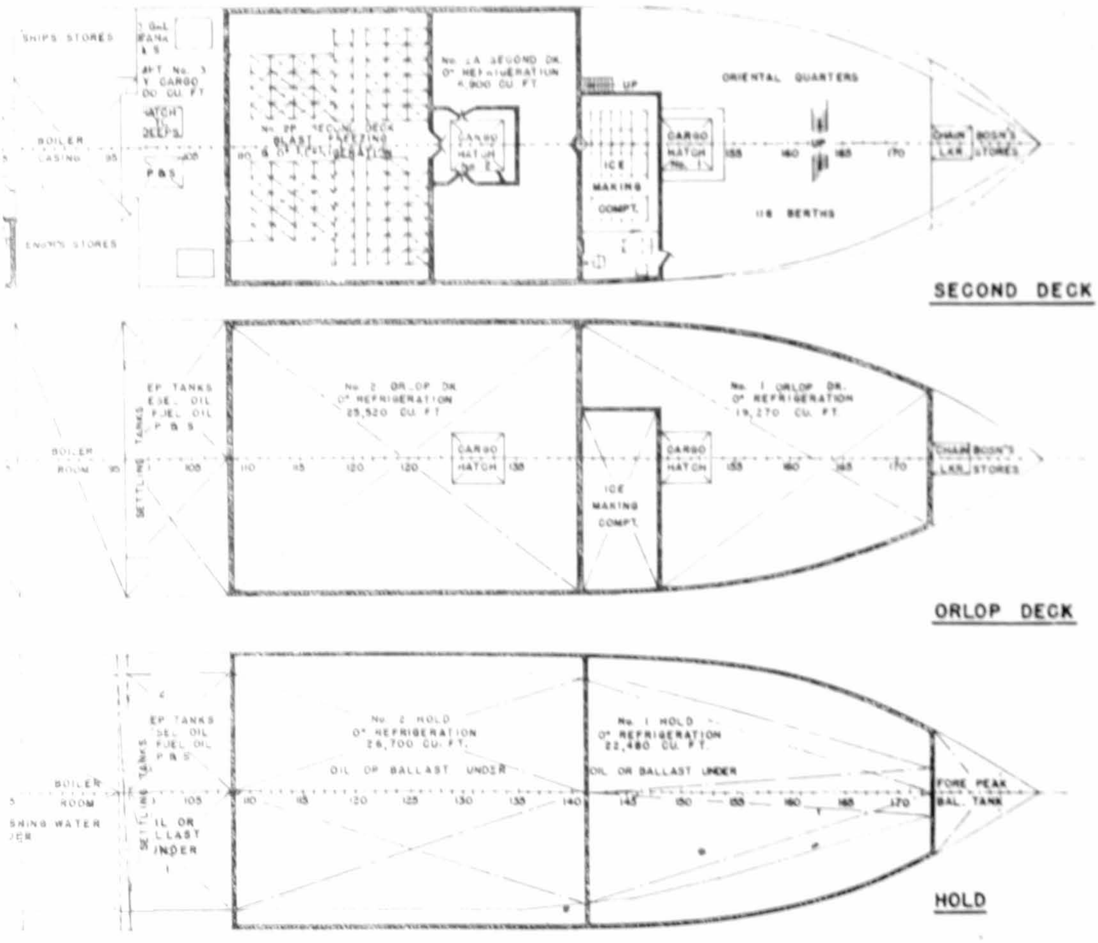

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live bait system is at present the dominant method of catching tuna off Central America must be balanced against these disadvantages in selecting a fishing fleet. Perhaps the flag line fishing (with frozen bait, such as sardines, herring, strips of fish, or squid) that has been developed by the Japanese in their high seas tuna fishery may eventually help to solve the bait and production problems. So long as supplies of live bait are readily available, such a change on the fisherman's part is doubtful because of the effectiveness of the present method.

The improved techniques of the purse seiners and the use of larger vessels and nets are becoming increasingly effective for the capture of tuna. The success of the purse seine method depends on the finding of sizable schools of tuna near the surface which are sufficiently quiescent to be captured. The purse seine method of fishing is not dependent on supplies of bait and offers a definite promise for the development of a truly high seas tuna fishing and mother ship operation. Of the vessels fishing for the Pacific Explorer, the purse seiners, as a group and for their period of operation, were far more successful in catching tuna than the bait boats. While the purse seiners were quite successful during the spring, there may be other seasons of the year, however, when the tuna will be extremely difficult to capture by this method.

Types of Refrigeration

The two methods of preservation that are used in the tuna fishery also present a complication to the operators of receiving ships. Historically, the purse seine boats and some of the live-bait boats, built along seine boat lines, engage in several seasonal fisheries and are fitted with large hatches having dimensions varying between 6 and 9 feet. When these vessels are engaged in the tuna fishery, a system of ice and mechanical refrigeration is most commonly utilized to preserve the catch. If the iced tuna are of recent capture and are not frozen in a solid mass, they may be removed from the fishing vessel at a reasonably rapid rate by utilizing large boxes which can be lowered directly into the holds. A serious complication occurs if the tuna are in a thoroughly frozen mass on the fishing vessel, for they are then difficult to remove.

Modern vessels, specifically intended for the tuna fishery, are universally fitted with a direct-brine mechanical refrigeration system for preserving and freezing the catch. These vessels are usually fitted with small hatches approximately three feet square. A two stage unloading procedure is advisable for a receiving ship operation. When unloading the catches of these vessels for the Pacific Explorer, the tuna were first raised to the main deck of the canopy deck, and then placed in a larger box for transferring to the receiving ship. The large box had to be carefully spotted in a restricted space on the deck of the clipper, which required a considerable amount of time and delayed the unloading operations.

Since a small but increasing number of purse seiners are adopting brine freezing systems, the problem of unloading fish through small hatches may be pertinent even with this method of fishing. The recent failures of the sardine runs off California may increase the trend of the purse seine vessels to exploit the tuna fishery for a greater portion of the year. On a long range program, some advantageous and economical method of discharging fish from brine refrigerated tuna vessels having small hatches must be developed.

Mooring the Fishing Vessels

The transfers of fish and supplies were made in protected waters and the fishing vessels were moored directly alongside the mother ship.

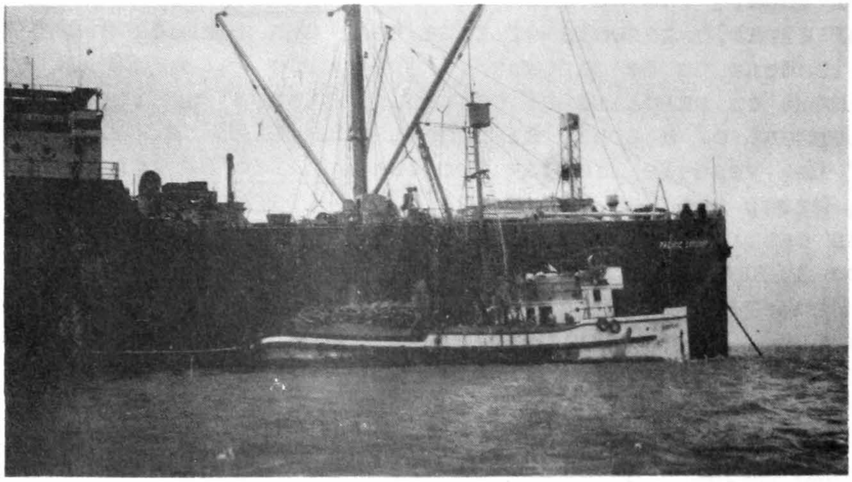

FIG. 4 - A PURSE SEINER MOORED ALONGSIDE THE PACIFIC EXPLORER AFTER UNLOADING FISH AND PREPARING TO LOAD ICE

Several sets of fenders, each consisting of three heavy truck tires suspended one above the other, on wire rope pendants, were used to minimize the shock. Figure 4 shows a set of the fenders and a purse seiner moored alongside the ship and awaiting the delivery of ice. Strong tidal currents persist at most locations in the Gulf of Nicoya, Costa Rica, and manila lines less than four inches in circumference were inadequate for mooring fishing vessels of 75 to 85 feet in length. It was necessary to use a section of wire rope in the mooring lines where they passed over the side of the ship to avoid damage to the lines by chafing.

