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EXPERIMENTS UTILIZING ELECTRICAL TRAWL CABLES--A PROGRESS REPORT

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SUMMARY

Experiments to adapt special trawl cables containing electrical conductors for use on commercial-size otter-trawling gear have shown a fair degree of progress during the past two years. Since the original installation of electrical cable as part of a depth-telemetering system on the U. S. Bureau of Commercial Fisheries exploratory fishing vessel John N. Cobb in 1958, further experiments utilizing new sensing units have extended the cable's usefulness to indicate water temperature, contact with the bottom, and presence of fish in the net's cod end. Changes in design of the cable have been made by the cable manufacturers to prolong its expected life. Although sufficient durability for commercial use has not been achieved, experiments in utility are being conducted simultaneously with experiments in durability in an effort to make installation of the cable and various sensing units economically feasible for commercial fishing vessels.

BACKGROUND

Trawl cables containing electrical conductors (fig. 1) were used in 1957 as part of a depth-telemetering system in midwater trawling experiments aboard the U. S. Bureau of Commercial Fisheries exploratory fishing vessel John N. Cobb (McNeely 1958). A sensing unit, located on the wing of the trawl, transmitted continuous depth information by way of the electrical cable to a meter mounted in the vessel's pilothouse. This allowed positioning of the net near schools of fish which had been located by echo-sounding. Telemetry of net-depth information was successful, and catches showed a positive correlation with echo soundings that indicated subsurface fish concentrations (Schaefers and Powell 1958).

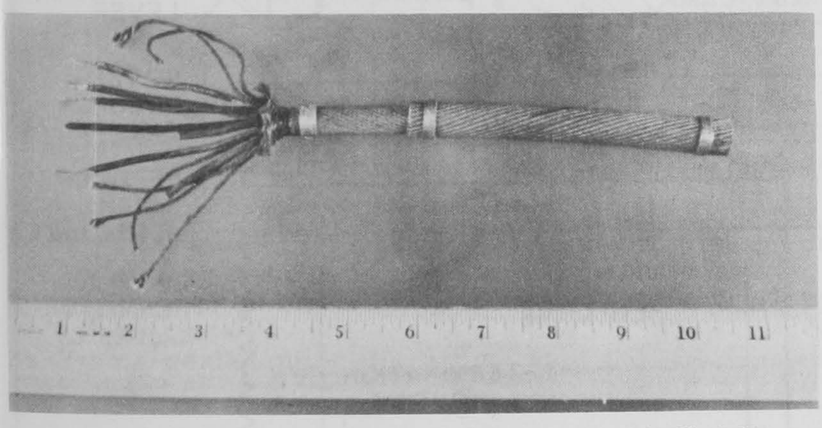

Fig. 1 - Sample of electrical trawl cable used on the John N. Cobb.

During the past two years, this depth-telemetering system has been modified for use on otter-trawling gear for simultaneous sensing and transmission of trawl-performance variables to the vessel (fig. 2).

