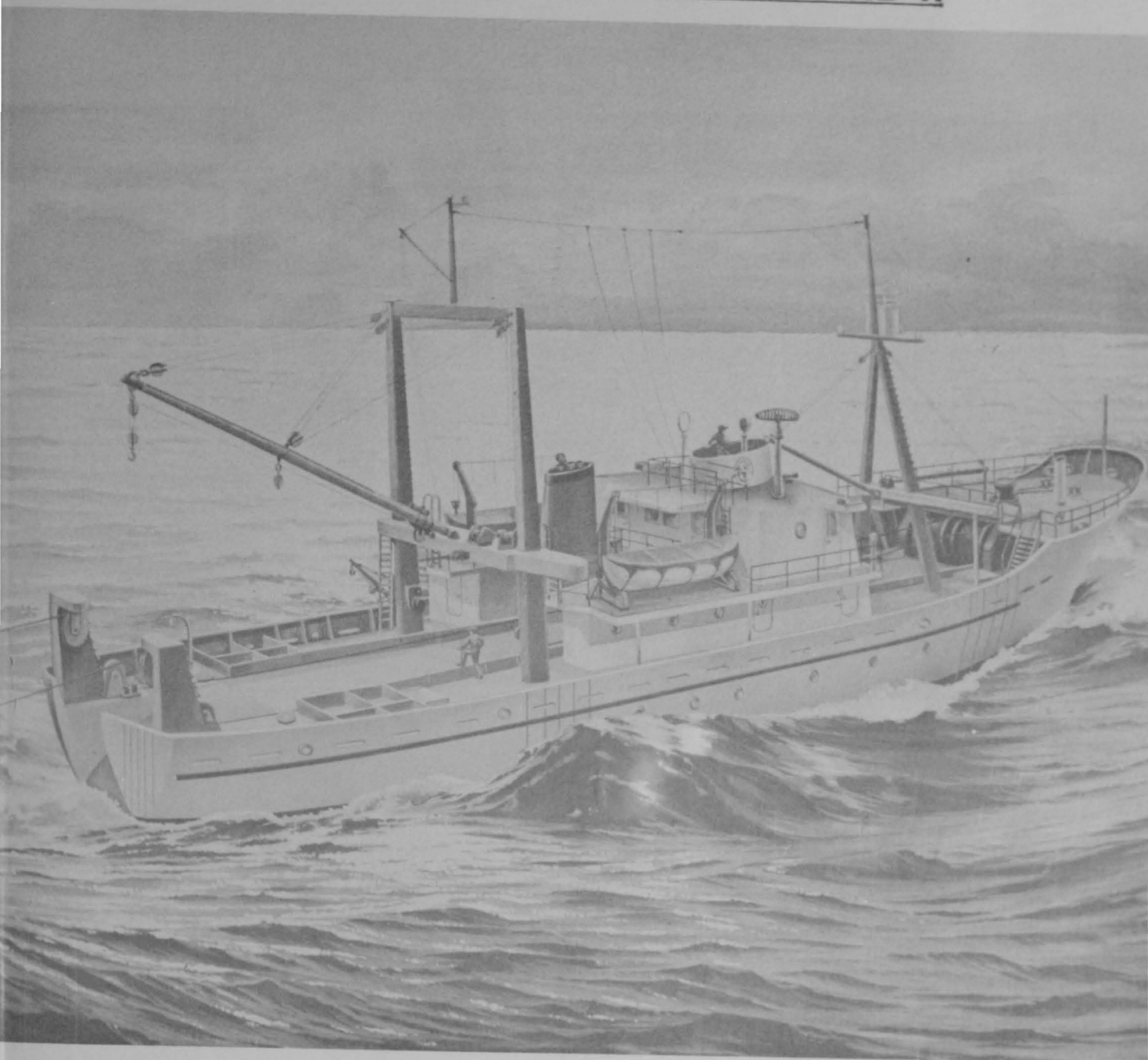
DESIGN OF THE MV DELAWARE II



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

Circular 273

Design of the MV Delaware II

By

UNITED STATES DEPARTMENT OF THE INTERIOR
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ABSTRACT

This exploratory fishing and gear research vessel of the Bureau of Commercial Fisheries was designed as a stern ramp trawler of 155.5 feet length overall and is under construction in South Portland, Maine. Delivery is scheduled for spring 1968. The new vessel will be operated by the Exploratory Fishing and Gear Research Base at Gloucester, Mass. Special efforts were made to design an efficient stern trawler with a mechanized trawl handling system. The design provides capability for side trawling, clam and scallop dredging, longlining, gill netting, and purse seining as well as for handling experimental fishing units and systems. The vessel will be powered by a 1,000-hp. diesel engine. The designed service speed is 12.5 knots, cruising radius is 8,000 miles, and the capacity for sustained operation at sea is 30 days.

INTRODUCTION

The MV Delaware II is a 155.5-foot stern trawler now under construction as an exploratory fishing and gear research vessel and a prototype demonstration, medium-size stern trawler. The vessel was designed to be a versatile platform for performing a wide variety of fishing and research tasks.

George G. Sharp, Inc. of New York City,[1] naval architects and marine engineers, executed the contract design and specifications for the Delaware II. It is being built by the South Portland Engineering Co., South Portland, Maine, and is scheduled for delivery spring 1968. The vessel was conceived and planned to replace the MV Delaware, which is now the principal research vessel of the BCF (Bureau of Commercial Fisheries) Exploratory Fishing and Gear Research Base, Gloucester, Mass.

The Delaware (fig. 1) was designed and built in 1937 as a typical large, commercial, steel otter trawler or "beam trawler." She has a length overall of 148 feet, a beam of 27 feet, and a total displacement (ready for sea) of about 350 tons. The main engine is a 735-hp., 260-r.p.m. diesel, which is coupled directly to the propeller shaft. Accommodations for 23 men are available, of which 13 to 17 are crew members (depending upon the type of work to be undertaken during each cruise). The scientific party usually is 2 to 4 people.

[1] Mention of trade names is for identification only. No endorsement of specific service is implied.

The new vessel, Delaware II, was designed to take over all functions of her predecessor and to have additional facilities for research, exploration, and demonstration that were impossible in a commercial "conversion" such as the Delaware.

