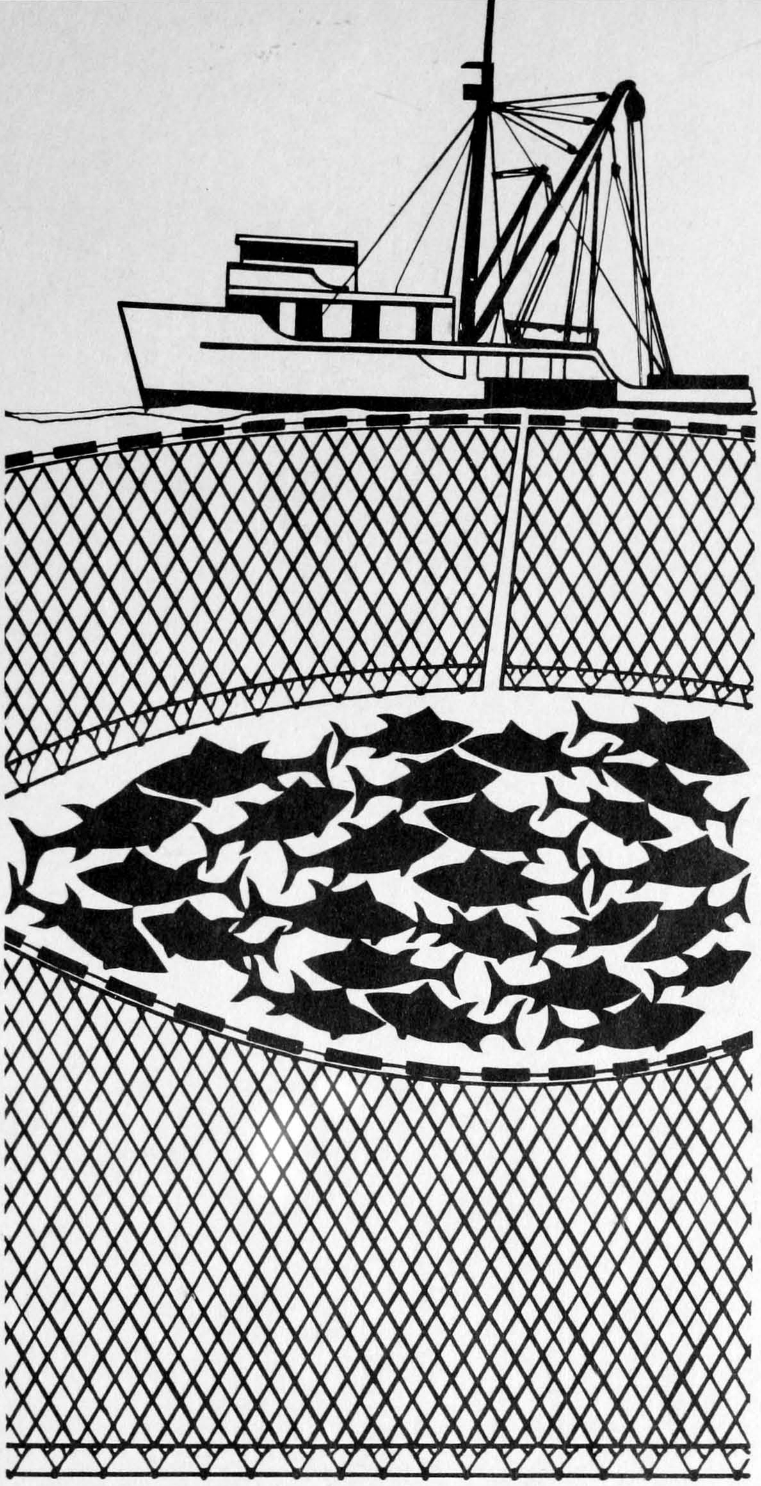

FISHERY INDUSTRIAL RESEARCH

VOLUME 4 NO. 3

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FISHERY INDUSTRIAL RESEARCH
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Created in 1849, the Department of the Interior—a department of conservation—is concerned with the management, conservation, and development of the Nation's water, fish, wildlife, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and Territorial affairs.

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EFFECT OF SPECIAL HANDLING OF HADDOCK ON THE POSTIRRADIATION SHELF LIFE OF HADDOCK FILLETS

by

Vincent G. Ampola and Louis J. Ronsivalli

ABSTRACT

Improved techniques for handling eviscerated haddock after capture resulted in superior quality of the fish prior to irradiation and a significant extension in the post-irradiation shelf life of fillets cut from them.

INTRODUCTION

Numerous studies indicate that the use of pasteurizing levels (less than 1 megarad) of gamma radiation promises to extend the shelf life of marine products. For example, Slavin, Steinberg, and Connors (1963) found that the shelf life of haddock fillets could be doubled or tripled by irradiating fillets at a dose level of 250,000 rads. To reduce experimental variables, the researchers normally used relatively fresh fish (1 to 3 days old).

Because a processor of radiopasteurized fish could not usually expect to obtain, commercially, fish that are only 1 to 3 days old, he needs to know whether or not this new method of preservation can apply to fish of commercial quality that might be a week or more out of the water.

For this reason, we determined how pre-irradiation quality of commercially handled haddock (ripped, gutted, and washed) affects the postirradiation quality of the fillets cut from these haddock. This work suggested it would be economically practical to radiopasteurize, at 250,000 rads, fillets cut from eviscerated haddock that had been held in ice up to about 9 days (Slavin and Ronsivalli, 1963). The work further suggested that better handling practices prior to icing and storage might significantly prolong the postirradiation shelf life of the fillets cut from the fish. We are reporting this latter observation, which has not previously been reported.

Author: Vincent G. Ampola, *Chemist*, and Louis J. Ronsivalli, *Supervisory Research Food Technologist*, Bureau of Commercial Fisheries Technological Laboratory, Gloucester, Massachusetts 01931.
Preprint No. 58, issued April 1968.

I. MATERIALS AND METHODS

Described in this section are the methods of preparing the samples and of making the organoleptic tests.

A. PREPARATION OF SAMPLES

Iced, freshly caught haddock (less than 36 hours out of water) undamaged by pitch fork were purchased from a local supplier and brought to the laboratory in ice. Some of the fish, which were chosen randomly, were filleted, and the fillets were washed, packaged in 1-pound cartons, plate frozen at −40° F., and then stored at 0° F. The rest of the fish were randomly divided into two groups: one group for commercial treatment; the other, for special treatment.

1. Commercially Treated Group

The commercially treated group was handled in the regular commercial manner (Slavin and Ronsivalli, 1963).

2. Specially Treated Group

The fish in the specially treated group were eviscerated and washed, and their gut cavities were manually cleaned of intestinal and liver remnants under running cold tap water; the gills of the fish were left intact. The belly cavities of the the fish were packed with flake ice to lower the body temperature rapidly, and the fish were carefully stored belly down (to permit drainage) in wooden boxes; each box contained about 125 pounds of fish. The fish were then covered with flake ice, and the boxes were placed in refrigerated storage at 42° F. The ice lost through melting was replenished at the top of the boxes as needed.

One lot of these specially handled haddock was taken from storage after 12 days. The fish were washed and filleted. The fillets were skinned, air packed in hermetically sealed C-enameled cans, and subjected to 250,000 rads from a cobalt-60 irradiator. After being irradiated, the cans were placed in storage at 33° to 35° F.

A second lot of the specially handled haddock was taken from storage at 14 days and was similarly processed and irradiated.

The fillets from both lots of fish were organoleptically tested concurrently with the fillets that were cut from the commercially handled haddock.

B. ORGANOLEPTIC TESTING

At periodic intervals after being irradiated, fillets were steam cooked and judged organoleptically by a 12-member panel experienced in the sensory evaluation of marine products. The samples were coded and randomized so that the panelists did not know the identity of either the irradiated samples or of the non-irradiated control. The steamed fillets were rated on a 5-point scale (5 = excellent, 4 = very good, 3 = good, 2 = fair, 1 = poor) for appearance, odor, flavor, and texture. These four characteristics were given equal weight in the analysis of the results, since we did not know what effect the relatively new process of irradiation or the length of refrigerated storage would have on each.

To determine product shelf life, we had to establish a fixed end point beyond which the product would be considered unsuitable for marketing. This point, an arbitrary one, was established on the basis of past experience. A panel average of 1.7 or less for an individual attribute or a panel average of 1.9 or less for the sum of the four attributes indicated that, although the product might still be edible, it was not of marketable quality, since fish receiving these scores showed signs of incipient spoilage.

II. RESULTS

The shelf-life times obtained are shown in Table 1.

The data support the hypothesis that better handling and icing techniques applied as soon as fish are caught will significantly improve the quality of the raw material for marketing in the round and will yield better quality fillets for the radiopasteurization process.

Table 1.—Postirradiation shelf life of fillets cut from commercial and specially handled haddock held in iced storage for different periods prior to their being processed and irradiated at 0.25 Mrads.

Handling method	Preirradiation iced storage period of haddock	Postirradiation shelf life (33°-35° F.) of fillets	Total holding time of fish and fillets
	Days	*Days*	*Days*
Handled in the ordinary commercial manner[1]	4	29	33
	6-7	28	34-35
	9	23	32
	11	12	23
	13	Spoiled (so not irradiated)	13
Handled specially	12	32	44
	14	14	28

[1] Data obtained from averages of three experiments as reported earlier by Slavin and Ronsivalli (1963).