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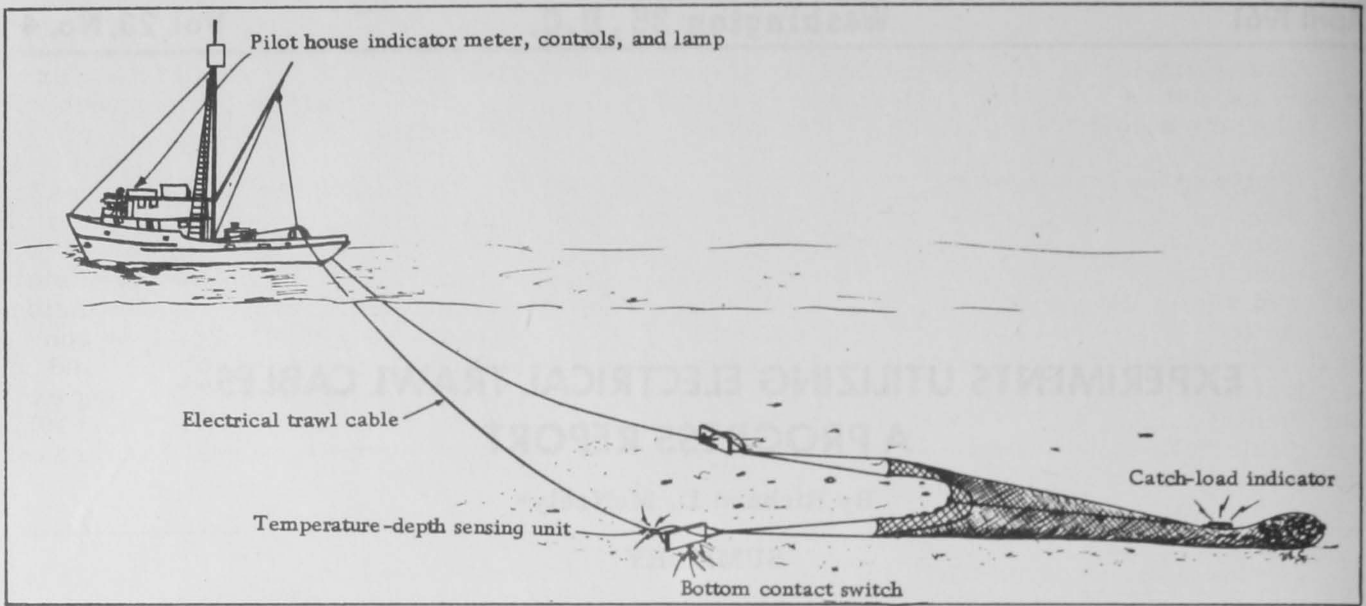

Fig. 2 - Multiple use of trawl cables containing electrical conductors on bottom trawling gear.