Duties of the Delaware II are, simply stated, (1) exploratory fishing, (2) gear research, (3) demonstrations of methods and gear, and (4) gathering of biological, chemical, and physical oceanographic data pertinent to fisheries.

Exploratory fishing is the search for new stocks and unutilized species of fish and shellfish. The search involves systematic coverage of the sea bottom, midwater, and surface zones with many specifically designed commercial-scale harvesting and sampling tools. These include otter trawls, midwater trawls, rakes and dredges, purse seines, and longlines. The Delaware II will explore waters off the North Atlantic States (Virginia to Maine) and international waters off eastern Canada as far east into the Atlantic as is in the interest of the United States commercial fishing industry. For this type of work, the vessel must be adaptable to several types of gear, be capable of self sustenance for moderately long periods at sea in all types of North Atlantic weather, have an operating range of several thousand miles or several weeks, and provide a desirable ratio of scientific-technical to vessel operating personnel.

Figure 1.--The Delaware.

Gear research involves the devising, development, adaptation or adoption, and testing of new or foreign (to the area) commercial harvesting devices. Vessel requirements for gear research are exacting. In addition to providing a stable platform, the vessel must be capable of maintaining a wide range of speeds under varying load and towing conditions and must provide a variety of auxiliary machinery including large electric generators, high-pressure water pumps, and hydraulic control and transmission systems.

To demonstrate gear and methods adequately and understandably, the vessel deck layout must closely resemble that of a commercial fishing vessel so the results will be directly applicable to present fishing operations. The deck layout of Delaware II is readily adaptable to commercial use.

Certain biological, physical, and chemical observations must be made during fishery explorations. Support facilities must, therefore, include an adequate and stable power supply for operation of an ever-increasing array of electronic devices for fixing position, detecting fish, mapping the bottom, measuring temperature and salinity, and for measuring the configurations, stresses, and attitudes of the gear. Special winches, hoists, and power systems are necessary for handling sampling equipment. Laboratory spaces are needed for analyses of fish catches and processing of environmental samples.

