A DEPTH TELERECORDING UNIT FOR MARINE BIOLOGY[1]

By

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A serious obstacle to critical examination of stratification and diurnal migration of plankton has been the lack of instruments that enable the biologist to ascertain accurately the depth of his collecting net at the time of opening, fishing and closing. This lack has been felt particularly by those interested in the biology of organisms in the sonic scattering layer (D.S.L.). Since the vertical migration of these animals starts rather suddenly, proceeds rapidly, and extends through a great distance, precise determination of the depth at which the net fishes is essential.

Much justifiable criticism has been levelled at earlier investigations in which the fishing depth has been inferred from length of wire out and wire angle at the surface. These objections have been met in part by use of a time-depth recorder which has shown the fishing depth *after* the tow has been completed. Frequently it has been discovered, too late, that the net was nowhere near the calculated depth and that time had been wasted. In addition, mechanical failure of the recorder is not detected until the instrument is brought to the surface. Thus such recorders as have been in use have merely revealed the depth at which the net was fishing and have not provided data for setting and maintaining the nets at the desired depth. To meet the need for more accurate observation and operation, an instrument has been developed which records on deck with great accuracy the depth at which the collecting net is being towed.

This Depth Telerecording Unit has been used successfully in controlling the depth of a one-meter nylon plankton net at all times within a range of 3 m during a horizontal tow, even when more than 450 m of wire is out. The biologist controls the depth, as indicated on deck, by careful adjustment of ship speed and amount of wire out.

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With a modified Leavitt mechanism,[2] the collecting net was opened and closed at a known depth.

Frequent use of this instrument together with the wire-angle method of ascertaining depth should provide data which will lead to greater accuracy for the latter method or which will, at least, describe the limits of accuracy for that method.

The Depth Telerecording Unit has been fabricated at Scripps Institution both as a separate unit and as a built-in accessory to other instruments. The instrument, which is relatively simple and inexpensive to build,[3] provides dependable accuracy as well as sufficient ruggedness to ensure long life expectancy.

The instrument consists essentially of a 10,000 ohm Giannini Microtorque potentiometer actuated by the Bourdon mechanism of a James P. Marsh 4-inch Master Gage, type 100, 0–1500 psi, 0.5% accuracy. These and other components of the instrument are protected from ambient hydrostatic pressure by a thick-walled pressure-tight steel chamber. The Bourdon element is completely filled with silicone oil to prevent corrosion by sea water. Pressure (depth) is measured through an opening in the pressure-tight chamber. This opening is sealed by a Sylphon 1-ply brass compliant bellows, approximately 2 cm in length and in diameter, to prevent loss of silicone or intrusion of air or water.

The 10,000 ohm potentiometer, selected because it produces only small battery drain, permits the use of mercury cells in the circuit. The result is essentially constant voltage for relatively long periods of time, thus making frequent battery changes or depth calibration unnecessary. The interior of the instrument, showing the method of connecting the Bourdon mechanism to the potentiometer, is shown in Fig. 1. Rotation of the shafts of the Bourdon and of the potentiometer is limited to 270°.

In assembling this instrument, proper adjustment of the flexible coupling between the Bourdon mechanism and the Microtorque potentiometer is essential. The coupling, nothing more than a short length of neoprene O-ring stock, is drilled at the ends for a press fit over the end of each shaft. However, in order to realize the low-torque characteristics of the potentiometer there must be no end thrust on the shaft. Adjustment may be made by eye because there is ample axial clearance. The actual adjustment is not critical so

[2] Leavitt, B. B., 1935, A quantitative study of the vertical distribution of the larger zooplankton in deep water. Biol. Bull. Woods Hole, *68:* 115–130.

[3] In the United States, cost of components and materials, exclusive of cable and recorder, is approximately $100. Shop time required to build the instrument is approximately 30 hours.