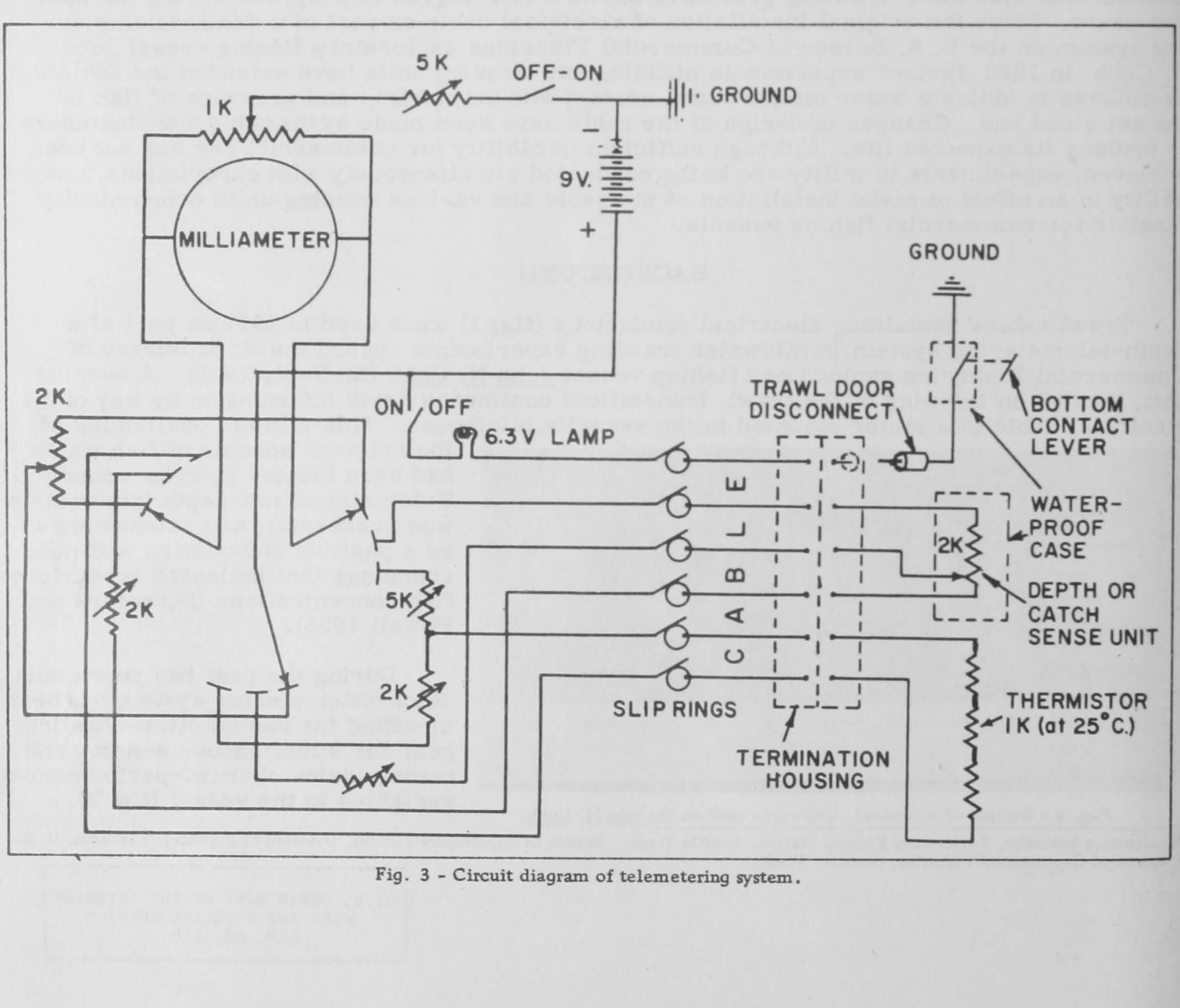

Fig. 3 - Circuit diagram of telemetering system.

SENSING UNITS

Transmission of data from three sensing units, designed during 1959 and 1960, has extended the use of electrical trawl cable to measure temperature, indicate bottom contact (and thereby actual time of fishing), and supply data on fish catches.

TEMPERATURE SENSING UNIT: Constant monitoring of bottom water temperatures was accomplished with a thermistor sensing unit. Three thermistors (figs. 3 and 4) with a nominal resistance value of 1,000 ohms each (at 25° C. or 77° F.) were hooked in series to form one leg of a bridge circuit actuating a meter located in the pilothouse. The thermistors, covered with a thin layer of rubber tape for insulation from salt water, were mounted inside a free-flooded section of either the depth-telemeter-sensing-unit housing or the cable connector.[1] The temperature-sensing instrument provides information which could be used for evaluation of fish distribution and abundance as related to water temperature during experimental fishing. Thermometric fishing techniques (Dietrich, Sahrhage, and Schubert 1959) using this unit could eventually be employed by commercial fisheries with probable increase in the catch per unit of effort.