All these features are provided for in the design of Delaware II, which should be a modern, up-to-date, specialized exploratory fishing and gear research vessel.

DESIGN FEATURES OF THE MV DELAWARE II

Design studies for the Delaware II were initiated without preconceived ideas or any prior commitment as to its size or type. A Vessel Design Committee of the Exploratory Fishing and Gear Research Base at Gloucester, Mass., formulated the major features of the vessel from a schedule of operational requirements based upon plans and aims of the long-range work programs of the Base. Before deciding upon the general type and size of vessel to be built, the Committee worked out, in conference with the naval architect, several preliminary designs, which were then reviewed by Bureau and private experts in fishing and research vessel operation.

As an exploratory fishing vessel in the Northwest Atlantic Ocean, the Delaware II had to be designed to fish effectively with otter trawl gear. The fisheries for groundfish (cod, pollock, haddock, and flounders), industrial fish, hakes, ocean perch, scup, and

others that constitute the otter trawl fishery produce 44.9 percent of the tonnage of the fish landed and 31.5[2] percent of the dollar value in BCF Region III (Maine through Virginia). Because of the trend among other major fishing nations to construct new stern-ramp trawlers and the demonstrated advantages of this type of vessel, the Committee decided early in the design study that the Delaware II should be primarily a stern-ramp trawler (see section on trawling).

The decision to build a stern-ramp trawler was not made hastily, however. As part of the Design Committee's study, I toured European fishing ports and made fishing trips on several European stern trawlers. The relative merits of various design features were considered carefully in conferences with naval architects and research vessel operators in Europe and the United States. As a result BCF decided that the new ship, as a modern research vessel for experimental fishing, must have the most efficient trawling method, which could best be achieved by a properly designed stern trawler. Capability for side trawling in the conventional manner, however, was also included in the design.

The program of exploratory fishing and fishing gear research in the North Atlantic region obviously must include, in addition to trawling, the use of several additional fishing methods--longlining for large pelagic fishes such as tunas and swordfish; bottom dredging for sea clams, scallops, and other shellfish; and gill netting for pelagic and bottom dwelling fish. The importance of purse seines in Region III waters for taking menhaden, herring, mackerel, and tunas made it essential that the research vessel also be able to handle this gear efficiently. The final design can use any of these gears, with only a minimum rearrangement of the vessel's deck gear and equipment.

Trawler Facilities and Operation

Prime capability of a large otter trawler designed into vessel.--After deciding that the vessel was to be a stern trawler, the Committee made special efforts to design a highly efficient stern-trawling system. Experience, study, and observations of other vessels had indicated strongly that one of the major advantages of a stern trawler, possibly the chief justification for the stern-trawling method, is ability to bring the trawl with its catch aboard in the shortest time and with the least labor. To achieve this advantage, the Committee decided that sufficient space should be available on the deck of the Delaware II to haul the trawl aboard in one continuous pull without taking successive hitches on the trawl's body and successive hoists to pull sections of the trawl board.