In comparing the quality of the eviscerated fish prior to irradiation, we noted that the 12- and 14-day-old specially handled fish were of acceptable quality and that they warranted radiopasteurization, whereas the 13-day-old commercially handled fish had been spoiled (as indicated by the presence of ammonia, sulfides, and other compounds).

With respect to postirradiation shelf life, the fillets cut from the 12-day-old specially handled haddock had a total shelf life of 44 days, a period almost double the total shelf life of the irradiated fillets from the 11-day-old commercially handled fish.

SUMMARY AND CONCLUSION

Freshly caught eviscerated haddock, washed and manually cleaned of intestinal and liver remnants, were packed with ice and stored belly down in ice for 12 and 14 days. Irradiated fillets cut from these fish were stored at 33°-35° F. and organoleptically tested as were irradiated fillets cut from commercially handled fish that had been stored in ice for up to 11 days. The markedly longer postirradiation shelf life obtained from fillets cut from haddock that were specially handled prior to being stored in ice as compared with the shelf life of fillets from commercially handled haddock indicates that a direct economic advantage is to be gained in using, for the radiopasteurization process, haddock that have been given special handling and icing techniques after capture and prior to storage.

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MS #1765

SONIC SYSTEM FOR DETERMINING DISTANCES BETWEEN SELECTED POINTS OF AN OTTER TRAWL

by

Leon E. French, Jr.

ABSTRACT

Trawl gear is rigged with several sonic transducers connected to a shipboard recording-type echo sounder by means of a special cable. Trawl dimensions are recorded continuously and simultaneously under a specially calibrated scale.

INTRODUCTION

In fishing-gear research, accurate systems are needed for obtaining remote underwater measurements of otter trawls to determine their mechanical performance while in operation. Kristjonsson (1959) has reported that theoretical calculations are replacing trial and error in the development of fishing gear but that theoretical solutions must be checked against empirical knowledge and must be tested in the field before they are accepted.

Complete knowledge of gear performance can be obtained only by getting data systematically through the use of various instrument and observation techniques. Getting these data, however, is difficult, for many complex testing procedures are needed. The literature on this field is reviewed in the appendix.

The system of instruments reported here was devised for accurately measuring and simultaneously recording linear dimensions between selected parts of the otter trawl. The report is divided into two sections. The first describes the system; the second, its operation.

Author: Leon E. French, Jr. (formerly Electronics Technician, Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base, Gloucester, Massachusetts 01930) now with the Portsmouth Naval Shipyard, Dover, New Hampshire 03820.

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I. SYSTEM DESCRIPTION

This part of the report is concerned with (A) the selection and design of the system and (B) its components.

A. SYSTEM SELECTION AND DESIGN

1. Selection

We began in early 1962 the review and evaluation of instruments available for measuring otter-trawl performance to obtain background information in our search for better methods of measurement. The principal aims of this review were to find a system that could provide: (1) a continuous readout of remote trawl measurements and (2) a permanent graphic record of the measurements. A continuous shipboard readout would permit an operator to monitor constantly the configuration of the trawl during its operation. He thereby could observe any important occurrence or make any towing adjustment necessary to correct an erratic operation. Permanent graphic records of the trawl measurements would permit the data to be analyzed at any time.

Of the methods reviewed, a refinement of the sonic technique described by Rathjen and Fahlen (1962; see also the appendix, page 124) seemed to be the most feasible approach to accomplish our aims. Because remote cable-connected sonic transducers were used by them to obtain vertical-opening measurements, we concluded that a modification of their method might be suitable for use by us to obtain other gear measurements.

A sonic measuring system uses the principle of echo-sound or of direct-sound transmission to measure distances. The elapsed time between the start of a sonic pulse and the reception of the sound, or of its reflected echo, is measured, and time is converted to distance.

Preliminary tests were made aboard the Bureau of Commercial Fisheries' research vessel *Rorqual* during October 1962 to determine the feasibility of electrically connecting two transducers in parallel and "sounding" between them. The results indicated that a sonic method of measurement was practical and that it was more accurate than were any of the earlier methods. Subsequent tests and modifications to this system were made aboard the *Delaware* during March and August 1963.

The system of measurement developed as a result of the August *Delaware* trials provides an instantaneous and continuous display of measurements aboard the fishing vessel. They are displayed graphically on the recording unit of an echo sounder, and the distances are indicated by the echo-sounder scale. A shipboard observer can determine selected dimensions of a trawl and observe simultaneously the influence of one or more measurements upon another. For example, he can observe the change in the spread of the trawl doors caused by a change in the ocean bottom or the change in the spread of wing-ends caused by a change in the spread of the trawl doors.

2. Design

The modified sonic technique used for the trawl-measuring trials differed from the conventional method used for echo sounding in the grouping and connecting of the transducers. The transducers were arranged in pairs and pulsed in parallel so that the acoustic energy traveled from one transducer to the other (Figure 1). This procedure eliminated the need for an echoed pulse and effectively improved the sensitivity of the system. The intensity of a sound received directly is many times greater than is that of its reflected echo. Because of greater signal intensities, the amount of signal amplification required by the echo-sounder receiver was reduced. This reduction allowed the gain of the receiver to be reduced correspondingly and eliminated most of the extraneous echoes received from turbulent water and ground reflections.

In the design of the trawl-mensuration system, the following aspects were important: (a) distances measured, (b) transducer location, (c) readout, (d) handling of conductor cable, and (e) bottom-contact indicator.

a. Distances measured.—The system simultaneously records the following: (1) headrope

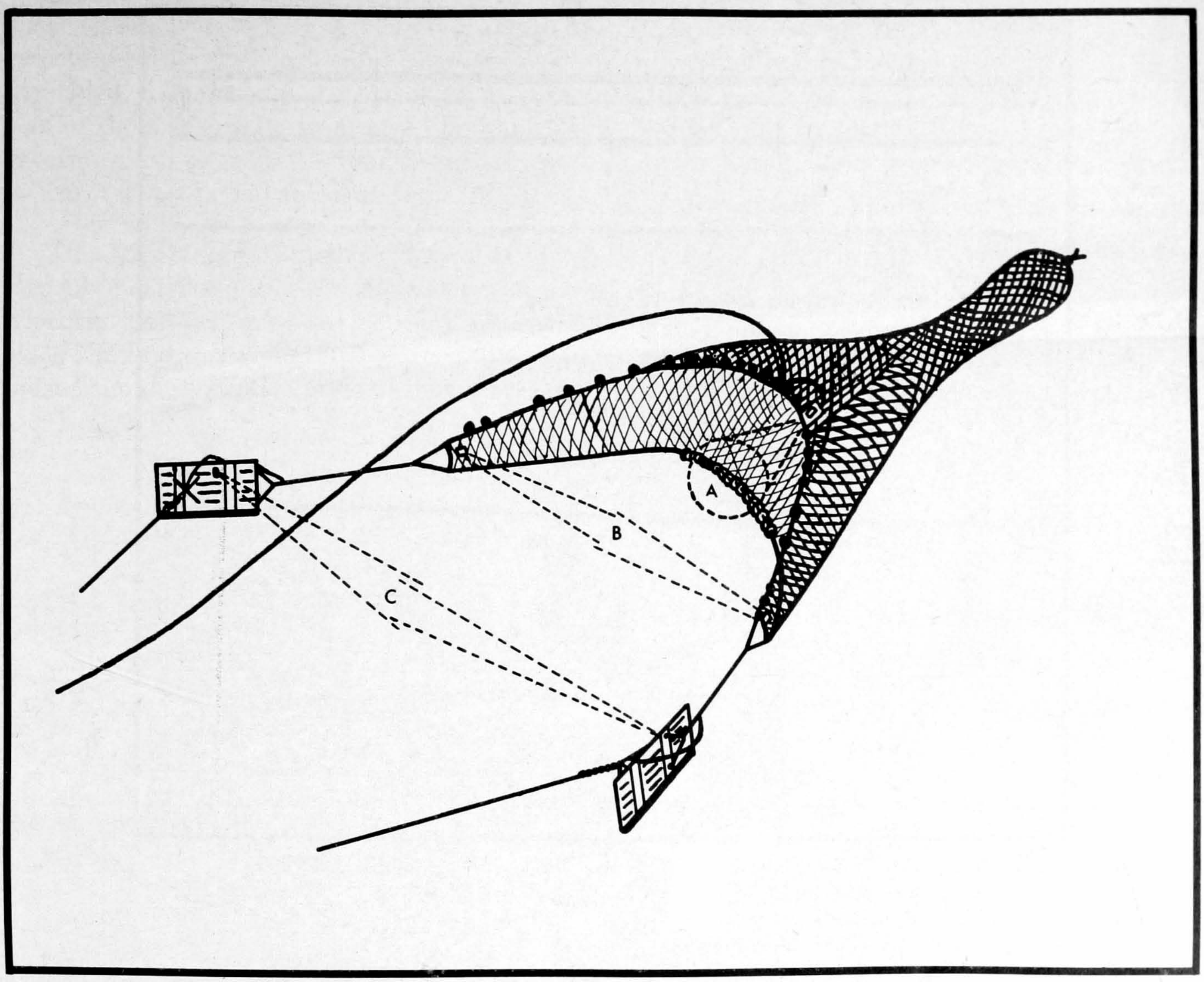

Figure 1.—Schematic diagram showing the transducer locations and measurements. A measures headrope height, B measures wing spread, and C measures door spread.

height above the ocean bottom, (2) distance between trawl doors, (3) distance between wing-ends of the net, and (4) distance to the bottom from the vessel's keel. Figure 2 shows an echograph recording of the linear dimensions measured during Cruise 63-7 by the *Delaware* in August 1963.

b. Transducer location.—A pair of transducers was attached to the trawl doors, a second pair was attached to the wing-ends of the net, and a single transducer was attached to the headrope of the net (Figure 1). The paired transducer measured the distances between opposite points of attachment—door to door and wing-end to wing-end. The headrope transducer sounded the bottom, just as a conventional echo sounder would, to measure the height of the headrope above the bottom.