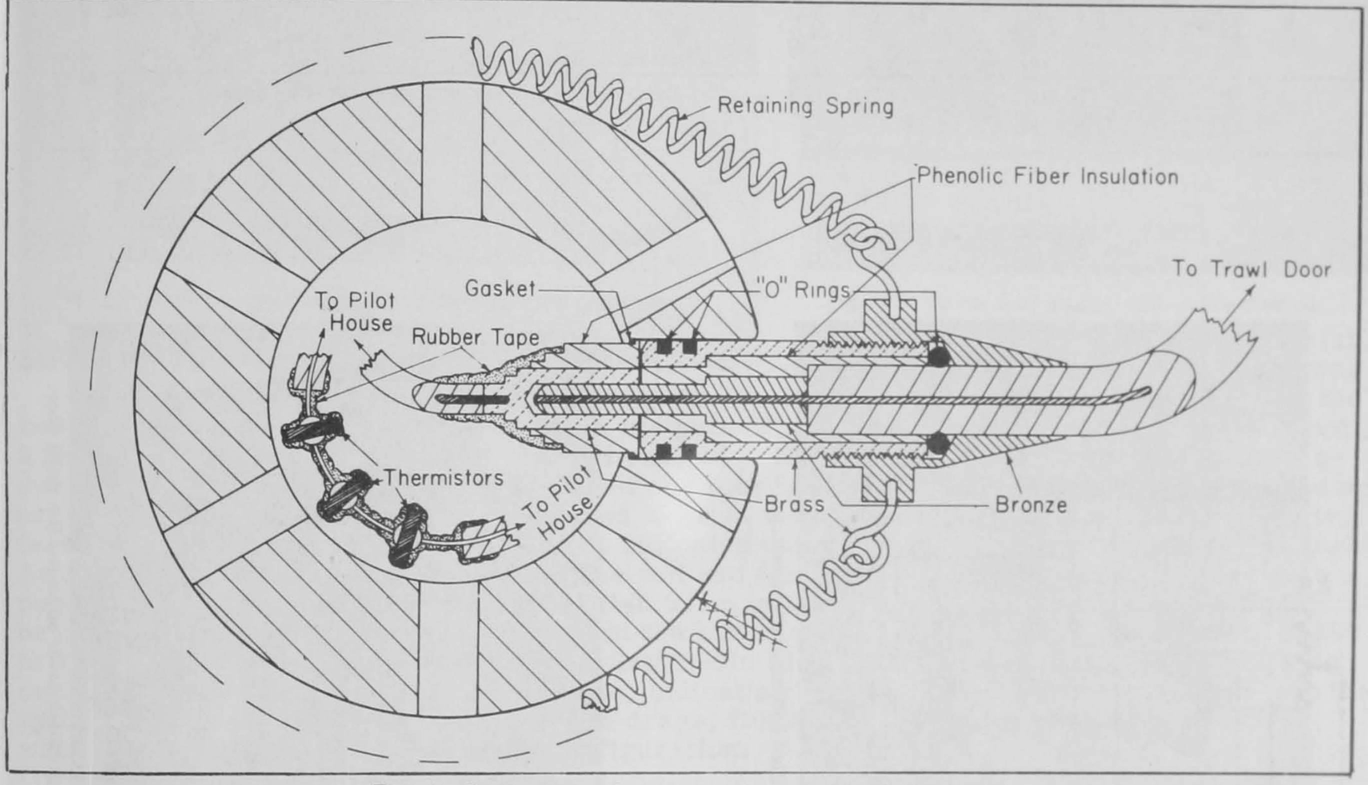

Fig. 4 - Cross-section of trawl door disconnect device.

BOTTOM CONTACT INDICATOR: This unit is designed to indicate when the trawl doors are: (1) on bottom, (2) on rough or irregular bottom, or (3) off the bottom. It is installed on the trawl door and consists of a small castor-oil-filled pressure housing (fig. 5) containing a set of contact points which are actuated by a hinge-type lever placed inside a cut-out section of the trawl-door shoe (figs. 6 and 7). When used with trawls employing dandyline gear, an O-ring-sealed quick-disconnect plug and interconnecting cable are used at the trawl door (figs. 4 and 8).

The unit operates by closing a circuit when the door is in contact with the bottom, causing a lamp to light in the pilothouse. Knowledge of the exact time the net reaches bottom, as well as information on the time the net departs from the bottom, should aid researchers in determining the elapsed fishing time of trawls and make possible more precise evaluation of fish catches.

1/Cable connectors are used whenever it is necessary to extend the electrical trawl cable past the detachable bottom-trawling doors to connect with sensing units located on the net (McNeely 1958).

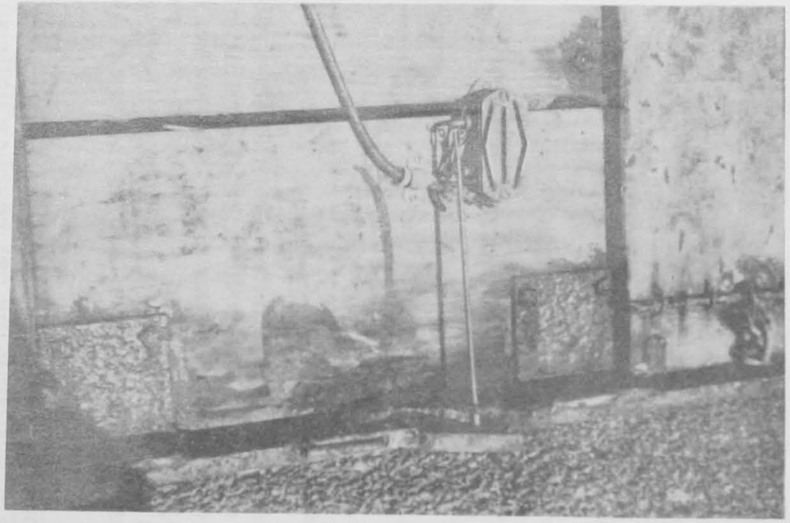

Fig. 5 - Oil-filled bottom contact switch.