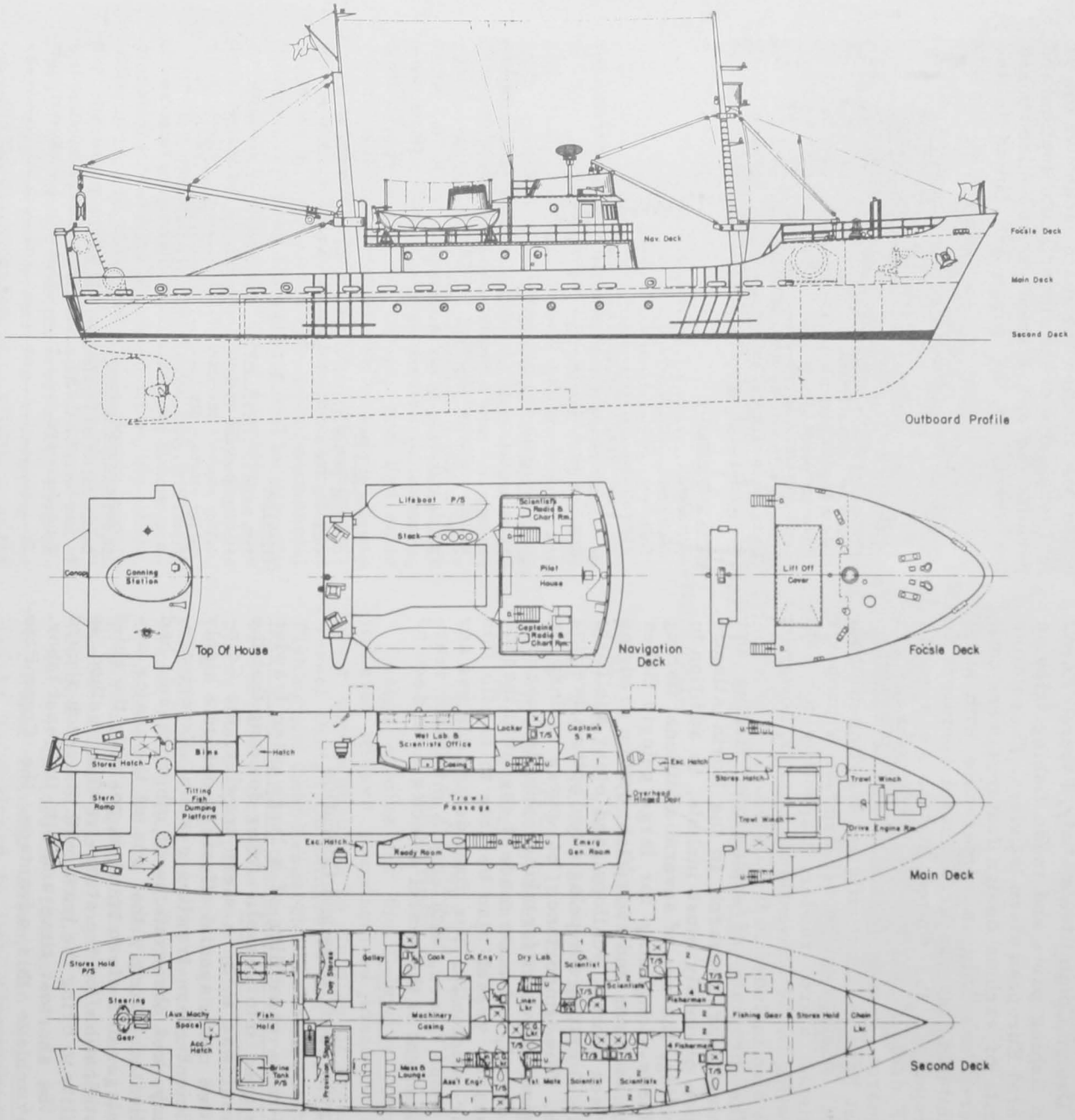
To achieve this aim, it was necessary to use almost the entire length of the 156-foot vessel (fig. 2 and table 1). A trawl passage or ramp was designed along which the trawl can be pulled from the position of the chute at the stern to the position of the trawl winch at the bow of the vessel. This ramp passes underneath the pilothouse and through the main deckhouse for 99 feet (exclusive of the sloped chute section) and permits the entire trawl to be hauled aboard the vessel as the wings are pulled to the

Table 1.--Design characteristics of Delaware II[1]

Dimensions:	
Length overall, including stern gate	155.5 feet
Length on load waterline	140.0 feet
Length between perpendiculars	132.0 feet
Breadth, molded	30.0 feet
Scantling draft, molded	11.5 feet
Depth to main deck at side, amidship	19.5 feet
Depth to second deck, amidship	12.0 feet
Normal Complement:	
Officers	2
Deck crew	8
Engineers	2
Steward/Cook	1
Assistant cook	1
Scientific party	6
Total on board	20
Speed, Power, and Fuel Consumption:	
Sea speed, sustained	12.5 knots
Maximum continuous horsepower	1,000 hp.
Maximum continuous propeller revolutions per minute	250
Fuel consumption, at sea (at cruising speed)	60 gal. per hour
Endurance at Sea:	
Cruising radius	8,000 miles
Capacity for sustained operation	30 days
Capacities:	
Fish hold	1,600 cu. ft.
Fishing gear and bosun's stores	3,700 cu. ft.
Galley stores - refrigerated	215 cu. ft.
Galley stores - dry	500 cu. ft.
Diesel oil	39,000 gal.
Fresh water	7,000 gal.
Displacement and Tonnages:	
Design full load displacement (at full load draft)	680 short tons
Total deadweight	180 short tons

[1] Capacities and values of "Characteristics" are estimates based upon contract design data. Final values will be established from shipyard construction plans, sea trials, and "inclining" tests.