The transducers that were positioned on the doors (Figure 3) were mounted within a hinged metal support and were attached to the top of the doors above the brackets. The hinged support allowed the transducers to be placed at an angle that would result in optimum strength of signal at the recorder. The angular placement of the door transducers was critical and had to be determined by experiment. Results of these angular placements are explained under "System Testing."

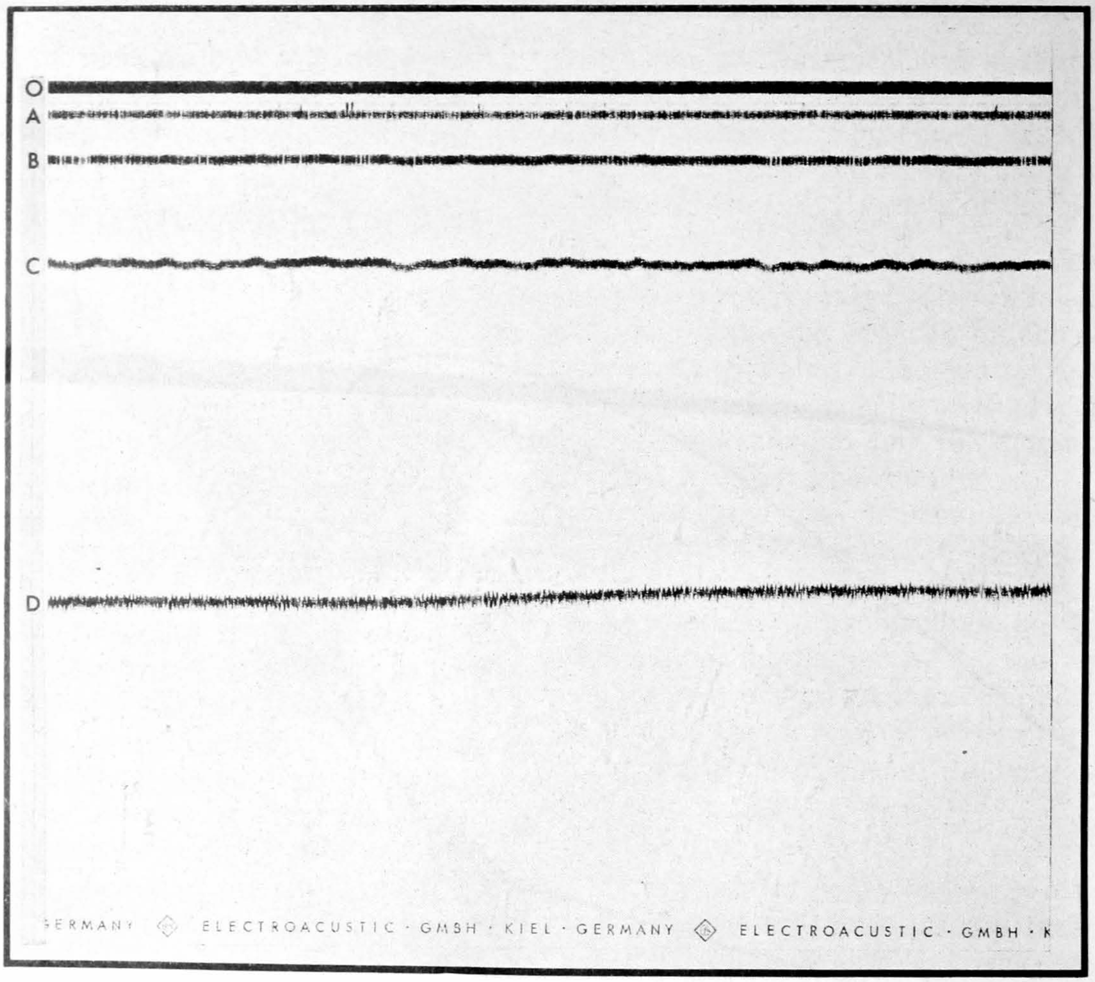

Figure 2.—A recording of trawl dimensions obtained during *Delaware* Cruise 63-7. All measurements are from the zero line.

O. Zero line or starting pulse
A. Headrope height above the ocean bottom (8 feet)
B. Distance between the net wing-ends (45 feet)
C. Distance between the otter-trawl doors (108 feet)
D. Depth of the water below the vessel's keel (162 feet)

The transducers positioned on the wings (Figure 4) were connected electrically in parallel and were mounted within polyester resin-covered plywood vehicles. These vehicles were attached to the wing-ends of the trawl by rope bridles. Floats were added to the vehicles to make them neutrally buoyant.

When the vehicles were placed outside the wing-ends and were allowed to trail outside of the net, the signals were received well. However, when the vehicles were placed inside the wing-ends, the signals were received poorly. This difference is probably due to the curvature of the net — the curvature prevented the vehicles from aligning themselves with the direction of tow.

The transducer positioned on the headrope (Figure 5) was mounted within a piece of plywood coated with polyester resin. It was secured to the headrope and twine of the net at the center of the bosom. In this position, the headrope transducer directed the sonic energy toward the ocean bottom. The elapsed time between the transmission of a pulse and the reception of its echo indicates the distance traveled by the pulse.

c. Readout.—The signals from the transducers were transmitted through a cable to a remote recorder on board ship. This recorder displayed a continuous graphical representation of the measured distances. Simultaneous recordings were made of four measurements by use of direct-signal and echo-signal methods.

The direct-signal method for obtaining measurements requires all transducers to be wired in parallel. All transducers are energized simultaneously and therefore emit sound pulses simultaneously. After a pulse is sent, each transducer acts as a receiver and relays the receiver pulse to the recorder.

When the direct-signal method is used, the distances measured by the echo-sounder recorder must be doubled because an echo travels twice the distance that direct sound does.

Direct and echo signals were transmitted concurrently to obtain simultaneous recordings of the measurements. All transducers were energized together and emitted coincident sound pulses. A combination of the direct-signal and echo-signal recordings thus was used in the determination of the measurements.

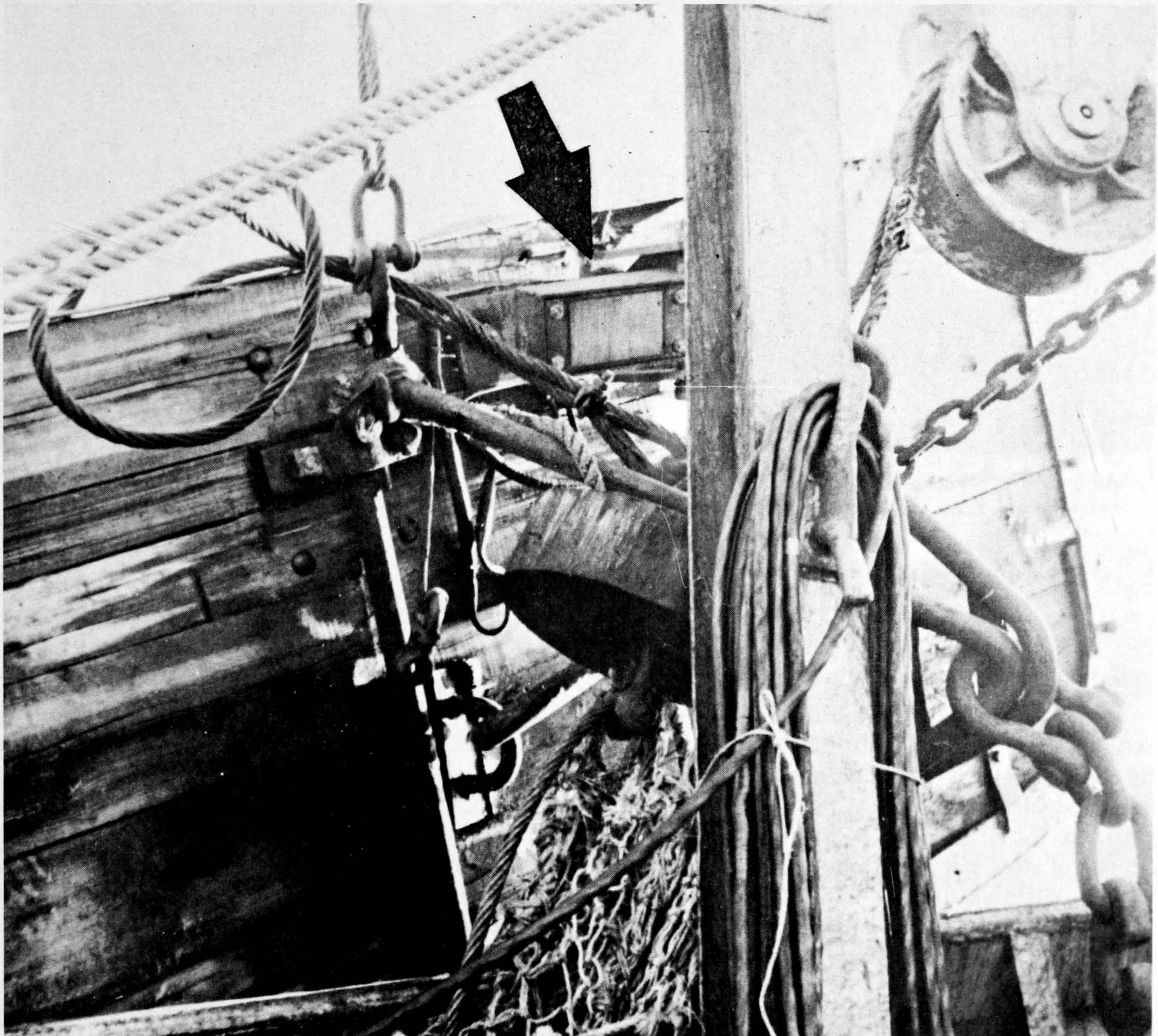

Figure 3.—Trawl-door sonic transducer. The transducer (indicated by the arrow) is one of a pair mounted on the inner surface of the trawl doors.