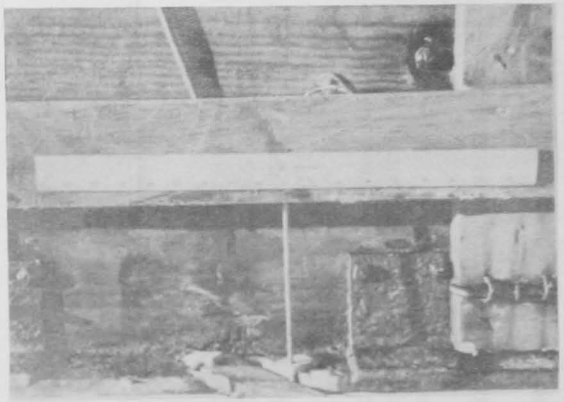

Fig. 6 - Bottom contact switch lever on small shrimp trawl door.

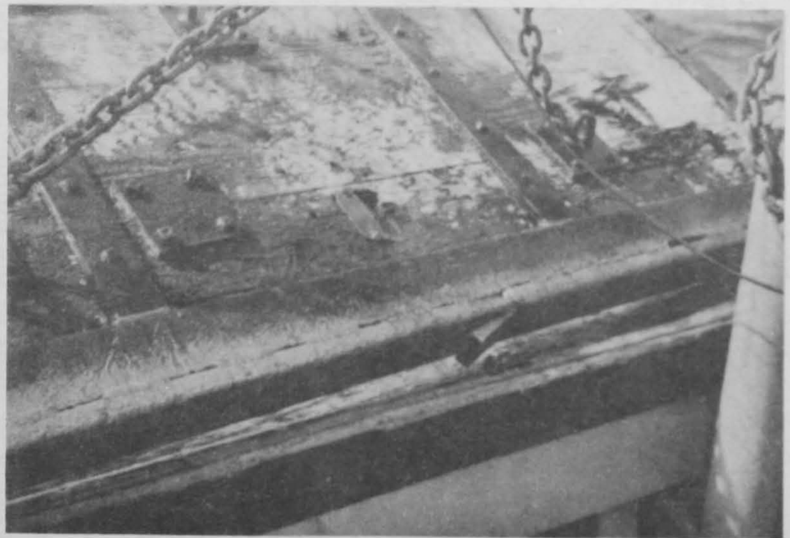

Fig. 7 - Bottom contact switch lever on heavy fish trawl door.

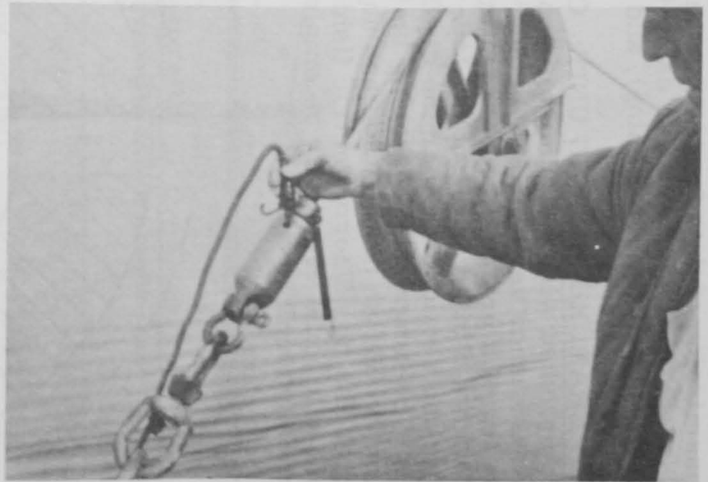

Fig. 8 - Disconnect device for trawl door instrumentation.

CATCH-LOAD INDICATOR: A sensing unit (figs. 9 and 10) designed to give continuous information on the quantity of fish caught as the drag progresses was given preliminary tests aboard the *John N. Cobb* during March and April 1960. This experimental sensing unit was named the catch-load indicator owing to the dual utility of the instrument. In addition to catch information, use can be extended to indicate changes in mesh configuration or strain on the mesh.