[2] Catch and value from Fishery statistics of the United States, 1964, by Charles H. Lyles. U.S. Fish Wildl. Serv., Statist. Dig. 58, 541 p.



PRINCIPAL DIMENSIONS

Length Over All (approx.)	155'-6"
Beam	30'-0"
Depth To Main Deck (at side amidship)	19'-6"
Design Draft (amidship)	11'-6"

Figure 2.--General arrangement of Delaware II.

winch. The cod end with its catch is hauled up the chute to the fish dumping position at the stern of the vessel. The otter boards are hauled to gallows at the stern of the vessel and are detached from the trawl-warp-groundrope-bridle assemblies prior to hauling these assemblies and the trawl wings up the stern chute.

A versatile high-powered trawl winch specified.--This winch has a capacity for 2,000 fathoms of 3/4-inch diameter wire rope on each of its two drums and is powered by a 227-hp. diesel engine driving through a high-pressure, positive displacement, variable speed hydraulic system. The winch will be operated from a control station located at the afterend of the pilothouse where the operator has full view of all operations on the afterdeck. Each of the two drums will have a maximum line pull of 20,000 pounds at a speed of 135 feet per minute, and of 4,000 pounds at 650 feet per minute. The operator can adjust the trawl winches to any speed, from 0 to 650 feet per minute (table 2).

Table 2.--Specified performance data (per winch drum at average drum depth)

Line pull	Average line speed
Pounds	Feet per minute
20,000	135
16,500	150
12,000	220
6,000	450
4,000	650

The winch, with its fine control, very high maximum speed, and high power, will facilitate hauling the trawl warps and landing the trawl aboard the vessel in minimum time.

Capability for side trawling included in design.--Gallows for side trawling are provided as extensions of the boom tables fore and aft at the starboardside of the vessel. By means of portable lead blocks, wires from the trawl winches can be led to hanging blocks positioned on these two gallows for handling trawl doors and the trawl at the side of the vessel. A specially wide passage is provided on the starboardside of the vessel, free of any obstructions, to allow hauling a trawl along the starboardside in a fashion similar to that used aboard conventional side trawlers. This capability for side trawling was included in the design for two reasons:

1. Because there are still differences of opinion in the United States on the relative merits of stern trawlers and side trawlers, tests of the two methods aboard a single vessel are desirable. Such a testing program should help settle the controversy over side trawlers versus stern trawlers for operation in the northwest Atlantic waters.

2. This arrangement enables BCF to operate two or more types of fishing gear on a cruise and to make a rapid changeover from one method to another between cruises. For example, purse seine or longline gear could be handled from the stern of the vessel while the vessel was rigged for fishing with a midwater trawl from the side. Alternately, longline fishing gear could be handled at the starboardside of the vessel without disturbing midwater or bottom trawling gear handled in the normal manner through the trawl passage and stern chute.

Longlining Operation

An excellent arrangement for handling floating (pelagic) or anchored longline fishing gear is achieved by the open deck forward of the deckhouse, the open stern, and the smooth continuous passage through the house that connects the two deck areas. Such gear can be most readily hauled aboard the vessel in the forward well-deck of the vessel where the operation is in full view of the helmsman. Space is available for power hauling units of the Japanese hauler-coiler type, powered reel and detachable gangion type, split sheave type, or others that might be developed. Adequate power is available for such units from either the auxiliary hydraulic system or the ship's service electrical system.