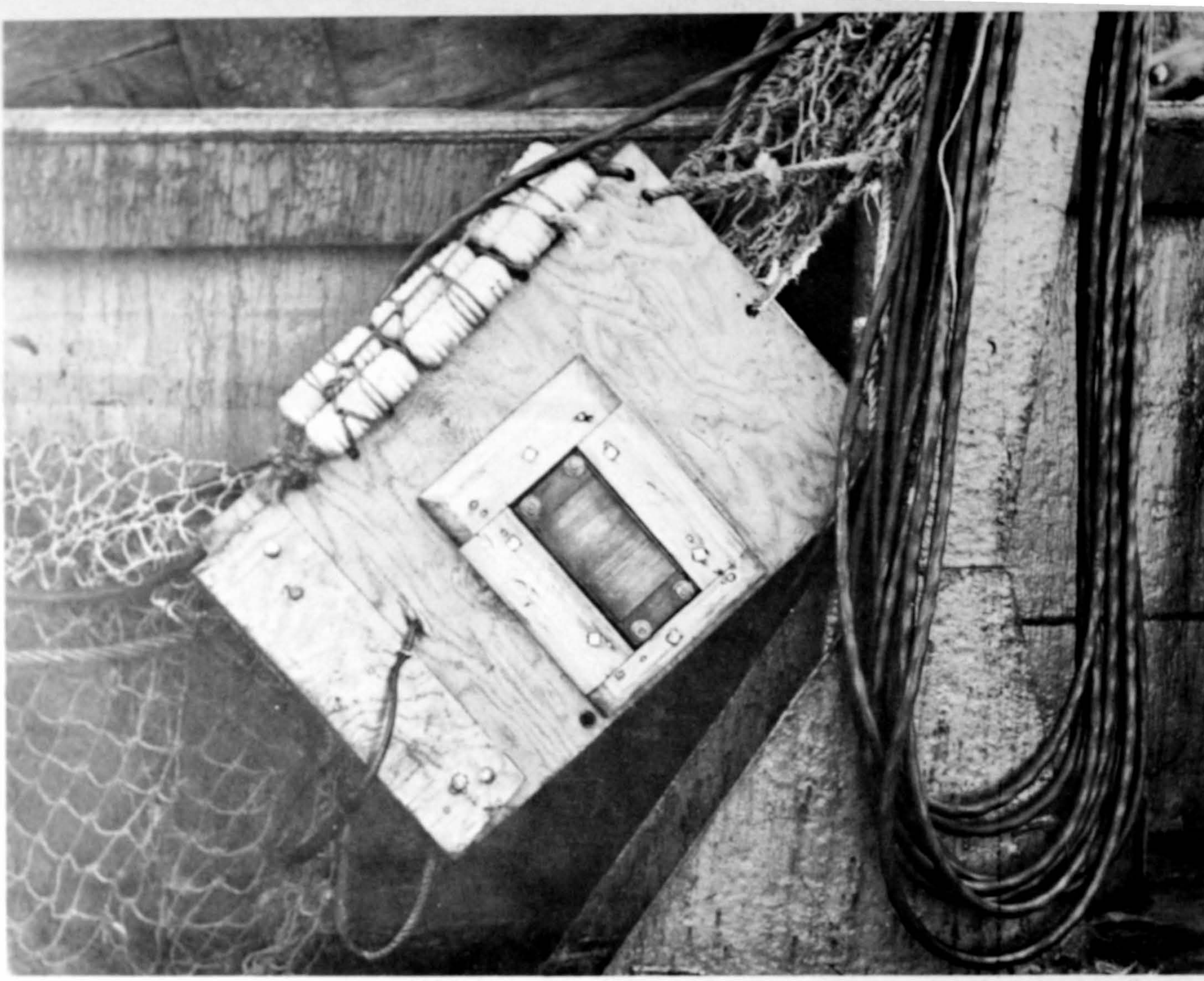

Figure 4.—Net wing-end sonic transducer. The transducer is mounted within a polyester resin-covered wooden framework. A similar transducer is attached to the opposite wing.

d. **Conductor-cable handling.** — A hydraulically powered reel mounted on the stern of the *Delaware* was used to set and haul back the transducer cable. This cable was 400 fathoms long. One end was secured to the center of the net headline; the other, to the winch. "Quick-disconnect" electrical connecters were installed at both ends of the cable to facilitate its attachment and removal.

e. **Bottom-contact indicator.**—A bottom-contact indicator (Figure 6) was secured to the footrope of the trawl net. The purpose of this indicator was to enable the investigator to know when the footrope was actually on the bottom. He needed this information because the transducer positioned on the headrope measured the distance between the headrope and the sea bottom, not the distance between the headrope and the footrope. Yet, it was the distance between the headrope and the footrope that the investigator wanted to know. Only when the footrope was on the bottom would the distance between the footrope and the headrope be equal to the distance measured by means of the headrope transducer. When the footrope was above the bottom, the distance measured would be erroneously large.

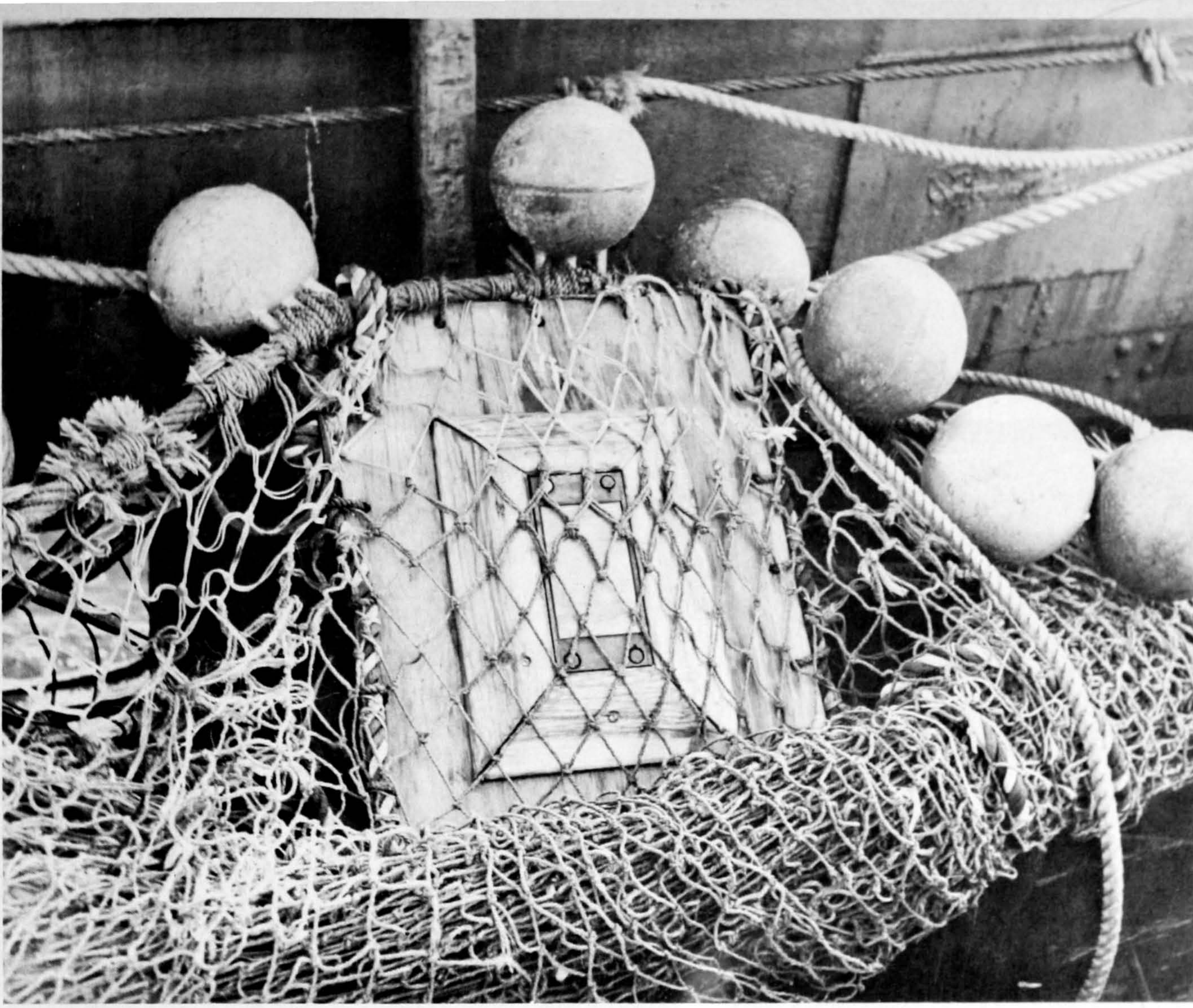

Figure 5.—Net headrope sonic transducer. This transducer is attached to the headrope and twine of the net at the center of the bosom.