The sensing unit for the catch-load indicator consists of a linear-displacement electrical dynamometer, 11 inches long by 1 inch in diameter. It is hermetically sealed in a castor-oil-filled rubber tube protected from external abuse by a free-flooded copper-tube housing. Having no air spaces, the sensing unit is usable at any depth. Electrical continuity from the unit to the electrical trawl cable is provided by threading a $\frac{1}{4}$-inch, 3-conductor, rubber-covered, interconnecting cable through the webbing and along the riblines to the upper left wing of the net. At this point a waterproof quick-disconnect plug is used to bridge a necessary swivel on the end of the dandyline.

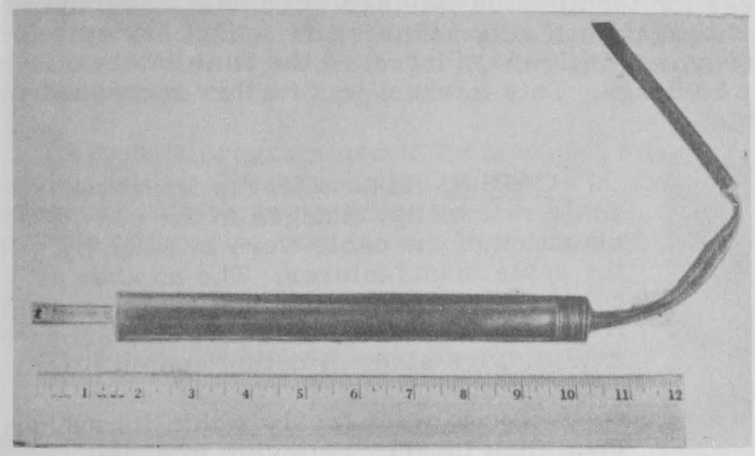

Fig. 9 - Catch-load sensing unit.

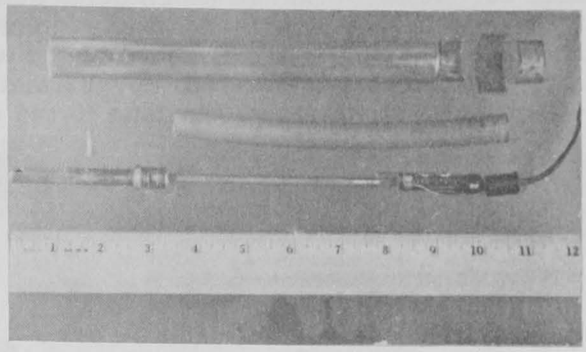

Fig. 10 - Catch-load sensing unit--disassembled.

During sea trials, 25 experimental drags were made in which this unit was tested in several positions on top of the cod end. When mounted perpendicular to the path of the trawl (cross-mesh) at points 1 foot, 2 feet, and 3 feet from the end of the cod end, wide fluctuations of the indicating meter occurred. When the sensing unit was placed one foot from the cod end, a rapid rise in reading was noted when only a few fish were found to be in the net.[2] By placing the instrument two feet from the cod end, a reading was not indicated until about 200 pounds of fish were caught. Attachment three feet from the end of the cod end further delayed indication of catches to a point that required about 700 pounds of fish to be in the net before a positive indication could be detected on the meter. When placed in the latter two positions and an initial catch of 200 to 700 pounds respectively was made, a detectable increase in meter indication took place over the remaining span of dragging time, indicating that fish were being caught and also the approximate rate of catch. During these drags, fluctuations of meter readings occurred, which suggested instability of mesh configuration.

Attachment of the sensing unit lengthwise to the meshes of the cod end at various positions from 3 to 8 feet ahead of the end of the cod end gave improved readings more closely corresponding to the fish catch,[3] and, although fluctuations still occurred, they were less pronounced. A series of drags with the sensing unit located eight feet from the cod end resulted in relatively stable readings and demonstrated that strain on webbing ahead of the cod end increases as the net loads with fish, and that this change can be detected and shown on a meter in the pilothouse.

CABLE AND CIRCUITRY MODIFICATIONS

Several modifications to the original trawl-cable telemetry system (McNeely 1958) were necessary to extend its use to bottom-trawling gear. The most important changes were made

2/Correlation of catches with meter indications was not attempted beyond noting gross values prior to hauling the net aboard and examining the catch. Towing time of these experimental drags ranged from 10 to 90 minutes.