The trawl passage is an ideal space for assembling the longline gear as it is hauled aboard in preparation for a new set (it could also be assembled in the space to the left of the trawl passage, on the forward deck, or on either side of the trawl passage aft). To set the gear, the mainline will be run aft through the trawl passage and out through the stern chute into the water as the vessel moves ahead. The long trawl passage and afterdecks provide excellent space for attaching branchlines (gangions), marker buoys, and floats, whether accomplished by automatic device or manually.

Purse Seining Arrangement

The vessel can be readily converted for purse seining. The deck arrangement of the Delaware II is similar to that of a large tuna seiner when the gallows, which are portable bolt-on units, are removed. The wide expanse of open afterdeck reaching to the stern, characteristic of a purse seiner, is broken only by the stern chute through which a seine can pay out as smoothly as a trawl. A long sturdy boom, capable of hoisting a 5-ton load, is provided for attachment of a power block, and an auxiliary,

medium-pressure (1,300 pounds per square inch working pressure) hydraulic system of 85-hp. capacity is available for driving the power block and accessory hoists. Provision is made just forward of the after kingpost for installing a portable purse seine winch that will be powered by the 227-hp., high-pressure hydraulic system of the trawl winch. Alternatively, the drums of the trawl winch can be used for pursing the seine through properly positioned lead blocks. Because of the "free wheeling" gear position or powered payout feature of the winch drums, purse lines can be payed out freely as required for purse seine sets.

Gill Netting

Gill nets are most easily set over the stern of a vessel as it moves ahead at low speed and are most efficiently hauled at the bow as the vessel "runs up" on the nets. The Delaware II is well suited to both operations. The stern trawl chute provides an excellent exit passage for nets as they are payed out into the water; the deck space forward of the pilothouse is ideal for hauling gill nets with a power hauling device. In preparation for successive sets, the gill nets can be stowed in the trawl passage. Fine control of the propulsion plant to provide a universal, stepless range of speeds from 0 to 12 or 13 knots will be a particular boon to smooth handling of such gear as gill nets and longlines.

Other Gear

In addition to the above-mentioned fishing gear units and systems, the vessel will be well equipped to use clam and scallop dredges and stationary gear such as fish traps and pots.

With its twin (forward and aft) open deck layout, its power reserve, and two separate auxiliary power systems, the Delaware II will be well equipped to handle all standard open-water fishing equipment and a wide variety of experimental units. To meet all projected needs, multiple hoists and winches are available to best advantage around the vessel.

SPECIAL RESEARCH VESSEL FEATURES

The Delaware II has specially designed and equipped laboratories, hydrographic boom and winches, scientist's radio and chartroom, pilothouse, and personnel accommodations.

Laboratory Spaces

The fish laboratory is in the after portside of the deckhouse near the area where trawl catches are landed. The laboratory has a 20-foot long stainless-steel counter and sink assembly on the outboard side and a second sink on the inboard side. Sinks have hot and cold fresh-water and salt-water faucets. Cabinets are above counter tops, and banks of shelves and drawers are below. Samples of fish catches will be examined and records of catches will be made here. Facilities and spaces are provided to preserve and store specimens for further study by scientific specialists ashore. Special racks and storage spaces are provided for bathythermographs, Nansen bottles, reversing thermometers, and miscellaneous hydrographic equipment.

On the second deck just forward and below the fish laboratory is a second or dry laboratory, which has a drafting-plotting table, a sink, and cabinets. The dry laboratory can be used also as a darkroom for photography and kinescope recording from an underwater television monitor.

Articulated Hydrographic Boom and Winches

The hydrographic boom is on the portside just aft of the fish laboratory. This is a hydraulically operated "articulated" boom that can be raised and lowered (topped) by an hydraulic ram and rotated 360° by an hydraulic motor and worm-gear drive. Thus, the tip of this boom can be rotated inboard and lowered to the vessel's rail for attachment of the various hydrographic devices and then swung outboard for lowering and hoisting. Wire ropes from the bathythermograph and hydrographic winches will pass through sheaves at the end of this boom. An operator will be able to attach, lower, and hoist hydrographic instruments from the control point at the aft end of the fish laboratory.

The hydrographic winch specified is hydraulically powered from the auxiliary hydraulic system. It is capable of stowing 12,000 feet of 5/32-inch wire rope and hauling in 300 feet per minute at a line pull of 1,200 pounds. It will haul also a light line (at 100-pound pull) at 600 feet per minute.