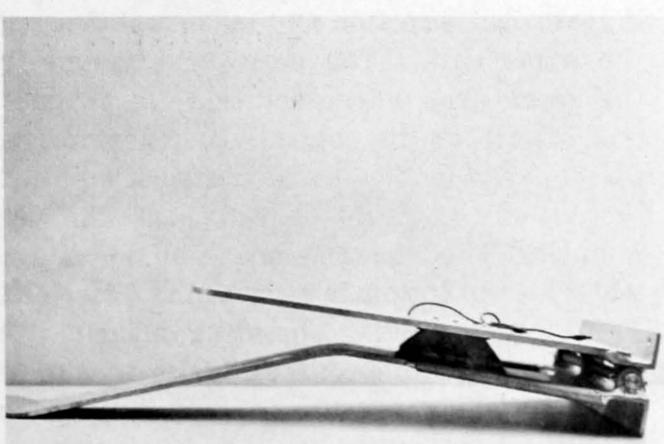

Figure 6.—Bottom-contact indicator. This device is attached to the center of the footrope to indicate when the net is on the ocean bottom. The indicator is shown in the closed position. When the net is off the bottom, the curved lower member hangs down and opens a magnetic switch attached to the upper portion.

B. SYSTEM COMPONENTS

The system consists, as we have seen, of measuring components and of a bottom-contact indicator.

1. Measuring Components

The sonic system for measuring distances has the following parts: (a) echo sounder and recording unit, (b) transducer cable, (c) sonic transducers, and (d) interconnecting cables and attachments.

a. Echo sounder.—The recording component of the system consists of a modified commercial depth sounder that is also used aboard the vessel during normal fishing operations (Figure 7). The depth scale of the recording unit, an integral part of the echo sounder, has been modified to give measurements in feet instead of fathoms. The manufacturer's designation for the sounder is "Elac-Echograph Superior Model LAZ-17."[1] The frequency of the transmitted pulses is 30 kilocycles per second with a pulse repetition rate of 20 to 160 pulses per minute, depending upon the range scale selected. The shallowest depth range, 42 fathoms (160 pulses per minute), was used during the trials.

b. Transducer cable.—A seven-conductor cable is used with the instrumentation system. It was manufactured to Bureau specifications. The cable conductors are plain, No. 12 (American Wire Gage) copper-stranded wires with polypropylene insulation. The insulated conductors are covered by (1) a neoprene jacket; (2) a basket-weave galvanized-steel layer, to provide strength and abrasion resistance; and (3) a second layer of neoprene, covering the entire assembly.

c. Sonic transducers.—Reconditioned "Elac LSE-24" sonic transducers are used to transmit and receive the sound pulses. The transducers are of the magnetostrictive type with magnetizable bodies that change in length when affected by magnetic fields. The transducers consist of a stack of thin nickel laminations, similar to transformer laminations, enclosed within a bronze bracket and wound with 11 turns of No. 12 insulated copper wire. Each transducer is $8\frac{7}{8}$ by $4\frac{1}{8}$ inches. The angle of the sound cone from these transducers is about 20 degrees across and 12 degrees lengthwise.

d. Interconnecting cable. — "Push-pull," high pressure, underwater electrical connecters (Figure 8) were used at all underwater cable-ends and transducer connections. These connecters have a short length of neoprene-insulated electrical cable that is suitable for splicing to the neoprene-insulated cables used with the instrumentation system. A cable vulcanizer was used to insulate the electrical splices. Plastic or self-bonding insulating tapes coated with rubber cement and applied in successive layers also provided serviceable splices.

2. Bottom-Contact Indicator

The frame of the bottom-contact indicator is made of $\frac{1}{4}$-inch stainless steel. Its overall dimensions are about 32 by 18 inches. The sturdy construction minimizes damage during handling and trawling operations.

The electrical components of the bottom-contact indicator are: (1) magnetic reed switch, (2) permanent magnet, (3) power source, (4) visual indicator (lamp), and (5) associated cabling. When the trawl net is on the ocean bottom, the hinged lower arm pivots in a vertical direction and makes contact with the upper arm. The permanent magnet on the lower arm in contact with the magnetic reed switch on the upper arm energizes the switch and completes the electrical circuit to the visual indicator located near the echo sounder. The lamp remains lighted until contact with the bottom is interrupted. McNeeley (1961) used similar operating principles to construct a bottom-contact device to indicate when trawl doors were in contact with the bottom.

[1] Trade names referred to in this publication do not imply endorsement of any commercial product but are cited to promote full understanding of the type of equipment used.

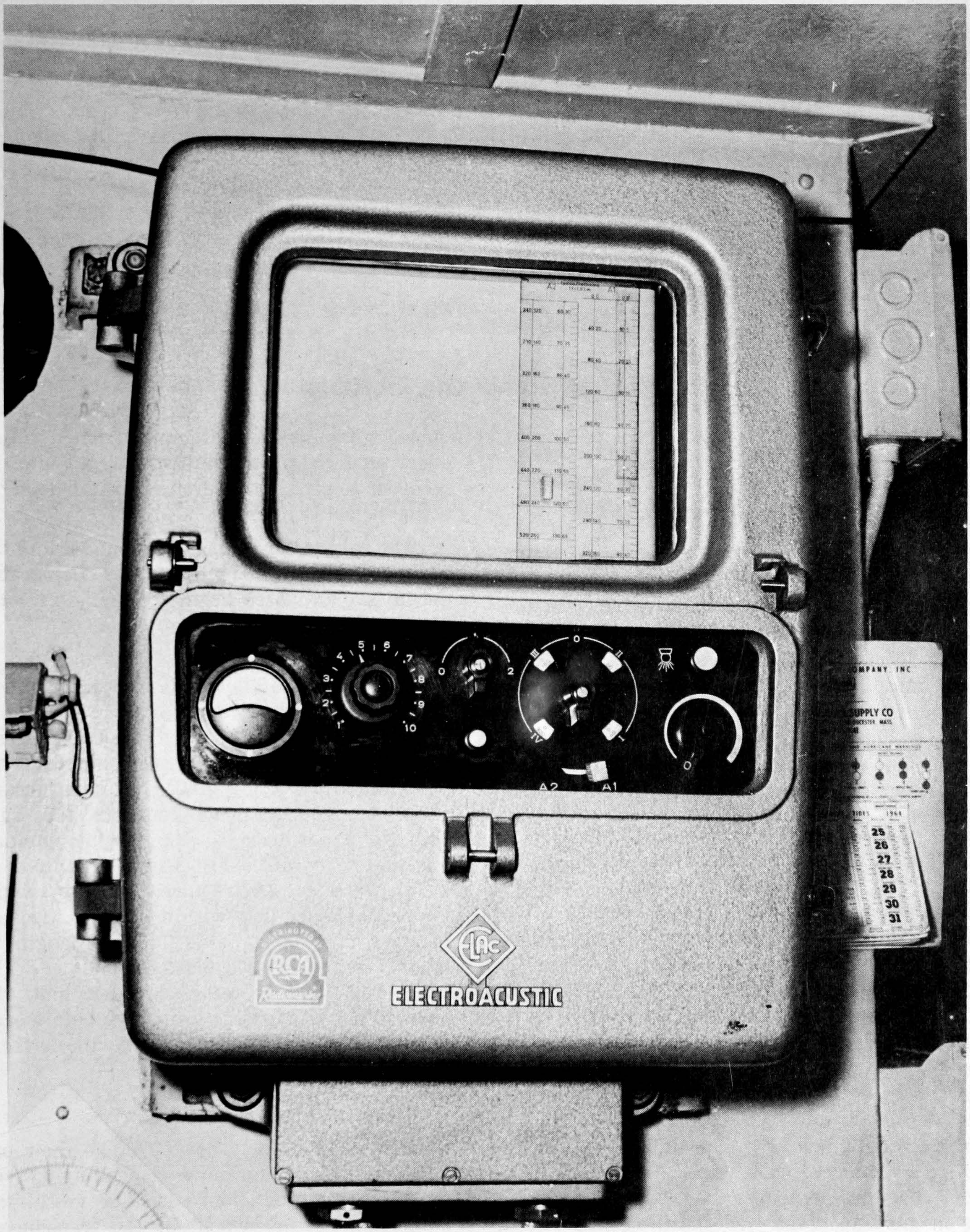

Figure 7.—"Elac-Echograph Superior," echo sounder and recording unit.

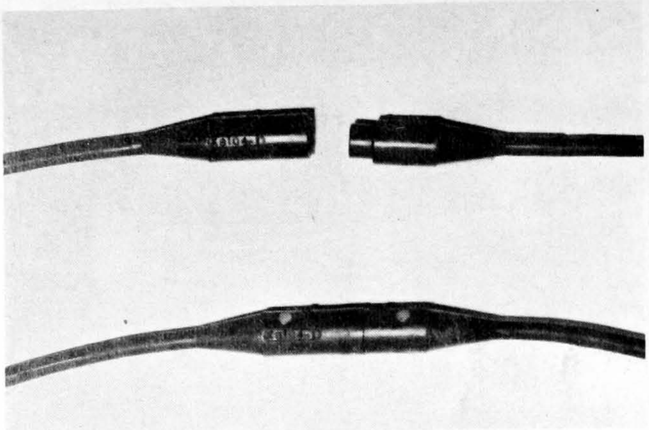

Figure 8.—Waterproof electrical cable connecters.