The Pacific Explorer is fitted with two sets of mooring booms, but their use was not required because nearly all of the tuna were transferred in sheltered waters. The one set of mooring booms is located forward on the starboard side and the other set aft on the port side, as shown in Figure 2. These vary from 26 to 35 feet in length depending on their position, and theoretically are designed to hold the center line of the fishing vessel at a distance of about 26 feet from the ship. In Figure 4 is shown one of these booms and the A frame which provides partial support in a stowed position along the rail of the Pacific Explorer and above the forward deck of the fishing vessel. The mooring booms are attached by a goose neck swivel and the outboard athwartships position can be fixed by forward and after guys. The level position of the boom shown in Figure 4 can be adjusted by two topping lifts from the boom to the A frame and the tower.

In Figures 2 and 4, a steel tower may be noted on the deck of the ship, which serves as a run for a counterweight of 5,000 pounds. This weight, to absorb the surge, can be directly connected to a mooring bit of a fishing vessel by a linkage of wire rope and manila line running through a series of blocks on the tower deck of the ship, and the end of the boom.

METHODS OF TRANSFERRING TUNA

The tuna were transferred to the ship by the conventional type of steam schooner rigging, as indicated in Figures 2, 4, 5, and 6. The bases of the booms are fitted to the ship by the usual gooseneck arrangement, and their vertical angles are maintained by topping lifts. The fore and aft position of each pair of booms is fixed by a side guy from each of the booms, and a crossing or schooner guy which provides an inboard connection between the tops of a pair of booms. The lateral and vertical movement of the fish box is controlled by a single cargo fall from each of a pair of booms, and power is supplied by a pair of reversible steam-driven winches. The ship's booms must be swung in a semi-permanent position, outboard from the ship's sides, to properly lower a fish box to a fishing vessel. Preventer stays are fitted

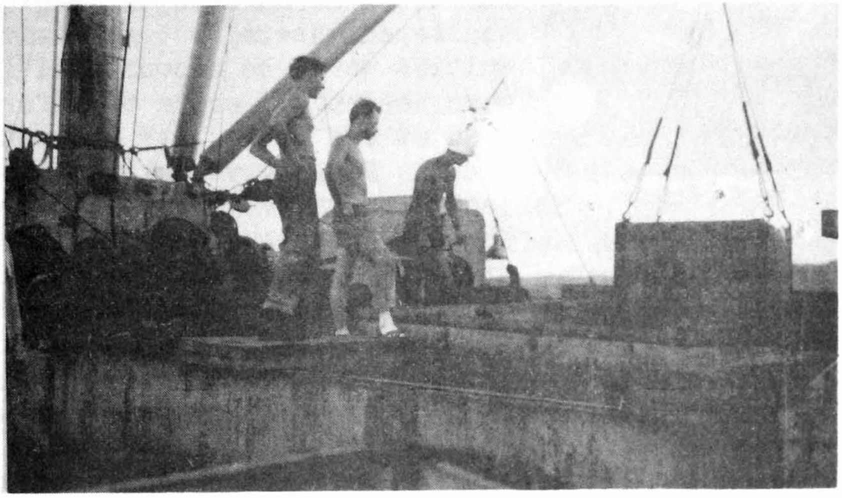

FIG. 5 - A PAIR OF THE SHIP'S WINCHES BEING USED TO LOWER A FISH BOX TO THE UPPER DECK.

between the mast and a connecting ring in each set of the side guys at a distance of about 15 feet above the deck to provide the necessary clearance for the rigging of the fishing vessels. This arrangement is shown in Figures 4 and 5.

The vessels were unloaded by placing the tuna in boxes which have dimensions of 56 by 39 by 31 inches, and hold about one ton of fish. These boxes, as shown in Figures 5, 6, and 7, were made of finished two-inch planking, reinforced by a welded angle iron frame, and fitted with a hinged door at one end to facilitate dumping the tuna. A four strap bridle of light wire rope was hooked to eyes at the corners of the box. By releasing the door catch and the two adjacent straps, the box could be readily dumped by lifting the opposite end with the ship's gear. This type and size of box was suitable for unloading the fishing vessels having large hatches, for the box could be lowered directly into the hold. When unloading brine boats or those with small hatches, the box was usually spotted on the main deck between the bait tank and the rail, being a delicate operation, or on the canopy deck as the circumstances permitted. This made it necessary for the fishermen to pass the tuna to the deck by hand or use the fishing vessel's gear to raise the fish. Small boxes holding about 500 pounds could be lowered directly into the wells of the brine boats, but the time required together with the greater number of weighings that must be made rendered the procedure prohibitive. To obtain an accurate weight of the fish, the box must be held in a steady position by the ship's gear so that the scale indicator may approach a rest position.

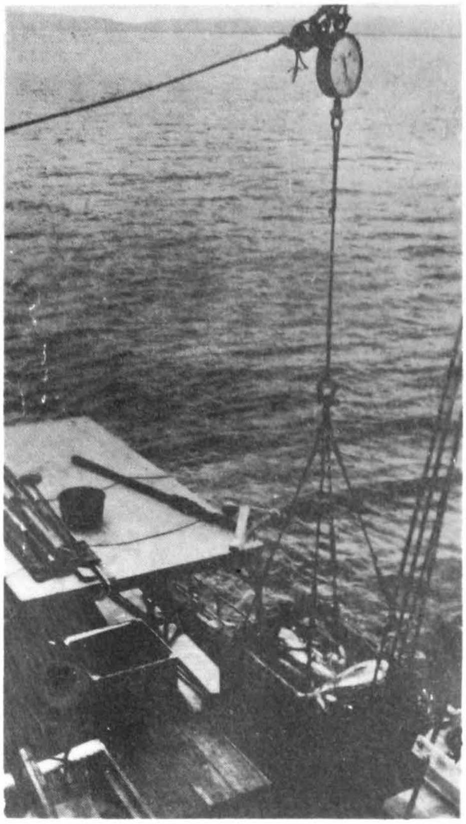

FIG. 6 - A BOX OF FISH BEING TRANSFERRED TO THE MOTHER-SHIP. NOTE THE DYNAMOMETER SCALE.

The use of rigid boxes for unloading fish was an acceptable practice in sheltered waters, but excessive difficulties would be encountered if these were used to effect a transfer of the fish at sea where both the mother ship and the fishing vessel would be subjected to varying degrees of rolling. The box, when suspended by the rigging, will tend to act as a pendulum and endanger both the crew of the fishing vessel and the refrigerated coils lining the hatchway. Attempts were made on the Pacific Explorer to use rope cargo slings of a mesh size of about nine inches on the bar. Unfrozen tuna handled in this way were prominently grooved because of the localized pressure on the ropes. The practice was discontinued because it was feared that local bruising might occur and affect the quality of the flesh. Normally, such a condition would not be expected with frozen fish. A single attempt was made to transfer tuna by using a round hoop brail net with a sack of 96-thread four-inch mesh cotton netting. No pronounced external marking was in evidence, but the noses of the fish tended to catch in the meshes. The experiment was discontinued because the hoop was too large for ready passage through the medium sized hatch on the particular vessel. Rope cargo slings with a mesh of small size are frequently used to unload fresh halibut; consequently, it is thought that these or a sling made of heavy canvas reinforced with rope might offer a more suitable arrangement than rigid boxes for transferring tuna in quantity.

Weighing the Tuna

The weights of the tuna were established by a dynamometer type of scale which was attached between the cargo hook and the bridle of the fish box, as shown in Figure 6. This scale had a capacity of 5,000 pounds, but the impact load when starting to raise the box and a ton of fish seldom exceeded 3,000 pounds. A scale of the same size having a capacity of 3,500 to 4,000 pounds should be adequate for weighing one ton of fish and would provide larger graduations. However, the spring would be weaker than that of a 5,000 pound scale and a longer time might be required to reduce the oscillations of the indicator. An appreciable period of time was required to permit the scale indicator to come to rest and to lower and raise the box through the comparatively small 10 by 12 foot hatches of the ship (Figures 2 and 5.) The accuracy of the dynamometer scales was periodically checked by test loading with weights established on a platform type of scale. With this precaution the variation in the weights of the fish as purchased by the ship and as unloaded at the cannery was approximately 1/2 of one percent. In a large part, this could be attributed to dehydration of the tuna and the loss of some portions of the fins and tails.