Scientist's Radio and Chartroom

A special scientist's radio and chartroom is on the pilothouse deck on the portside opposite the captain's radio and chartroom. This provides the essential space and facilities required for organization and direction of cruise operations by the chief scientist. Experience has established the importance aboard research vessels for such a properly equipped space, separate from that used for navigation of the vessel.

Pilothouse

The pilothouse has adequate space and power supply for proper placement and installation of present and future controls and navigation

and instrumentation facilities. The automatic steering console is forward amidships. Included also in this console are propulsion engine controls, indicator dials, and an engine order telegraph. The engine order telegraph system is an auxiliary or "backup" system to the automatic pilothouse control unit.

Navigation instruments include (1) magnetic compass with autopilot, (2) electromagnetic speed and mileage log, (3) depth sounder, (4) radar, (5) radio direction finder, and (6) two loran "A" receivers.

Scientific and special fishing equipment included are (1) ASDIC echo-ranging sounder and (2) white line sounder.

A winch control station is on the centerline at the afterend of the pilothouse. The operator at this station controls the main trawl winch, the hoist and topping-slewing winches for the main boom, and the net tackle winch on the afterdeck of the vessel (fishing deck). From this position he has a clear view of all fishing operations and can also speak directly to the helmsman. The machines controlled here are all those normally used in trawling.

Personnel Accommodations

Special effort was made during design of the Delaware II to provide comfortable and convenient accommodations for all personnel aboard the vessel. Four staterooms for a scientific field party of up to eight persons are on the second deck. Individual staterooms are provided for the captain and chief engineer. Others of the ship crew will be berthed in two- or four-man staterooms. Each room has a deadlight for daylight and an adjoining toilet and shower room. All personnel spaces are serviced by a central air-conditioning and heating system.

PROPULSION SYSTEM

Although a diesel engine of 1,000 hp. continuous rating was specified for propelling the Delaware II, a 12 cylinder V-type engine of 1,200 brake hp. continuous rating (by manufacturer) was purchased by the builder. The manufacturer who was chosen to supply the engine builds 800- and 1,200-hp. engines but does not build 1,000-hp. units; the next larger size was, therefore, selected. Consequently, the vessel should be able to maintain its designed sustained speed of 12.5 knots with a conservative load on the main engine, which will be governed to deliver a maximum of 1,000 hp.

Several types of speed reduction-shaft-propeller arrangements were studied, including gear reductions, electric drive, and controllable pitch propellers. The selected unit is a two-speed reduction and reverse gear with a slip clutch. Propeller speeds of 100 to 250 r.p.m. are attained by speed control of the engine driving through the high-speed gear train. Further speed reduction, down to 40 r.p.m. is accomplished through the low-speed gear train. Propeller speeds below 40 r.p.m.--the propeller speed when the engine is at its lowest idling speed--are accomplished with an air-cooled slip clutch that is designed to operate with a continuous slipping at propeller speeds of 0 to 40 r.p.m.

A single lever in the pilothouse operates the pneumatic controls for gear shifting and speed control.

AUXILIARY-POWERED EQUIPMENT

The electrical system of the Delaware II will operate on 3-phase, 450-volt a.c., part of which will be transformed to 1-phase, 110-volt a.c. for lights and electronic equipment. This system permits use of simple 3-phase a.c. induction motors for power requirements and standard, off-the-shelf, alternating current equipment throughout the ship. Also, it will permit attachment to regular alternating current shore power lines when the vessel is at dockside. All galley equipment--cooking range, dishwasher, refrigeration--will be electrically powered.

Power will be supplied by two 150-kw. generators. As the maximum continuous electrical load designed into the vessel is under 115 kw., one generator will be able to carry the ship's load continuously and still have an ample reserve for installation of additional machinery. The electrical switchboard is arranged so that one of the generators (capable of 180 kw. continuously for 2 hours) can be attached to external loads such as electrical fishing equipment while the other carries the regular ship's load.