II. SYSTEM OPERATION

Reported in this section are the testing of the system and its performance.

A. SYSTEM TESTING

A sonic mensuration system was tested initially aboard the *Delaware* during March 1963. Since that time, improvements in the system have been made. These improvements were successfully field tested in August 1963. The most notable improvement has been the simultaneous recording of all measurements. The earlier version recorded each measurement on a time-sharing basis (Figure 9). This version required an elaborate switching system.

For simultaneous recordings of the measurements, the echograph amplifier should receive an input signal of equal intensity from each transducer. A strong input signal causes the echograph paper to blacken, however, if the gain control on the receiver is advanced to increase the intensity of a weaker signal. Because the door transducers produced the weakest signal inputs, the gain of the echograph receiver was set to obtain maximum recorder clarity of the door measurements. The signal inputs from the wing-end and the headrope transducers were attenuated by insertion of capacitors of proper value in the transmission cable to obtain equal marking intensity of the signals from the transducers on the trawl doors. A supplemental input from a transducer mounted on the hull was wired into the recorder to give a measurement of the depth of water below the vessel's keel.

The calibration of the echo sounder and the adjustment of the angles on the door transducers are discussed in the following sections.

1. Calibration

Capacitors and installation instructions are furnished with the equipment to ensure proper cable match between the transducers, and the recorder. For normal shipboard installation of the echo-sounder, a comparatively short transducer cable connects the hull-mounted transducer to the display cabinet. When longer cables are used, capacitors of smaller values are required because of the inherent capacitance within a cable. So, capacitors of proper value for the length of transducer cable used must be installed. The calibration of the echo sounder must be checked by a competent technician before each trial to ensure that the system will perform properly.

2. Door-Transducer Angles

Because the trawl doors change their angular position during tows—depending on type of bottom, current, and speed of vessel—no single angular placement of the transducers on the doors will be satisfactory under all towing conditions. The signals are received best only when the door transducers point directly at each other.

Tests were conducted aboard the *Delaware* to determine the correct placement of transducers for three ratios of warp length to ocean depth. The alignment of the transducers was systematically adjusted at each trawl door until the correct angular placement was found for each ratio. These angles presumably vary for each set of doors and towing vessel. The best angular placement must therefore be determined by the individual investigator.

We changed the angle of the door transducers whenever we changed the ratio of warp length to depth. In this way, we obtained equal strength of signal, though we used various length of warp.

B. SYSTEM PERFORMANCE

The simultaneous recordings presented a clear and instantaneous graphic indication of selected trawl measurements combined with an indication of the ocean depth and the kind of bottom. The only complication experienced with the system was the placement of the door transducers. A more complete knowledge of trawl-door behavior for various ratios of warp length to depth or an improved transducer suspension system would lessen this problem.

Experience with the trawl doors used in 26 fathoms of water during the tests aboard the *Delaware* indicated that: (1) with a 5:1 ratio of warp length to depth, the doors appeared to lean inward—that is, toward the brackets; (2) with a 4:1 ratio, the doors appeared to lean outward—that is, toward their backs; and (3) with a 3:1 ratio, the doors appeared to be towing on their forward end, or nose. These indications are reported here because they were helpful in determining the placement of the door transducers. A detailed discussion of trawl-door behavior is presented by De Boer (1959)

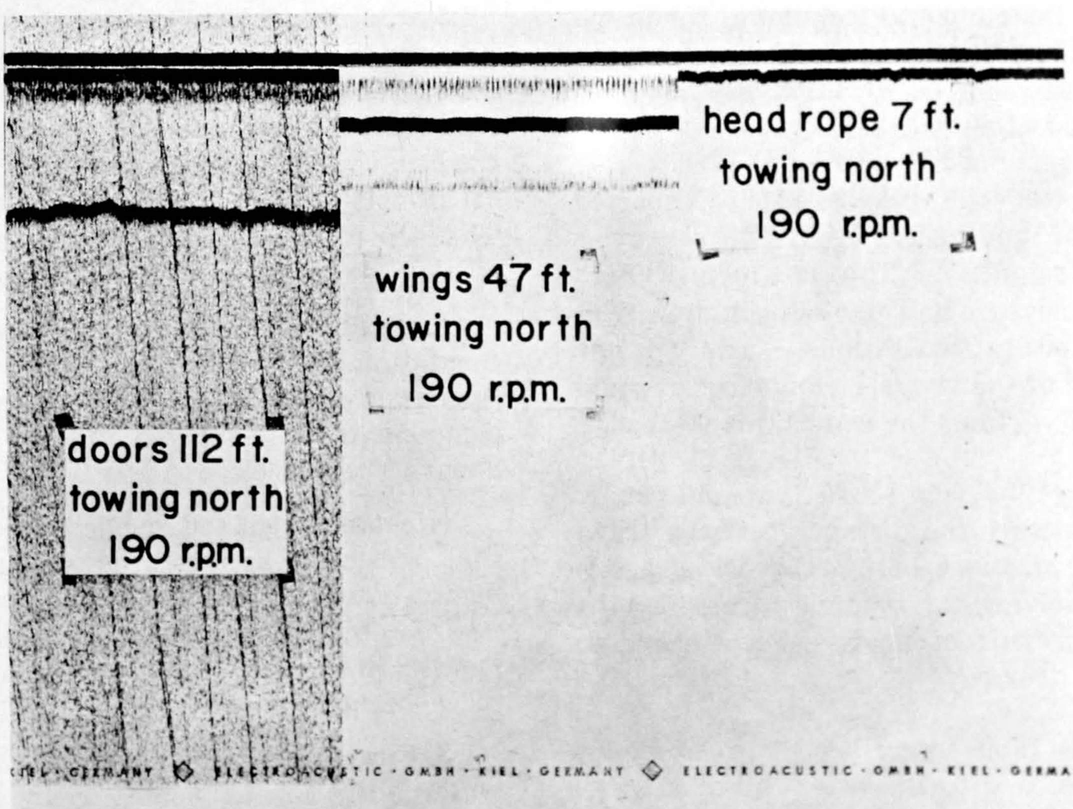

Figure 9.—A recording of certain linear dimensions of an otter trawl made using a time sequencing or "stepping" arrangement.

SUMMARY

Extensive efforts of fishing-gear researchers to study and improve the efficiency of trawl fishing gear have caused increased demand for instrumental techniques.

A sonic measurement system was developed to display and to record selected dimensions of an otter-trawl net while it is in operation. A shipboard echograph records simultaneously the height of the headrope above the ocean bottom, the distance between wing-ends, the distance between trawl doors, and the distance to the bottom from the vessel's keel. Direct-sounding and echo-sounding principles are applied to obtain the measurements.

The measuring system has the following components: (1) echo sounder and recording unit, (2) transducer cable, (3) sonic transducers, and (4) interconnecting electrical cables and attachments. A bottom-contact indicator is used to tell whether or not the net is in contact with the sea bottom.

During the trials reported here, sonic transducers were attached to the trawl doors, wing-ends, and headrope, but other points of attachment—for example, along the trawl warps—could be used to give supplemental data.

In general, the system performed well. The only complication was in the placement of the door transducers. This problem could be lessened by an improved system for suspending the transducers.

APPENDIX

Review of Literature

Various instrumental techniques for measuring spread dimensions—that is, interspace distances between trawl components—have been used by other workers.

Dickson (1959) and Fried (1957) reported a method of underwater gear studies by a team of "frogmen." The frogmen worked in pairs to measure and photograph nets. Unfavorable natural conditions—such as low temperature of the water, strong currents, and poor visibility—limit the use of this method.

Wathne (1959) used a sextant and rangefinder to measure the distance between trawl doors. The distance between doors was calculated by solving the triangle formed by the vessel and a pair of floats—one attached to each trawl door.

De Boer (1959) described a spread meter, which is fastened to the after-end of a trawl door, to measure the spread distance. A steel wire connects the spread meter and the opposite trawl door.

Rathjen and Fahlen (1962) described an acoustic transducer system for recording the distance between the headrope of a midwater trawl and the ocean bottom; the distance from the headrope to the footrope; and the presence of schools of fish, within or below the net. The information from the headrope transducer is used for positioning the midwater net.

Holt (1964) developed an acoustic instrumentation system to study trawl mechanics. A measurement of distances between trawl components is displayed on an oscilloscope aboard the vessel.

Nicholls (1964) described a sonic system that measures and records distances underwater between two fixed units without the use of interconnecting cables. The measurements are received and recorded at the unit's place of attachment.

Several methods for studying the underwater operation of fishing gear are covered comprehensively in *Modern Fishing Gear of the World* (2 volumes: the first was published in 1959; the second, in 1964).

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MS #1708

ECHO REFLECTOR FOR SONIC MEASURING SYSTEM ON AN OTTER TRAWL

by

Leon E. French, Jr.