3/No precise calibration of the meter was made as these tests were of a preliminary nature aimed at gaining design criteria for future units.

in the cable construction, pilothouse circuitry, cable terminations, and the slip-ring-brush assembly.

SLIP RINGS AND BRUSHES: To facilitate transmission of data from multiple-sensing units, the number of slip rings on the winch was increased to six. To accommodate the larger number of slip rings and brushes, ring width was reduced to one-eighth inch leaving a cross-sectional brush-contact area of approximately $\frac{1}{8}$ x $\frac{1}{4}$ inches. Carbon-filled bronze bushes, $\frac{1}{4}$ inch in diameter, were installed to improve brush wearing quality.

CIRCUITRY: Pilothouse circuitry (fig. 3) was modified to allow use of a 0- to 1-milliamp indication meter having a total pointer travel of $14\frac{3}{4}$ inches through 275°. Battery voltage requirements were lowered from 45 volts to 9 volts d.c. by use of low resistance values in the multiple-sensing units.

CABLE TERMINATIONS: Redesign of the cable termination was necessary to reduce cable conductor breakage which occurred near the termination fairlead when heavy commercial trawling gear was used. Replacement of the fairlead ring with a short socket having a cable support radius of $1\frac{1}{8}$ inches at the emergent end (fig. 11) increased the time interval between conductor failures to approximately 30 drags. This interval was further increased by factory-designed modifications to the cable.

Fig. 11 - Emergent end of cable termination socket.

CABLE: In an effort to improve cable reliability, changes in the construction of the cable were effected by the cable manufacturer. The number of copper wires per conductor was increased from 6 to 42 while retaining a No. 22 A.W.G. wire size. A cotton center filler and sheath was added to permit each conductor to work freely within its rubber insulation thereby relieving internal strain and increasing flexibility.

CABLE PERFORMANCE

The improved cable in use on the John N. Cobb has withstood 250 drags of heavy otter-trawling gear. During these drags there has been no indication of conductor failure other than near the cable termination (as previously mentioned). The time interval between conductor failures near the termination was found to be approximately 60 drags when the cable was new, decreasing with usage to approximately 20 drags between failures after 225 drags. At this writing, no breakage of steel strands has occurred. However, a serious problem with the cable was encountered during the last 50 drags. Loosening of the outer strands of the cable (fig. 12) was noted whenever 1,200 feet or more of cable was used. This condition is sometimes referred to as "birdcaging." Although the exact cause of this condition is unknown, three possible causes are suspected:

Fig. 12 - "Birdcaging" of electrical trawl cable. Match sticks are inserted to show looseness of strands.

1. Repeated snagging of the fishing gear on the bottom, in which the forward momentum of the vessel is completely stopped, placing a load on the cable estimated to be in the range of 12,000 to 16,000 pounds.

2. Differential torsional resistance in the two layers of steel strands.

3. "Rolling mill" action on the outer strands during passage through the trawl blocks.

A solution to the first two possible causes seems to entail re-design of the steel cable to provide a larger size with sufficient strength to counter the surges, and the accompanying acute strains, which occur frequently during bottom-trawling operations. A stronger cable does not appear to be a solution if the third possible cause exists.

A report on cable performance has been forwarded to the manufacturer's engineering section for study and recommendations.

COMMERCIAL OUTLOOK

Marine application of many electrical aids has markedly changed fishing-vessel operation in the past few years. Communication, navigation, indication, illumination, and control devices demonstrate the numerous uses of electricity. Electrical trawl cables may also eventually be used on commercial fishing vessels. Although sufficient durability for commercial use has not been achieved, experiments in durability of the system are being conducted simultaneously with experiments in utility. Since the term "sufficient durability" is relative to "utility" it is conceivable that successful development of a particular aid or combination of aids to commercial fishing gear may make the cable readily acceptable in its present stage of development.

Although programmed to be of direct benefit to the commercial fisheries, electrical towing cables also have numerous uses in oceanographic and fisheries research work. The experiments now in progress on the John N. Cobb are providing a foundation upon which private enterprise may build a new phase of the commercial fishing industry.

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