The services of three sailors were required by the particular maritime agreements to transfer the fish. The crew supervised by a mate consists of a signal man, a winch driver, and a hook tender to release the load. Technically, the responsibility of the hook tender ended with the release of the load, but he generally assisted a cold storage worker in passing the fish to the freezer compartments located on the second deck (Figure 3).

Movement of Tuna to Freezers

After the fish were dumped from the boxes they became the responsibility of the cold storage crew. Initially, the cold storage crew consisted of a foreman and 6 workers which were an adequate number to stow the cargo of one fishing vessel in a freezer. If two vessels were unloaded simultaneously the cold storage crew was divided to form the nucleus of two gangs which were brought to full number by recruiting sailors or other crew members from a free watch. Compensation for the latter groups in handling fish was on an overtime basis of time and a half.

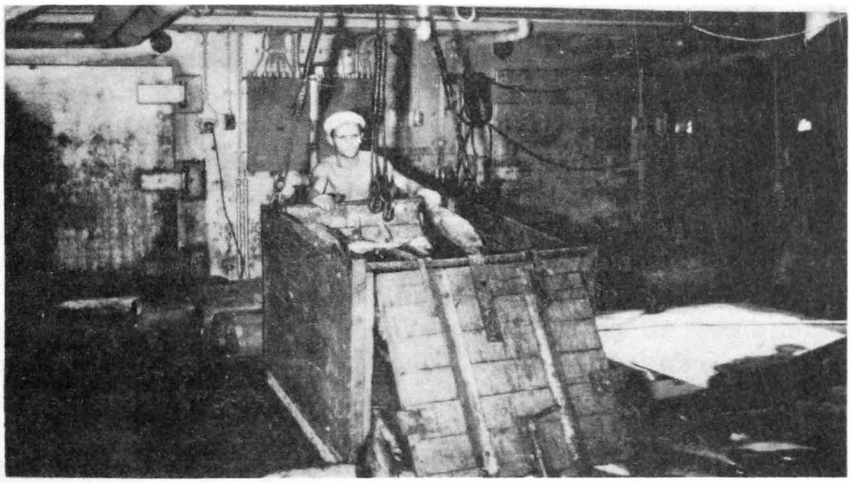

FIG. 7 - A FISH BOX BEING EMPTIED ON THE UPPER DECK

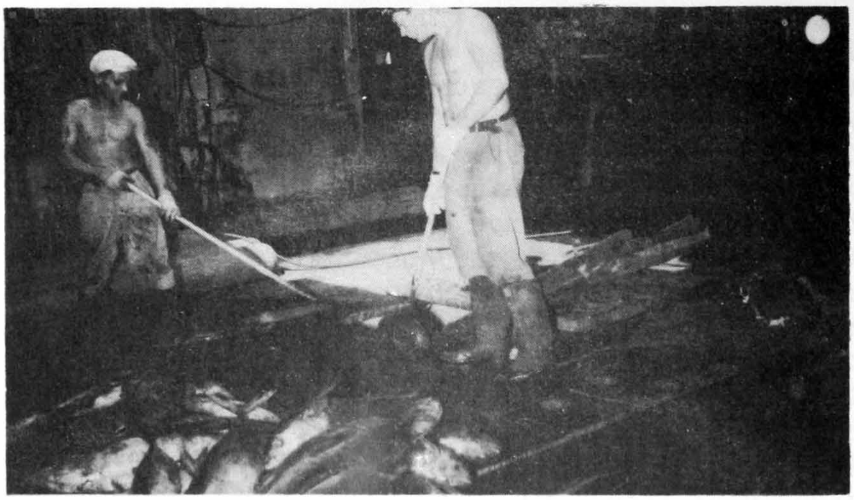

FIG. 8 - DIRECTING FISH DOWN CHUTES TO A FREEZER

As the voyage progressed, most of the cold storage crew and the ship's unlicensed personnel returned to the United States. The Government of Costa Rica and the local unions became increasingly insistent that a larger number of Costa Ricans be hired to perform work aboard the ship. Occasionally seafaring men from the various maritime nations would be available in Costa Rica or Panama. Whenever possible, these sources were utilized to maintain a ship's working complement. However, it was difficult at times to maintain even a working crew of skilled sailor winch-drivers or watches below deck. The Costa Ricans were used chiefly in the cold storage crew and the steward's department, and performed satisfactory service. Their smaller stature required a somewhat larger number of persons in the cold storage gang to perform a given amount of work as compared to the initial cold storage crew, but this difference was offset by a lower rate of compensation. Contrary to the general conception of tropical labor, the Costa Ricans were found to be willing workers and were quite satisfactory as unskilled labor after a period of training.

Under the supervision of the cold storage foreman, one of his gang, assisted by the hook tender, graded the tuna for quality and directed them onto the chutes leading to the freezers. Depending on the type of freezer, the rate of delivering fish, and the type of labor, four to eight men were required to remove the tuna from the chutes and place them in a position for freezing. When the rate of unloading the tuna was slow, the crew on the ship experienced periods of idleness. If the tuna were delivered at rates in excess of eight tons per hour, it was necessary for the crew to work at a fair rate of speed when they were loading the shelf freezers. However, they could readily stow in excess of eight tons per hour in the blast freezers. If the individual tuna averaged over 40 pounds in weight, three or four members of the initial freezer crew could stow tuna at the rate of eight or more tons per hour for a short period of time in any of the freezers.

If the tuna averaged less than 20 pounds in weight, six or more men were required to place the fish in any of the freezers at rates in excess of eight tons per hour. The shelf freezers on the Pacific Explorer were more difficult to load than the blast freezers because of the odd shape of the rooms and the arrangement of the shelf coils, which required additional handling of the tuna.

Table 2 presents some data on various man-hour time studies for unloading tuna from the vessels and stowing them in the freezers. Some conflicts with the general statements are apparent. These occur because of a number of factors such as the experience of the crews, their degree of energy on a given day, variable amounts of time off for rest periods for which they are compensated, and the type of labor. However, the data are presented as being generally representative of the conditions. The first column designates the most apparent factor which limited the rate of unloading. It may be noted in the section dealing with shelf freezers, that a crew of four and six men was the limiting factor when fairly large fish were unloaded at a rate of approximately eight tons per hour. If Costa Ricans were used as a cold storage crew, it was reported by the foreman that their smaller stature made it necessary to allot three men to do the same amount of this heavy work that could be performed by two men from the United States.

In several instances the tuna were a frozen mass in the holds of either brine or ice boats and had to be thawed while being removed. This condition limited the rate of unloading and was beyond the control of the personnel on the ship. It also may be noted that the ship's gear was a factor which limited the unloading to rates of approximately 9 to 11 tons per hour. In these cases one box was being loaded on the fishing vessel while another was in transit by the ship's gear. The difference in the limiting rates of unloading attributable to the ship's gear was occasioned by the degree of experience of the original crew of winch drivers as contrasted to that of the replacements obtained in Central America. The small average size of the tuna in certain lots likewise limited the rate at which they could be removed from the holds of the fishing vessels and graded aboard the ship. In one instance, as shown in the column headed, "Type of Refrigeration", the tuna were held in a cold brine solution aboard a clipper and not frozen in a solid mass. Even then the rate of unloading was slow because of the small hatches and the care which must be exercised by the signal man and the winch driver to land the box in a very restricted space between the bait tank and the rail of the clipper.