ABSTRACT

Sonically measuring distances between points in an otter trawl during operation by use of transducers and an echograph recorder presents problems. For example, when the headrope height of an otter trawl is about one-half the wing-end spread, the headrope and wing-end measurement traces appear at the same location upon the recording paper. The simultaneous overlay of signals can be corrected by use of a sonic echo reflector to replace one of the wing-positioned transducers in the measuring system and by use of the echo-signal method instead of the direct-signal method. The echo signals, however, are weaker than the direct signals.

This paper reports on a test of three reflectors: plain wood, aluminum sheet, and checkered aluminum. All three reflectors gave usably strong echo signals. The best quality signal was given, however, by the aluminum reflector.

INTRODUCTION

The true configuration of a trawl can be found only by a system that yields accurate measurements of the trawl while it is being towed. Since 1963, the Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base at Gloucester, Massachusetts, has been using a sonic measuring system to get linear measurements of otter trawl gear (French, 1968). In this system, the direct-signal method of measurement is used to obtain horizontal measurements—for example, the distances between trawl wing-ends and those between trawl-doors; whereas the echo-signal method is used to obtain vertical measurements—for example, the height of the net headrope above the ocean bottom. The measurements resulting from each type of signal transmission are recorded simultaneously on the moving paper of a shipboard echo recorder.

The trawl-net measurements are determined by observing a transparent calibrated scale superimposed upon the recorder traces (Figure 1). Because two techniques of sound measurement are used simultaneously, each recorder tracing must be interpreted differently. When the echo-signal method is used, the measured distances correspond to the markings engraved upon the recorder's scale. When the direct-signal method is used, the

Author: Leon E. French, Jr. (formerly Electronics Technician, Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base, Gloucester, Massachusetts 01930) now with the Portsmouth Naval Shipyard, Dover, New Hampshire 03820.

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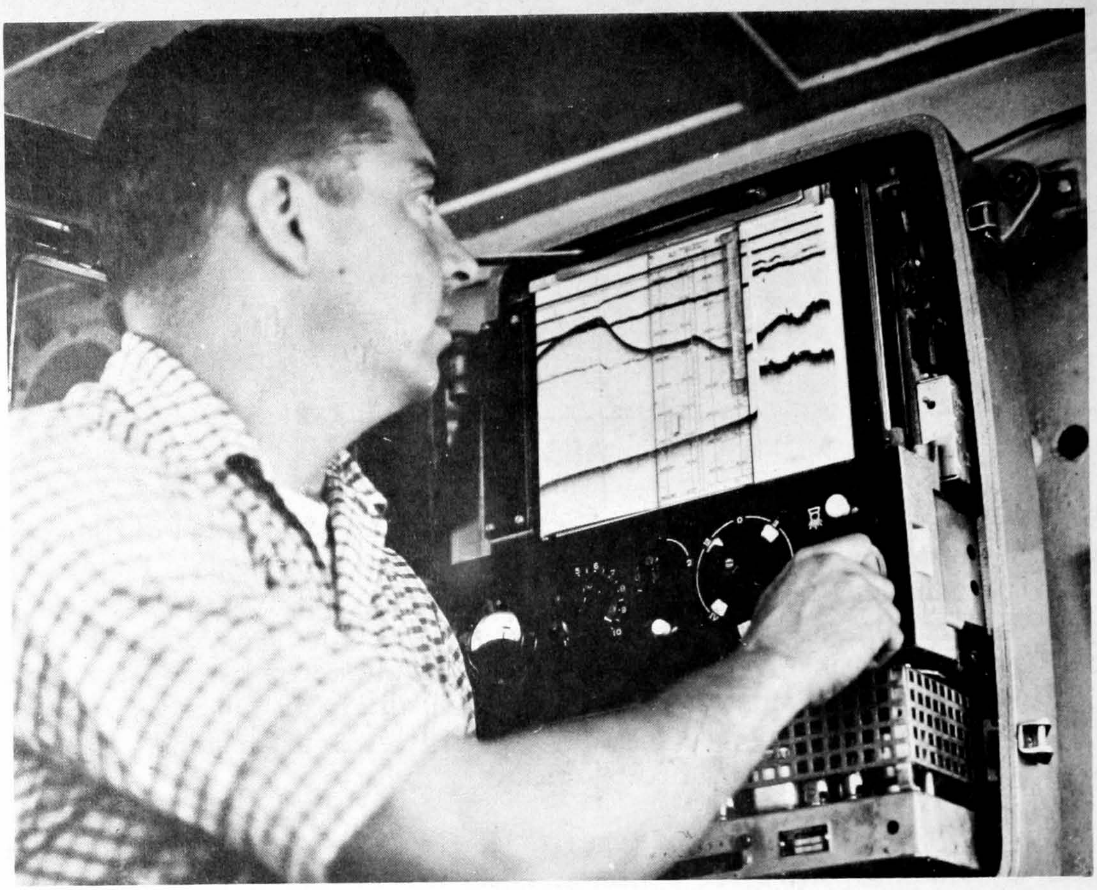


Figure 1.—Echo sounder and recording unit showing mensuration marking traces and scale overlay.

measured distances indicated by the scale must be doubled, since the recorder is designed for an echo signal.

The position of the tracing obtained with the direct-signal method does not cause any problem when trawl nets with low headrope heights, such as the No. 41 otter trawl, are used. A recording problem, however, was encountered in June 1965 during Cruise 65-5 of the research vessel *Delaware* (Commercial Fisheries Review, 1965) while testing otter trawls with high headrope openings.

Because of changes in velocity and towing forces during drags with the Atlantic Western Trawl, Model III, the measured headrope height may vary from 10 to 30 feet, and the measured wing-end spread may vary from 36 to 56 feet. It therefore is possible occasionally for the headrope and wing-end measurement traces to appear at the same location upon the recording paper. For example, the recording traces resulting from a headrope height of 18 feet and a wing-end spread of 36 feet would appear at the 18-foot location upon the recording paper.

This note reports the approach we used to eliminate the measurement interference encountered while testing an otter trawl with a headrope height about one-half the wing-end spread.

I. MATERIALS AND METHODS

The sonic echo reflector is not needed for trawl-door measurements because the distance between these components is considerably greater than are the other distances to be measured concurrently, so the recorder marking traces are separated sufficiently to preclude interference with the other traces.

The sonic echo reflector is needed, however, for measurements of the distance between wing-ends because, as we have seen, interference is obtained with measurements of the headrope height. To correct the simultaneous overlay of signals, we used a sonic echo reflector to supplement the measuring system when required. The reflector replaced one of the wing-positioned transducers in the system, and the echo-signal method was used instead of the direct-signal method.

The echo-reflector vehicle and its attachment to the net were identical to the wing-positioned vehicle and its attachment described by French (1968). The sonic transducer was removed from a wing-positioned vehicle, and a block of wood was inserted in its place. Three reflectors—plain wood, sheet aluminum, and checkered aluminum—were tested.

Described in this section are the reflectors and the method used to test them.

A. REFLECTORS

1. Wooden Reflector

The wooden reflector consisted of the original wing-positioned vehicle with the transducer removed. A lead weight and floats were attached to the vehicle to maintain vertical alignment and neutral buoyancy.

2. Sheet-Aluminum Reflector

The sheet-aluminum reflector (Figure 2) was made by attaching a $17\frac{1}{4}$- by 24-inch sheet of $\frac{1}{8}$-inch aluminum to the side of the wooden reflector facing the vehicle's counterpart wing-positioned transducer. The ve-

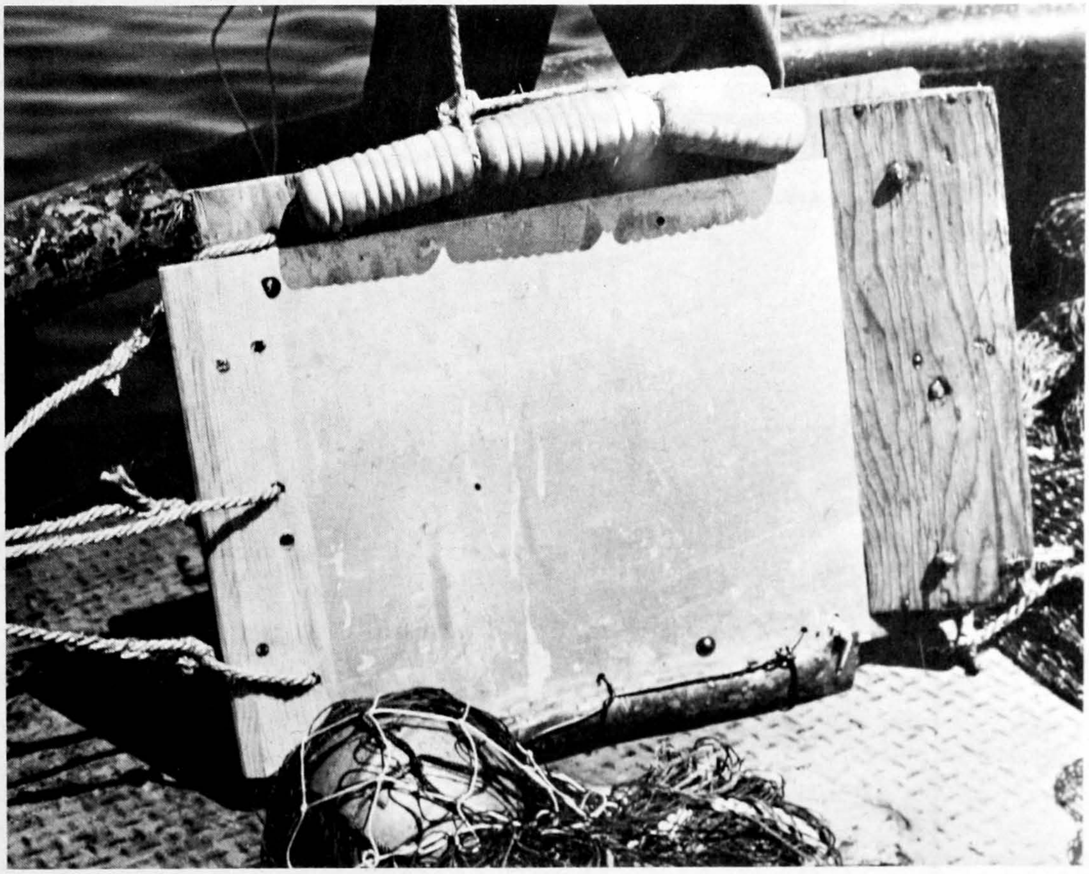


Figure 2.—An echo reflector with 1/8-inch aluminum sheet.

hicle's buoyancy and stability were checked and corrected as necessary.