An emergency generator set of 10-kw. capacity is located in a special compartment on the main deck. If the main generator should fail for any reason, the emergency generator will automatically start and take over the electrical load of the following systems: emergency lighting, electro-hydraulic steering, propulsion control, and the electronics equipment for communication and navigation.

The auxiliary power is needed also for the hydraulic system, steering system, and refrigerated hold.

Central Hydraulic System (Hoists and Winches)

Two electrically driven pumping units of 60 hp. and 25 hp. drive the auxiliary hydraulic system that powers the deck hoists and winches other than the main trawl winch. Hydraulic fluid is pumped at 1,300 pounds per square inch working pressure to a common accumulator tank from which it is piped to

the various machines of the system. Machines driven by the auxiliary system are as follows:

Two winches provided for the forward 1-ton boom. The hoisting winch is capable of 2,300 pounds line pull at 85 feet per minute, and the topping winch 1,200 pounds at 85 feet per minute.

The aft 5-ton boom has three winches. Two topping winches operate the double topping lift attached to each kingpost. These winches, capable of 4,600 pounds line pull at 100 feet per minute, are used to raise and lower the boom and swing (slew) it from side to side. They are controlled remotely from the winch control position at the afterend of the pilothouse. The hoisting winch at the base of the boom is capable of 3,700 pounds at 100 feet per minute.

A net tackle winch is on the cross-platform between the after kingposts. This is capable of a line pull of 8,500 pounds at a speed of 100 feet per minute.

Three deck capstans are provided. One is deck mounted on a stand on the portside of the forward deck and two are on the inside surface of the after kingposts. These have double "stepped" winch heads of 12-inch and 24-inch diameters. Maximum line pull of the 12-inch head is 5,500 pounds at 50 feet per minute and of the 24-inch head is 2,750 pounds at 100 feet per minute.

A power block can also be driven from the 85-hp. auxiliary hydraulic system. This will be mounted at the tip of 5-ton boom aft (fig. 2).

The stern closing gate, which is a section of the trawl chute deck, is opened and closed by hydraulic rams operating from the central hydraulic system. When closed, the gate fits flush to the top of the stern bulwark and forms the center section of the transom.

The hydrographic winch and davit are operated hydraulically and controlled locally. The winch has a capacity of 12,000 feet of 5/32-inch wire and has a line pull of 1,200 pounds at 300 feet per minute. The davit is topped by an hydraulic cylinder and rotated by an hydraulic motor.

Steering System

The vessel will be steered by an electro-hydraulic power steering system that is coupled to a magnetic compass autopilot unit to provide automatic steering on a set course. For emergency steering in the event of power failure, the system will automatically revert to manual steering.

Fish Hold

The 1,800 cu. ft. fish hold is forward of the fish dumping platform. Access hatches are just forward of the fish sorting bins on the main deck. This space holds about 80,000 pounds of iced fish or 100,000 pounds of frozen fish.

The hold is to be insulated and have an extremely flexible refrigeration system. The entire hold can be refrigerated by blast freezer units, or refrigerated coolant (brine or propylene glycol) can be circulated in dip tanks or containers for fish freezing experiments. The coolant fluid will be circulated selectively to the blast freezer unit for general cooling of half the hold or the entire hold, or it can be used to cool individual portable containers in the nonrefrigerated hold. The refrigeration machinery is designed to cool the entire hold to -10° F. when holding only. It will be capable of freezing 500 pounds of fish per hour in the dip tanks. The system is to be powered by electric motors driving Freon 12 refrigerant compressors. Two fish-freezing tanks, 4 by 4 by 6 feet high of 3/16-inch steel plate with epoxy coating, will be provided also.

CONSTRUCTION

On May 22, 1964, a contract for construction of the Delaware II was awarded the South Portland Engineering Company, South Portland, Maine. Delivery of the completed vessel was scheduled for January 1, 1966. During the winter of 1964-65, hull sections of the vessel were fabricated inside a large building of the shipyard; these were to be moved to an outdoor dry dock for final assembly. On May 5, 1965, fire consumed the building housing the partially completed hull sections and destroyed all construction completed to that date. The contract for the vessel was reactivated on April 30, 1966, and delivery of the Delaware II is now scheduled for approximately March 15, 1968.

MS. #1705

GPO 929.233