Movement of Tuna to Storages

The movement of the tuna from the freezers to the storage compartments (Figures 2 and 3), was a relatively simple operation if they were to be stored in a compartment in the same hold as the freezer. Figures 9 to 12 illustrate the various phases of transporting the tuna to their final destination in the cold storage compartments. The tuna were removed from the shelf coils or the blast freezer trays, pushed along smooth surface metal or wood chutes at a slight incline, and allowed to fall into a lower storage room. Frozen tuna will slide quite well on smooth surface chutes, but a type of roller chute, commonly used for transporting cased goods, was not suitable. By

Table 2 - Date on Unloading and Stowing Fish in Freezers

Factor Limiting Unloading Rate	Vessel Factors		Size of Gang		Time Required		Amount of Tuna			Amount of Tuna Unloaded per Man Hour					
								Unloaded per Hour		Unloading Operation			Total Operation 4/		
	Type of Refrigeration 1/	Type of Gear 2/	Ship's Crew 3/	Freezer Crew	Unloading Operation	Total Operation 4/	In the Load	Unloading Operation	Total Operation 4/	Ship's Crew 3/	Freezer Crew	Total Crew 5/	Ship's Crew 3/	Freezer Crew	Total Crew 5/
			Men	Men	Hours	Hours	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
FISH PUT IN SHELF FREEZERS															
Freezer Crew	Ice	B.B.	9	4	1.0	1.7	8.2	8.2	4.8	0.91	2.05	0.63	0.54	1.21	0.37
Freezer Crew	Ice	B.B.	9	4	1.1	1.9	9.0	8.2	4.8	0.91	2.05	0.63	0.53	1.28	0.63
Frozen Fish	Ice	B.B.	9	6	5.0	5.7	31.6	6.3	5.5	0.70	1.05	0.42	0.62	0.92	0.37
Frozen Fish	Ice	P.S.	9	7	11.3	11.9	35.1	3.1	2.9	0.35	0.44	0.19	0.34	0.42	0.18
Freezer Crew	Ice	P.S.	9	6	2.5	3.1	20.0	8.0	6.5	0.89	1.33	0.53	0.72	1.08	0.43
Ships Gear	Ice	P.S.	9	10	2.2	2.8	24.6	11.2	8.8	1.24	1.12	0.59	0.98	0.88	0.46
Frozen Fish	Brine	B.B.	9	6	4.3	5.0	22.4	5.2	4.5	0.58	0.87	0.34	0.50	0.75	0.30
Frozen Fish	Brine	B.B.	9	6	18.5	19.7	91.4 6/	4.9	4.6	0.55	0.82	0.33	0.52	0.77	0.31
FISH PUT IN BLAST FREEZERS															
Ships Gear	Ice	P.S.	9	5	2.0	2.4	18.8	9.4	7.8	1.04	1.88	0.67	0.87	1.57	0.56
Small Fish	Ice	P.S.	9	6	2.4	3.3	20.2	8.4	6.1	0.94	1.40	0.56	0.68	1.02	0.41
Small Fish	Ice	P.S.	9	6	8.3	8.9	51.8	6.2	5.8	0.69	1.04	0.42	0.65	0.97	0.39
Frozen Fish	Ice	P.S.	9	6	1.3	1.9	8.1	6.2	4.3	0.69	1.04	0.42	0.47	0.71	0.28
Ships Gear	Ice	P.S.	9	6	1.1	1.7	12.5	11.4	7.4	1.26	1.89	0.76	0.82	1.25	0.49
Ships Gear	Ice	B.B.	9	6	3.5	4.1	32.5	9.3	7.9	1.03	1.54	0.62	0.88	1.32	0.53
Frozen Fish	Brine	B.B.	9	5	7.0	7.6	39.6	5.7	5.3	0.63	1.13	0.40	0.58	1.04	0.37
Small Hatch	Cold Brine	B.B.	9	6	3.7	4.4	18.5	5.0	4.2	0.56	0.83	0.33	0.47	0.71	0.27
Average	-	-	-	-	-	-	-	7.3	5.7	0.81	1.28	0.49	0.64	0.99	0.40

1/ Vessels with ice refrigeration have large hatches. Those with brine have small hatches.
2/ B.B. is bait boat--P.S. is purse seiner.
3/ Ship crew consists of mate, tally man, 3 sailors, plus engineer and 4 of "black gang".
4/ Total operation includes time for unloading operation plus preparation and close up time of the hatches and freezers.
5/ Total crew includes men listed in ship and freezer crew.
6/ 30 tons of load went into blast freezer.

allowing the tuna to slide down an inclined chute they can be projected for a considerable distance inside a storage compartment from the starting point. Tuna, dropping for an actual vertical distance of approximately 10 feet, on an inclined chute at an angle of about 30 degrees, can be projected by momentum for distances of 30 to 40 feet inside a storage room. The chutes varied in size from 18 to 24 inches of inside width with restraining sides from 4 to 6 inches in height, depending on the available material, and from 12 to 20 feet in length to suit the locations. Chutes made of one-inch lumber were serviceable only for short periods of time and even those made of two-inch planking were in need of occasional repairs and replacement. A sheet metal chute reinforced with one-inch angle iron is shown in Figures 10 and 12. It was superior to the wood chutes since it was lighter and far more durable. A canvas tube, similar to that which has been developed as a life saving device in removing persons from burning buildings, was fabricated to test its practicability for sliding frozen tuna into the storage compartments. It was found to be impractical because the sharp fins of the frozen tuna would cut the canvas. Perhaps a chute of a more durable material such as belting might be suitable for the application of this basically sound principle.

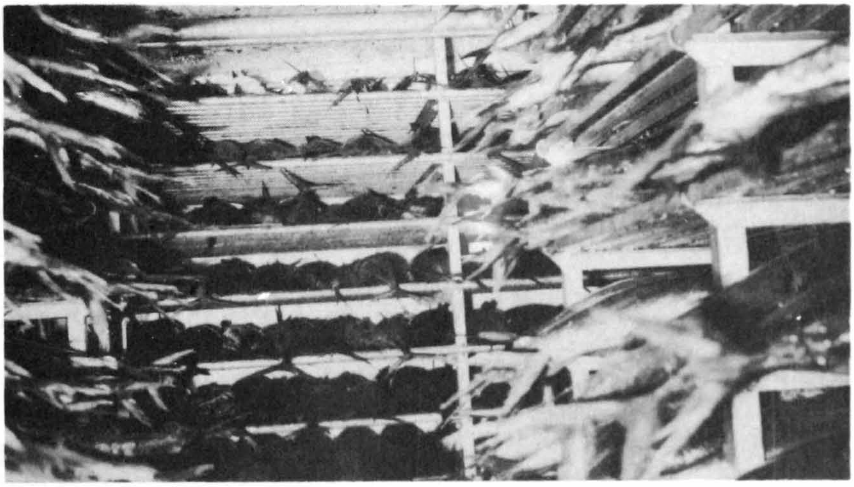

FIG. 9 - TUNA BEING FROZEN ON SHELF COILS

Transferring fish from a freezer in one hold to a storage compartment located in another hold is a far more complicated and time consuming procedure than the simple process of dropping the tuna from a freezer to a storage compartment in the same hold (see Figures 2 and 3). Unfortunately, the dual purpose of the <u>Pacific Explorer</u>, to operate in the Bering Sea for king crabs and bottom fish and to operate in tropical waters for tuna, did not permit the inclusion of a freezer for number 1 hold. Consequently, most of the tuna which are destined for storage in number 1 hold must be frozen in number 2 blast freezer or in the after freezers. The movement of the frozen tuna from the number 2 freezer to the forward hold is not an unduly serious problem for the clearances are adequate to admit a conveyor to raise the fish to the upper deck and to permit their sliding to number 1 hold by gravity.

When the frozen tuna were transferred from the after freezers to the forward hold, they were placed in boxes, raised to the upper deck with the ship's gear, landed on pallets, trucked forward, and conveyed by belt between number 2 and number 1 hatches. Figures 13 and 14 show the trucking and conveying operations. Since the ship's gear was required to lift the boxes, the procedure was expensive because four men of the engine department and four men of the deck department had to be paid at overtime rates in addition to the cold storage crew on regular time. The power of the one-ton capacity fork lift trucks was barely adequate to move the load from number 2 to number 1 hatches when the batteries were fully charged, consequently the tuna were conveyed by belt over this distance. The restricted space and the uneven deck, which required that the load be moved slowly, were factors contributing to the apparent lack of power of the trucks.