3. Checkered Aluminum Reflector

Forty-four 2-inch aluminum squares were attached with screws to the wooden reflector on the side facing the vehicle's counterpart transducer at the wing position. The reflector's buoyancy and stability were checked and corrected as necessary.

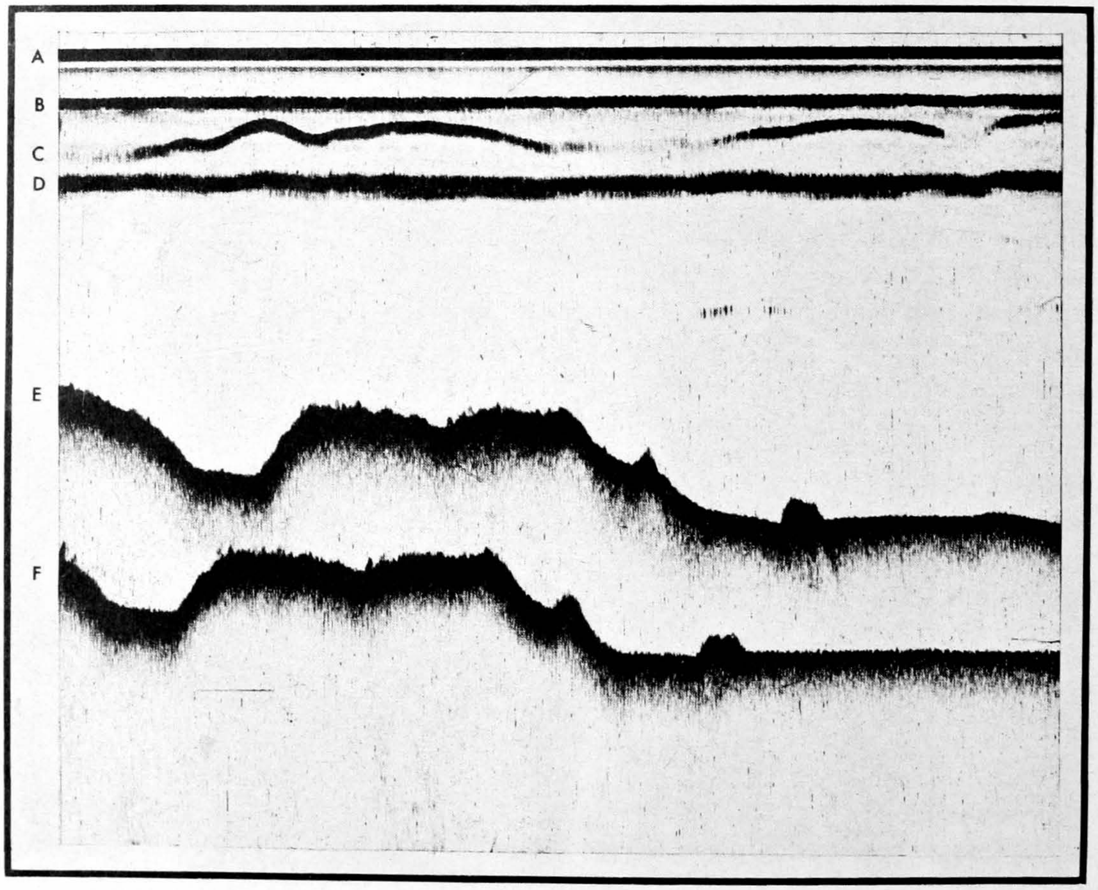
B. METHODS OF TESTING

The three types of sonic echo reflectors were tested aboard the Bureau of Commercial Fisheries' research vessel *Rorqual* during July 1965. Each type of reflector was attached successively during alternate tows to one wing-end of a midwater trawl as described by Rathjen and Fahlen (1962), and a mensuration transducer was attached to the opposite wing-end of the trawl.

The recorder's marking trace with each type of reflector was examined for quality of presentation during duplicate towing and recording conditions. Since measurements are determined by visual readout of recorder marking traces, application of electrical instruments and procedures to test the signal strength was not considered necessary to evaluate the performance of each type of reflector.

II. RESULTS

All three types of reflectors gave usable echo presentations on the recorder. The sheet-aluminum reflector gave the signal of best quality (Figure 3), followed closely by the sig-



nal from the checkered aluminum reflector. Although the wooden reflector did provide a usable echo, the quality of the echo was definitely inferior to that of the others and might prove unsatisfactory under unfavorable circumstances. Thus, of the reflectors tried, the sheet-aluminum reflector is preferred.

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Figure 3.—A recording showing the trawl dimensions and position of the net above the bottom. Marking trace "D" was made while using the sheet-aluminum echo reflector.

A. Zero line or net headrope.
B. Net footrope (net opening = 16 feet).
C. Instrument cable.
D. Distance between the net wing-euds (41 feet).
E. Ocean bottom beneath the net (147 feet maximum).
F. Ocean bottom beneath the vessel (189 feet maximum).

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SUGGESTIONS TO AUTHORS WRITING FOR *FISHERY INDUSTRIAL RESEARCH*

by F. Bruce Sanford, Lena Baldwin, and Mary S. Fukuyama

A. APPROACH

Write your paper for a reader who has had advanced scientific training. Organize and write it in such a way that he can read it rapidly, yet understand it the first time through.

B. COMPONENTS OF THE PAPER

1. Title

Select a title that reveals the overall purpose of your research. When appropriate, include scientific names of species.

2. Abstract

Make the abstract semidescriptive: tell what the report is about, and end with a statement of your overall conclusion. (This conclusion will answer the question stated, or implied, by your overall purpose.) Keep the abstract short, but do not use the title of the paper as the assumed antecedent of otherwise irreferable pronouns.

3. Table of Contents

Include a table of contents.

4. Introduction

In the introduction, (1) orient the reader to your overall purpose, (2) state the purpose explicitly, (3) orient the reader to the subpurposes, and (4) end with a listing of the subpurposes.

Include in each orienting discussion all the important words that will occur in the subsequent statement of purpose. Avoid unnecessary reviews and economic data.

When stating the overall purpose, include a word such as "purpose" so that the reader can quickly identify the statement for what it is.

5. Main Divisions

Do not use such generalized divisions as "Experimental." Instead, be specific by making the main divisions of the paper correspond to the main divisions of your research—Experiment I, Experiment II, and so on. Give each experiment a specific title so that the reader will gain immediate insight into the scope of the experiment.

For main divisions, do not use "Materials," "Procedures," and "Results" (except when, as is rare, your paper reports only a single unit of research, such as Experiment I); instead, use these headings for minor divisions. When you use them, consider the following suggestions:

a. Materials and methods.—Describe in detail the materials and the methods used in your first experiment. If the materials and methods used in succeeding experiments are similar to those in the first, merely describe the differences when you report the succeeding experiments.

If a method includes several closely consecutive steps, number them and write out the steps; use the active voice —for example, "In the separation of acids from the aqueous phase, the analyst:

1. Neutralized a 1-milliliter portion of the aqueous layer to a pH of 10 with 0.1 N NaOH.

2. Transferred the neutralized solution to Flask A.

3. Placed Flask A in a bath . . . ."

b. Results.—Report all numerical data in tables and graphs—avoid cluttering the text with numbers. In the discussion of results, do not repeat the data that are contained in the tables and graphs. Instead, analyze the data by pointing out significances and implications. Use summary tables; do not overwhelm the reader with unnecessary

6. Conclusions

Draw conclusions from your results. Make sure that the overall conclusion and the subconclusions correspond with your overall purpose and subpurposes. Present the conclusions in logical sequence.

7. Summary

End the report with a summary. Make the summary quantitative, not merely descriptive. If the report is short, end it with "Summary and Conclusions." If it is long, separate the two.

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Make your citations complete and accurate so the reader can find the original with ease. Follow the format used in *Fishery Industrial Research.*

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2. English Usage, Punctuation, and Capitalization

Meticulously follow established practice in grammar, punctuation, and capitalization. For precise, forceful statements, use personal pronouns where appropriate and thereby avoid illogical constructions or ambiguities.

3. Headings

Use the system of headings shown in the latest edition of *Fishery Industrial Research.*

4. Numbers

Use Arabic numbers unless you have a compelling reason to use Roman numbers or to write the numbers out. See the latest issue of *Fishery Industrial Research.*

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