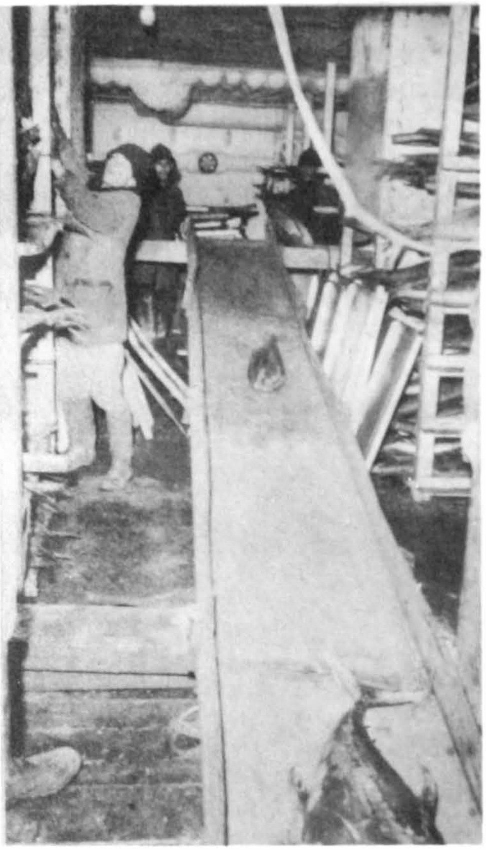

FIG. 10 - TUNA BEING REMOVED FROM THE BLAST FREEZER TRAYS.

Table 3 presents some data on transferring tuna from the freezers to their final destination as stacked fish in the storage rooms. When the tuna are stored in the same hold where the freezer is located, the rate of handling fish is shown to vary from 0.90 to 1.25 tons per man hour. The services of a cold storage crew of only 5 to 7 men were required for a transfer of this nature. Transferring fish from an after freezer to number 1 hold required the services of a much larger crew consisting of 12 to 14 cold storage workers and 2 sailors to serve as a winch driver and a hook tender.

Fortunately in number 1 hold the problem of lowering thoroughly frozen tuna, at a temperature of 0° F. or colder was not serious. They could be dropped from the upper deck to the orlop deck, a distance of more than 20 feet, without suffering an apparent degree of excessive external injury. However, if the tuna were to be dropped from the upper deck to the hold deck, a two stage fall was necessary to avoid excessive damage. It was advantageous to use a sheet metal chute, even at a very steep angle, to guide the fall of the tuna because they then tend to strike the deck with a glancing blow which minimizes the amount of damage. Adjusting the position of the chute tended to deflect the tuna toward the place where they were to be stacked. Frozen tuna, when sliding down a chute at an angle of 20 degrees or less from the vertical, attained a considerable velocity. Hence, it was necessary to provide a steel plate in the area of contact between the falling tuna and the wood deck gratings to avoid damage to the wood.

A special spiral chute was provided to be used in lowering frozen tuna or canned products in number 1 hold. Since this was not used, no statement as to the true worth of such an arrangement can be made, but the following thoughts are advanced. The spiral chute would be cumbersome to assemble and support. It would interfere with the maintenance of suitable refrigerated storage temperatures unless the necessary openings in the hatches for the chute could be closed or the chute could be partially dismantled when it is not in use.

Table 3 - Data on Time Required for Transferring and Stacking Tuna

Amount of Tuna Transferred	Route of Tuna		Time Required				Tuna Transferred Per Man Hour	
	From Freezer	To Storage	Cold Storage Crew	Deck Crew	Black Gang	Total Crew	Cold Storage Crew	Total Crew
Tons	No.	No.	Man Hrs.	Man Hrs.	Man Hrs.	Man Hrs.	Tons	Tons
44.5	2	2	49.5	-	-	49.5	0.90	0.90
39.0	2	2	35.0	-	-	35.0	1.11	1.11
15.0	5	5	12.0	-	-	12.0	1.25	1.25
32.5	2	2	28.0	-	-	28.0	1.16	1.16
39.1	4	1	88.8	13.0	26.0	127.8	0.44	0.31
15.5	4	1	42.0	6.0	12.0	60.0	0.37	0.26
30.0	4	1	83.5	16.9	33.8	134.2	0.36	0.22

Glazing of Tuna

Fish held in cold storage for prolonged periods of time must have a protective glaze of ice or some other coating to minimize dehydration and oxidation of the flesh. A satisfactory glaze can be applied by dipping the frozen fish in cold water. This is common practice in the halibut and salmon industry to enhance the quality of the fish when they are to be used as a direct consumer item, but the operation will be an added and unnecessary item of expense on the receiving ship, when the final product is to be canned. The tuna on the Pacific Explorer were glazed by periodically spraying either potable or sea water over and through portions of the pile as the fish were being stacked. After a row was completely stacked, it was then subjected to an additional and voluminous spraying operation to provide a further degree of protection.

The glaze was usually applied by a spray of water delivered through a common garden hose and a spray nozzle. A greater volume of water and a more rapid glazing could be applied by using a fire hose but the thickness of the glaze varied greatly. The initial glaze applied by a garden hose spray averaged about 1/16 of an inch in thickness and ranged from probably no glaze at all where the fish are in contact, to about a maximum of 1/8 of an inch. The areas of contact between the fish could be sealed off from the air by the surrounding glaze. From the viewpoint of time required, the final glaze for each stack could be advantageously applied with a fire hose. Because of its salt content, sea water is considered to produce a glaze of greater resistance to cracking than fresh water and for economic reasons is advantageous for use aboard a ship. According to a report from the cold storage workers handling the tuna at Astoria, Oregon, there was no noticeable evidence of deterioration of the fish that could be attributed to inadequate glazing. Stack glazing of the tuna appeared to have a further definite advantage because the glaze tended to cement the fish together and prevent the stacks from collapsing.

MANUFACTURE AND MOVEMENT OF ICE[1/]

Ice must be used to preserve the catch of tuna on the fishing vessels which are not equipped with a direct brine freezing system. A total of 1,076 tons of ice, comprised of 642 tons produced on shore and 434 tons produced on the ship, was used during the first tuna trip of the *Pacific Explorer*. In addition, each ice boat took a full cargo of ice upon leaving the United States and several of the boats obtained a small amount of ice in Costa Rica.

FIG. 11 - A TUNA FALLING FROM CHUTE TO STORAGE HOLD.

During the design period, it was obvious that storage of the necessary large quantities of ice would present several problems in the movement of materials and of convenience in storing cargo. Space occupied by ice would not be available for cargo. A large concentration of ice in any hold would delay loading the area and would necessitate an excessive degree of movement of the tuna enroute from the freezers to the storages. Distribution of the ice throughout the holds would require an equally objectionable movement of ice or the provision of duplicate space and equipment for delivering crushed ice to the vessels. An analysis of these conditions indicated that a supply of ice obtained from shore, supplemented by ice produced aboard the ship would be the most desirable combination.

In the light of experience, the most satisfactory solution for the ice requirements of a tuna receiving ship is to obtain a sufficient quantity of ice when outfitting in port because of the difficulties encountered in making cake ice aboard the ship[1/]. It is estimated that the cost of producing potable water, suitable for making ice, is between five and six dollars per ton. The amount of water required to produce the rated capacity of ten tons of ice per day is a substantial load on the evaporators. Ice produced on shore can be purchased for about five dollars per ton in the United States. It is estimated that the additional labor and other expenses involved in producing ice aboard the ship is roughly equal to the stevedoring costs of loading ice in port. Of even greater concern, the production of ice aboard the ship is an added

1/ **A complete description of the ice plant on the Pacific Explorer is given in "S.S. Pacific Explorer, Part III - Below Deck Arrangements and Refrigeration"** (Fishery Leaflet 316), by Carl B. **Carlson.**

complication of considerable magnitude to an already large and diversified operation.

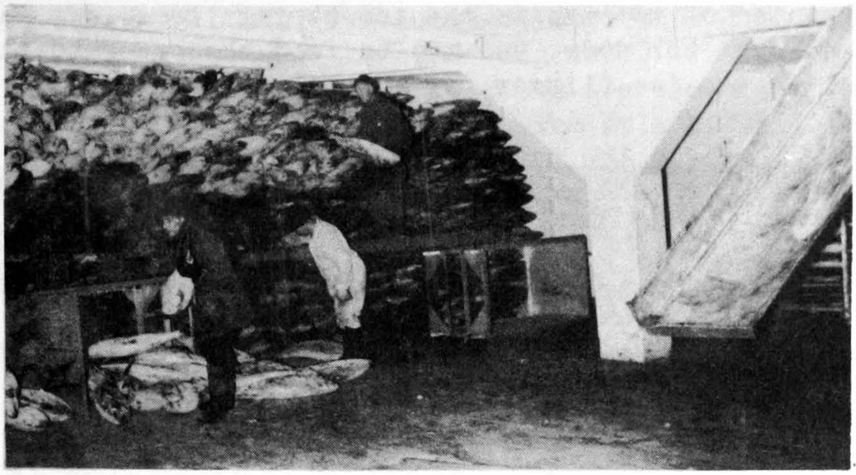

FIG. 12 - STACKING FROZEN TUNA IN A STORAGE HOLD.
NOTE THE METAL CHUTE FOR GUIDING THE TUNA.

In brief the various steps in the production and movement of ice aboard the ship were: freezing the water; transporting the ice to the storage room; removing the ice from the storage as needed; crushing; and delivering the ice to the fishing vessels. The ice was made in cans holding about 300 pounds, and these were removed from the freezing tank by a conventional overhead crane. The cans were transported by the crane to a thaw tank where the surface of the ice in contact with the cans was melted to free the cake of ice. Upon withdrawing the can from the thaw tank, the ice was dumped and dragged into a storage room (Figure 3, compartment 2A) where it was stacked and stored until needed. When ice was being made, at least one and usually two men were on duty for a period of 8 hours per day to fill the cans, remove the ice, and transport it to the storage room. If the ice was to be stacked in remote portions of the temporary storage room which has a total capacity for about 150 tons, more help was necessary. In addition to the labor required to manually handle the ice, the jobs of routine inspections, maintenance of proper brine temperatures, adjustments, and repairs to the ice-making system imposed an additional burden on the ship's engineers and the refrigeration engineers.

When ice was needed for delivery to the fishing vessels, it was withdrawn from storage, passed through a rotary crusher, conveyed to the shelter deck through a roto-lift, discharged into an ice flinger, and delivered to the hold of a vessel through a flexible rubber hose. A slight change in the design of the system at the time of construction would have permitted the ice discharged from the roto-lift to fall by gravity to the fishing vessel. However, an ice flinger was incorporated in the system to provide for icing any fish temporarily stored on deck in the northern operation. The capacities of the crusher and the roto-lift were in excess of that of the flinger, which proved to be the bottle neck of the ice delivery system. When the ice delivery system was functioning in a proper and balanced condition, and delivering aged ice, somewhat more than 20 tons per hour could be handled. Usually, however, the rate of delivering ice was slightly less than 20 tons per hour. A minimum crew for operating the ice delivery system at near capacity levels consisted of two men in the ice storage room, one man to pass the cakes through the door, two men to feed the cakes to the crusher, and one man at the ice flinger, or a total of 6 men.

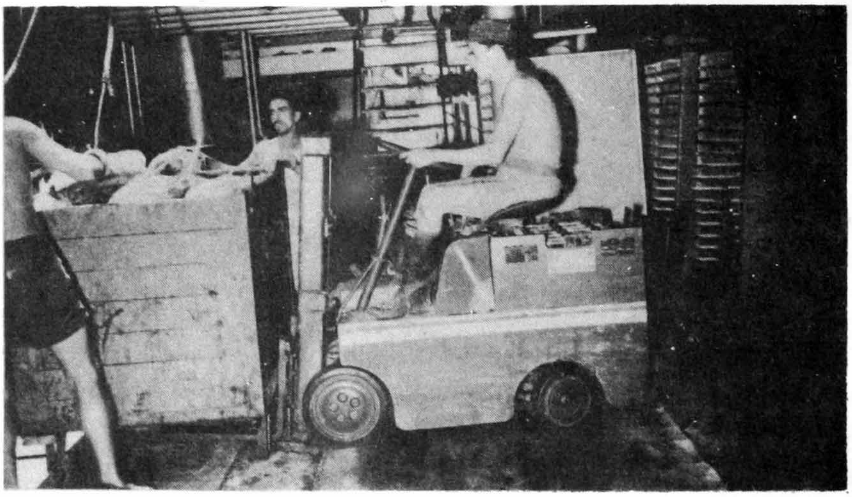

FIG. 13 - TRUCKING TUNA WITH ONE TON CAPACITY FORK LIFT TRUCKS.

The reserve ice from the lower holds was raised to the temporary storage room (Figure 3, compartment 2A) as needed, during periods of spare time in the regular duty hours of the cold storage crew. The reserve ice was withdrawn from the stacks at the lower hold levels and raised on portable vertical-lift elevators to the level of the temporary storage. A Costa Rican crew of efficient proportions consisted of four men at the lower level to supply the elevator and four at the upper level to remove the cakes from the elevator and stack them in the temporary storage. During an observation on the rate of moving ice in this manner, 36 tons were transferred in 5 hours by 8 men, or at rates of 7.2 tons per hour and 0.9 tons per man hour. On several occasions, the ice was lifted between the levels by using the ship's rigging, but the need for a complete opening of the hatches tended to change the temperatures in the holds. Furthermore, the rate of moving ice by this means was not substantially in excess of the elevator method and it was more expensive since the use of the ship's winches necessitated premium payments to the sailors and the black gang. However, the use of the ship's gear was advantageous in moving the ice from the lower number 2 hold to the temporary 2A storage, as a two stage operation of elevators from the hold to the orlop, and the orlop to the temporary storage would otherwise be required.

MOVEMENT OF VESSEL SUPPLIES

The food orders for the fishing vessels were filled by the chief steward and the transfer became the responsibility of the crew of the vessel. If the fishing vessel was discharging tuna, the food was generally placed in a special box at the point where the vessel was being unloaded and transferred by the ship's gear. Otherwise, the responsibility for transferring the stores was that of the crew of the vessel to avoid calling a watch to operate the ship's winches.

The deliveries of Diesel and lubricating oils and potable water were under the supervision of the chief engineer. The lubricating oil was carried in drums on the shelter deck and the use of the ship's gear was necessary to effect a transfer. The bulk Diesel oil was pumped from the ship's tanks through a meter and a hose. The water was delivered as needed,at no charge to the vessel, when a surplus was available on the ship. Except when ice was being made, which required about 10 tons of water per day, the 45 ton daily capacity of the ship's evaporators was able to supply an adequate quantity of potable water. It appeared that many of the ship's crew were unduly wasteful of potable water in bathing, resulting at times in a drastic curtailment in the amount of water which could be allowed to the fishing fleet. Under the maritime agreements and regulations, it was feared that rationing of water on the ship, when it was being given to the fishing fleet, might have resulted in serious complications. It also appeared that the crews of certain fishing vessels were apt to use excessive quantities of water unless restrictions were applied.

The bookkeeper was in charge of keeping the account of each fishing vessel and the ship, keeping the time of the crew, dispensing medicines, operating the slop chest and calculating the monies for local taxes. Since the transfers of fish and supplies were made in Costa Rican waters, customs duties were charged on all items except water and ice. The taxes were computed under an extremely complicated system, making it necessary to hire a Costa Rican with a knowledge of English and Spanish and an understanding of the tax structure. The tax statements prepared aboard the ship were further processed by an agent on shore and forwarded to the Costa Rican Government. These statements might circulate several times between officials of the Government, the ship, and the agent because of minor interpretations of the law and the subsequent adjustments. It was originally believed that only a flat tax rate of two dollars per ton on fish and supplies would be charged and it is expected that such a regulation will be incorporated in the new fishing code applying to mother ships in Costa Rica. (Converting the weight of a can of peas to a metric equivalent and calculating several cumulative but differing tax rates is an irksome procedure.)

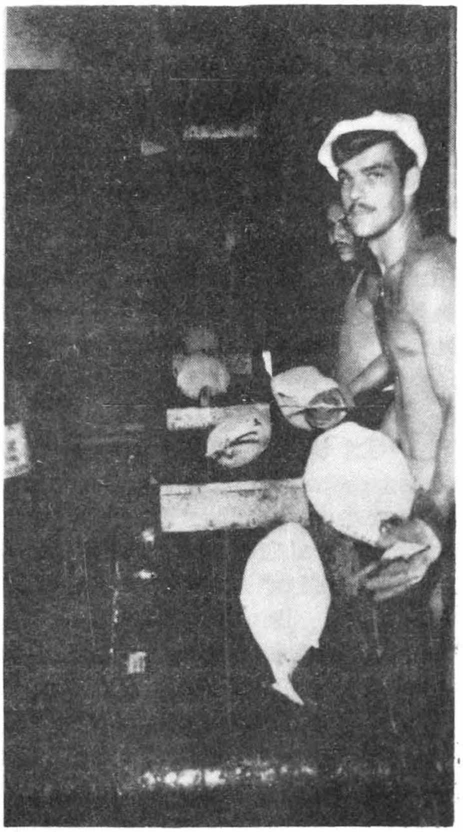

FIG. 14 - CONVEYING TUNA FROM NUMBER 2 TO NUMBER 1 HOLDS.

It was also necessary for the ship to assume the expense of hiring, housing, and feeding a customs guard designated by the Government of Costa Rica.

PREPARATION OF FOOD

The food for the crew of the ship was prepared in a central galley located on the shelter deck. From there it must be transported to four mess rooms to be served to the sailors, black gang, cold storage crew, and the licensed officers. Five men of the steward's department were required for this service.

WORKING AGREEMENTS

Under the coastal maritime union working agreements applying to the Pacific Explorer, transferring the tuna to the ship and dumping the boxes of fish were the responsibility of the deck crew. These agreements provided that loading cargo was an overtime job and required a deck crew of four men consisting of a mate, signal man, winch driver, and a hook tender. These men were on a monthly rate of compensation for which they performed a security watch of eight hours per day. On all days except Sundays and holidays, the deck crew could be called during their regular watch to handle cargo and had to be compensated for the hours of their regular watch during that day, plus an overtime rate for handling cargo. If the sailors were called to handle cargo at hours other than their regular watch, they were only compensated at the overtime cargo rate. During periods of handling cargo on Sundays and holidays, the watch on deck was paid at the regular monthly rate plus overtime for standing their security watch, but a free watch of sailors had to be called on overtime to handle the actual cargo. Furthermore, it was provided that the engineer on watch, a fireman, a water tender and an oiler must be compensated at their regular monthly wage for a routine watch below decks, plus a time-and-a-half cargo rate whenever steam was being supplied to work the winches.

In a normal steamship operation the rate of handling cargo is far in excess of the rate at which tuna can be removed from a fishing vessel and transferred to the Pacific Explorer. In the former case the cargo usually is readily accessible on the dock, need not be weighed by the ship, and but few delays are experienced in the operation of the winches. Because of the restricted space on the fishing vessels, extensive care had to be exercised by the winch crew when lowering the box to avoid damage to the vessel or injury to its crew. Time was required to load the boxes on the fishing vessels and to allow the box and scale suspended in mid-air by the ship's gear to become steady for obtaining an accurate weight. Furthermore, loading cargo in the normal steamship trade is a relatively continuous operation while the landings of the fishing vessels are highly erratic in time and volume. Thus, loading a steamship from the landings of fishing vessels becomes a very expensive operation under the working agreements with the maritime unions.

After the tuna were dumped from the boxes, they became the responsibility of the cold storage crew. The working agreement with this crew provided for an eight hour day to start at whatever time the crew was called. Any work in excess of an eight hour day, even though it extended beyond midnight, was on a time-and-a-half basis. Regular time did not start after such work until a rest period had been allowed. If at any time additional help was needed to handle fish below decks, other members of the ship's crew had to be called and paid at the rate of time-and-a-half. A source of complaint might then develop since the cold storage workers would be on a straight time basis while a sailor in the gang would receive time-and-a-half. As the number of the original ship's crew was depleted by the men quitting and going home, an increasing number of Costa Ricans were hired for the cold storage work, steward's department, and other jobs for which they were qualified. The Costa Ricans were willing workers but in general a larger number were needed for a given task as compared to persons of the original crew.

The working agreements applying to the steward's department, engine room, and deck officers were based on the usual provisions applying to off shore cargo ships. Table 4 presents a summary of the man hours for which the various groups on the ship were compensated during the period of the voyage extending from January 4 to July 23, 1947.

RECOMMENDATIONS

Type of Ship

The factor of paramount importance to the prospective operators of tuna receiving ships is the selection of suitable and advantageous floating equipment. A receiving ship is primarily a fish processing station which proceeds to a given fishing area and operates for a prolonged period of time to obtain and preserve a cargo. By contrast, a normal cargo carrying ship spends only relatively short periods of time in port to load cargo and a proportionately larger period as an ocean carrier. The working agreements with the maritime unions on the Pacific Explorer are predicated on the latter type of service and are expensive when applied to a fishing operation. Tuna receiving ships should be of such a type that they can be registered in the uninspected class of vessels. The use of motor vessels should be favored and steam propelled ships should be considered only as a last resort, if at all. A considerable number of Diesel-powered surplus military craft are now available that should be qualified for registration as uninspected vessels. These offer advantages because ex-service men are now available who have been trained to operate the equipment on these types of craft, and surplus equipment is relatively low priced.

The ship which is selected should have a basic arrangement to permit the efficient handling of a large volume of tuna and the performing of the usual ship's services with a minimum amount of labor. The freezers must be handy to both the loading gear and the storage holds to simplify the movement of tuna. An efficient system of storing and delivering ice to the fishing vessels which requires only a minimum amount of mechanical equipment and labor should be incorporated. The number of machinery spaces should be reduced to a

Table 4 - Payroll Time Summary of the Pacific Explorer, January 4-July 23, 1947

Month	Cold Storage Crew			Costa Rican Crew3/		Mechanics and Electricians			Deck Officers4/			Deck Crew		
	Reg. Hrs.1/	O.T. Hrs.2/	Total Hrs.	Reg. Hrs.	Total Hrs.	Reg. Hrs.	O.T. Hrs.	Total Hrs.	Reg. Hrs.	O.T. Hrs.	Total Hrs.	Reg. Hrs.	O.T. Hrs.	Total Hrs.
January	1,386	389	1,775	-	-	656	314	970	768	340	1,108	1,920	1,495	3,415
February	1,344	348	1,692	1,139	1,139	704	324	1,028	768	346	1,114	1,920	659	2,579
March	1,456	951	2,407	2,072	2,072	576 6/	292	868	823	600	1,423	1,856	1,443	3,299
April	1,456	956	2,412	2,149	2,149	528	219	747	832	472	1,304	1,848 6/	1,193	3,041
May	656 5/	347	1,003	6,985 5/	6,985	456 6/	214	670	864	582	1,446	1,344 6/	1,515	2,859
June	432 5/	263	695	6,210 5/	6,210	256 6/	177	433	832	613	1,445	1,584 6/	1,602	3,186
July	320	57	377	290	290	176 6/	131	307	640	198	838	1,744	554	2,298
Total	7,050	3,311	10,361	18,845	18,845	3,352	1,671	5,023	5,527	3,151	8,678	12,216	8,461	20,677

Month	Steward's Department			Engineers4/			Oilers, Wipers, Firemen, Water Tenders			Summary		
	Reg. Hrs.	O.T. Hrs.	Total Hrs.	Reg. Hrs.	O.T. Hrs.	Total Hrs.	Reg. Hrs.	O.T. Hrs.	Total Hrs.	Reg. Hrs.	O.T. Hrs.	Total Hrs.
January	2,304	586	2,890	2,112	992	3,104	2,112	737	2,849	11,258	4,853	16,111
February	2,304	886	3,190	2,112	688	2,800	2,112	650	2,762	12,403	3,901	16,304
March	1,894 6/	1,355	3,249	2,224	1,665	3,889	2,024	1,143	3,167	12,925	7,449	20,374
April	2,184	1,355	3,539	1,848 6/	900	2,748	1,792 6/	1,225	3,017	12,637	6,320	18,957
May	1,928 6/	558	2,486	2,160	1,174	3,334	2,112	989	3,101	16,505	5,379	21,884
June	1,888 6/	370	2,258	1,768	990	2,758	1,980	1,214	3,194	14,950	5,229	20,179
July	1,936	535	2,471	1,936	548	2,484	1,936	330	2,266	8,978	2,353	11,331
Total	14,438	5,645	20,083	14,160	6,957	21,117	14,068	6,288	20,356	89,656	35,484	125,140

1/ Regular hours--hours of time paid for at base rate.

2/ Overtime hours--in case of cold storage crew, these are additive to regular 8-hour day. With ship's crew, overtime hours may coincide with regular base pay time.

3/ Includes 2 men for customs guard and accounting services. Does not include persons hired for other departments. Breakdown on overtime not available but estimated at approximately 15 percent.

4/ Neither the captain, manager or bookkeeper is included since they are not subject to overtime. The chief engineer is included in regular time but not overtime.

5/ Most of the cold storage crew hired in the United States left the ship and they were replaced with Costa Ricans.

6/ Part of the crew left the ship.

7/ Some of the overtime for the sailors is in dispute as to category but the 8,461 hours listed includes 3,537 overtime hours on ship duties and 4,724 hours overtime for handling cargo.

minimum, and the types and sizes of mechanical equipment should be standardized where possible to minimize the number of watches and the problems of maintenance.

On the Pacific Explorer, four separate groups of watches must be maintained in the boiler, main-engine, Diesel-electric and compressor rooms. It might be advantageous to locate the refrigeration machinery in a deck house to avoid the need for an elaborate system of ventilation. If possible, storage space should be provided for supplies of water and fuel oil adequate for the needs of the entire operation and an automatic type of potable water evaporator, utilizing a direct source of heat or waste exhaust gases, should be incorporated for emergency use. Since sea water is largely used for bathing and galley purposes in the tuna fishing fleet, similar practices on receiving ships should be acceptable. Such an arrangement would greatly reduce the requirements for potable water and the consequent dependence on supplies from foreign nations.

The mess rooms should be adjacent to the galley and the number should be held at a minimum to reduce the load on the mess personnel. On the Pacific Explorer, agreements require the operation of four mess rooms for the tuna operation. The living quarters should be concentrated in one section of the ship and distinctions in rank should be avoided in order to localize and diminish the need for services. Adherence to these general observations should minimize the amount of work required to perform the prime objective of a receiving ship which is to handle fish and to render the necessary allied services.

Working Agreements

The working agreements on tuna receiving ships should be made with the unions regularly supplying men for the fishing industry. Men from these various groups should be more desirable as they are skilled in all the phases of the fishing industry, including navigation; catching, handling, and preserving fish; operation and maintenance of equipment; and they are, in addition, sympathetic to the ultimate purposes of a receiving ship operation. Compensation on a share basis is common practice on fishing vessels and such an arrangement might well be to the advantage of all concerned on an efficient and well managed receiving ship.

If the vessel is in the inspected class, the working agreements will have to be made with the maritime unions. The operation and structure of the ship must comply with more stringent maritime regulations and maritime union agreements, which are unnecessary for the type of service. Even when the Pacific Explorer was at anchor and cargo was being handled, a security watch was maintained. The mates were theoretically charged with the supervision of the cargo loading operation but actually the specialized operation below deck was under the supervision of the cold storage foreman. The chief duties of the mates when the ship was on the fishing grounds consisted of patrolling the ship and occasionally supervising the sailors. An extra man was even required to record the weights. The engine room crew of the Pacific Explorer consisted of 22 men, whereas 6 to 10 men should be adequate to operate the mechanical equipment on a somewhat smaller vessel having only Diesel engines and a simplified system of refrigeration.

Movement of Materials

Prospective operators of receiving ships should devote considerable thought to improving the methods of handling tuna and the consequent cost of this phase of the operation. A practical immediate improvement on the Pacific Explorer would be the use of a conventional electrically-powered, inverted L type of hoist or a boom located near the rail of the ship to avoid the use of the typical steam winch and schooner type of gear. The need for a signal man could be avoided, and the electrical motors should place an additional responsibility on only the electrician and possibly a Diesel engineer instead of the four men in the engine department as when steam winches are used. It would be advantageous to land the tuna on a grading table and devise some efficient means of directing the fish to the freezers and the storages. The use of a grading table would permit weighing the fish after, rather than before, they have been dumped on the ship and would speed up the transferring operation.

The freezers on receiving ships should be advantageously located with respect to the storages and have capacities in relation to the volumes of the respective storages to avoid unnecessary movement of the tuna. If the tuna are to be frozen dry, it might be advantageous to locate the freezers on the shelter deck and between hatches. The use of reversible-travel conveyors with fixed or hinged ends may offer advantages in the movement of tuna through such freezers. If the freezers are located below deck, a system of conveyors or chutes should be utilized to direct the tuna to the freezers. Perhaps a winch and boom could be used to deliver the fish from the deck of the fishing vessels to the freezers if the layout of the selected ship permits such an arrangement. The use of conveyors or inclined chutes are quite acceptable for moving fish from the freezers to the storage rooms, but in some installations it may be advantageous to truck fish into the freezers. If the height of the storage compartments is above a convenient working level, the use of a variable-incline portable conveyor will be of marked advantage in the stacking of tuna for dry storage.

Fishing Fleet

The operators of receiving ships should utilize a balanced fishing fleet of both purse seiners and live bait boats to stabilize the rate of production. If bait is readily obtainable and the tuna are biting well, the bait boats will be consistent producers. If either of these conditions change, the production by the bait boats will be erratic. The purse seiners will catch large quantities of tuna if the schools are sufficiently quiescent. Schools of yellowfin tuna can be captured more readily if they are accompanied by skipjack or porpoise. When other conditions prevail, the purse seiners may find it difficult to catch yellowfin tuna.

Future Considerations

The operators of tuna receiving ships should plan to develop ultimately a truly high seas fishery. The receiving ship and its allied fishing fleet should be capable of long range operations, be able to effectively transfer tuna and supplies on the high seas, and be developed with the idea of having eventual freedom from the regulations of foreign governments. Since there is reason to believe that the tunas are distributed over much of the tropical waters of the Pacific Ocean, thought should be given to the development of methods for eventually utilizing these areas in addition to the more efficient utilization of the tuna fishery off the Americas.

Regardless of the type of gear or vessels that are used, transferring tuna in the open ocean during adverse conditions of weather is a problem which must be solved. If any type of container is used to effect the transfer, various undesirable conditions will be encountered. The transferring operation will necessarily be intermittent and may be unduly expensive if the tuna are difficult to remove from the fish holds. Rigid containers such as boxes or tubs may be dangerous to the fishing crews or may damage the equipment on the vessels. While rope slings are expected to cause damage to unfrozen tuna, they should be suitable for transferring frozen fish. Reinforced canvas slings are preferable to rope slings. The useof any type of container necessitates an intermittent and careful operation of the winches and lifting gear, which will be time consuming and consequently disadvantageous.

Some flexible and continuous method of unloading should be devised. On special purpose factory ships, the whales are customarily dragged up an incline in the stern. The principle of such an incline might be incorporated by a recess in the side of a receiving ship which could accommodate a movable inclined conveyor that could be supported mutually by the ship and the fishing vessel after the latter is moored alongside. Perhaps a vertical conveyor, recessed in the hull of the ship for protection, and fitted with an unloading hopper may be practical. If the freezers are located below deck, a conveyor capable of being extended to the moored vessel through a watertight door in the side of the ship may be feasible and acceptable. Sardines are readily transferred by means of pumps in the fishery out of Monterey, California, and similar methods have been successfully used by the floating reduction plants out of San Francisco. Most of the cargo of canned salmon was successfully salvaged from the sunken M.S. Diamond Knot[1] by the use of venturi principle siphon pumps. Modifications of this type of equipment might be applicable to the transfer of tuna but large and bulky equipment would be necessary to handle the tuna.

The operators of receiving ships should develop their technique to achieve independence from regulation by foreign governments. The present live-bait tuna fishery is mainly dependent upon supplies of bait taken from the waters of bays under foreign jurisdiction. If the receiving ships are dependent on tuna caught by this method of fishery, the ships can be brought indirectly, if not directly, under the jurisdiction of foreign governments. They will then be subject to local

1/ Shipwrecked salmon, Anonymous, Pacific Fisherman 45, No. 13, 35, December 1947.

taxes and other regulations which will be disadvantageous. Further, the tuna purchased in foreign waters may be considered as an import cargo and subject to additional regulations when it is landed in the United States. No supplies of suitable live bait are known in the present area of our high seas tuna fishery, and explorations to find such sources might well be of a "long shot" nature. Vast quantities of oceanic anchovies are known to exist off Peru but these waters are beyond the present area of our fishery. The exploitation of this area might be practical for a receiving ship operation. However, if truly high seas receiving ships are to be dependent on tuna caught by bait methods, a different technique or even different methods of fishing may have to be developed. These also will require extensive research. The purse seine technique for catching tuna is becoming increasingly effective and is not dependent on supplies of bait under foreign jurisdiction.

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