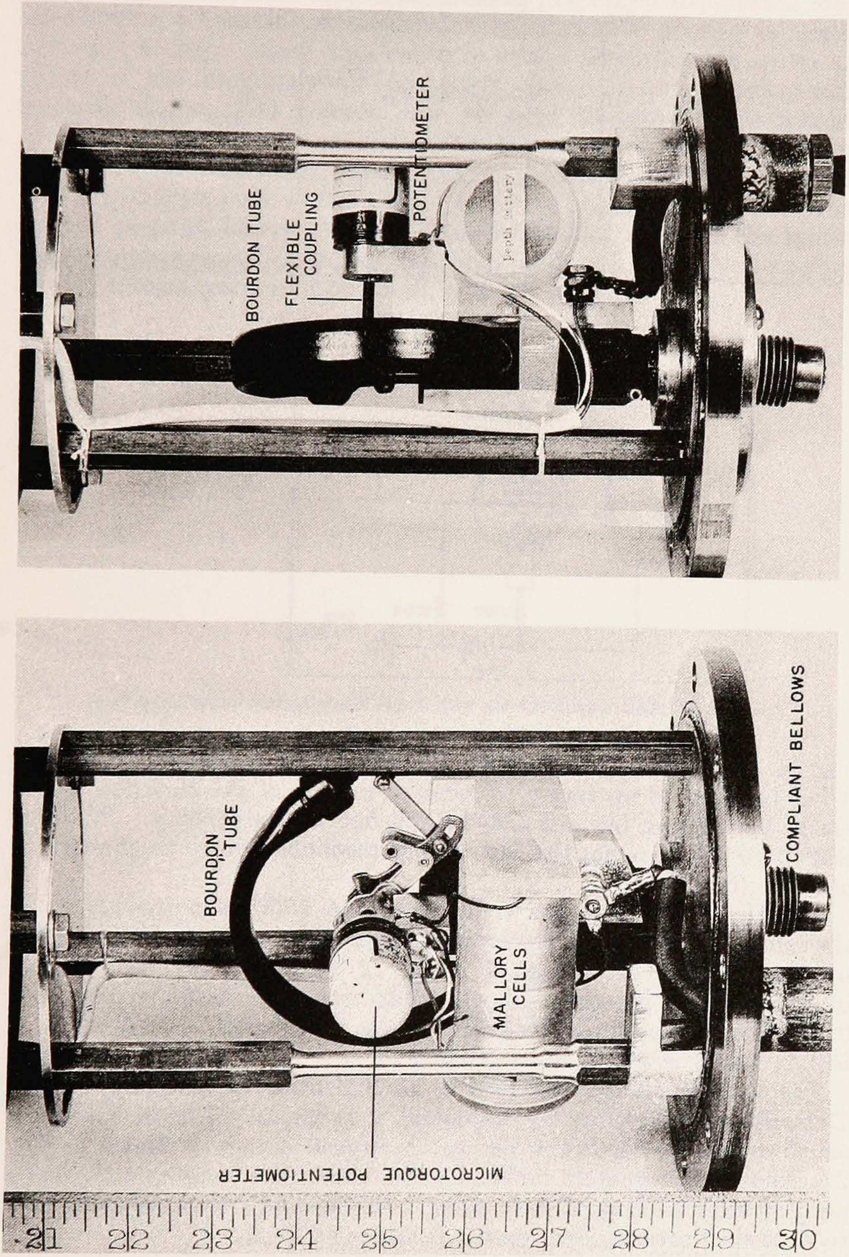

Figure 1. Interior views of Depth Telerecording Unit. 1V5 vacuum tube not shown. Scale in inches.

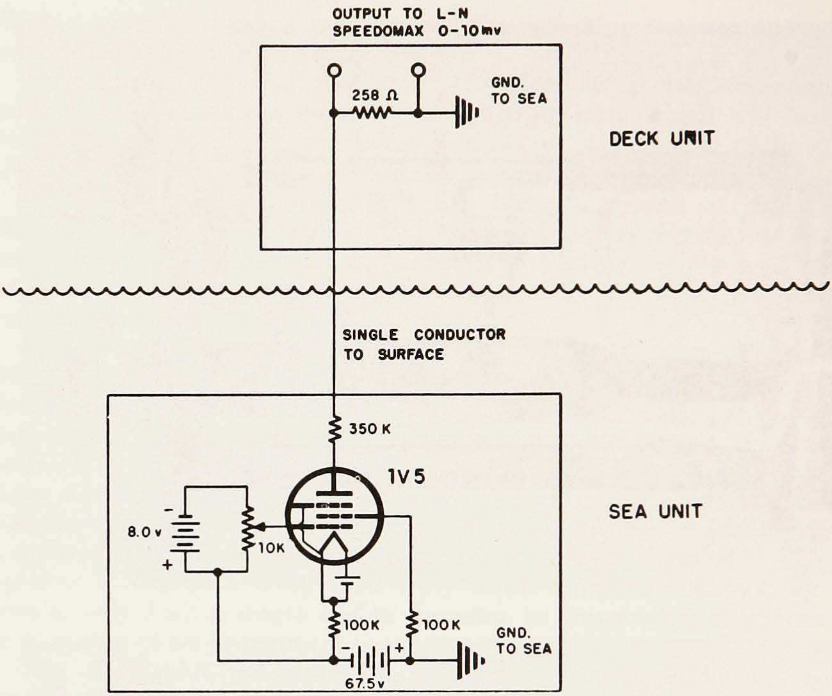

Figure 2. Typical circuit for use with single insulated conductor to surface.

long as the shaft is nearly midway between the thrust limits. Also, it has been found necessary to increase tension of the Bourdon mechanism hair spring beyond that established at the factory. Without these two adjustments the instrument responds poorly to changes in pressure (depth).

The Unit is accurate to within less than 0.5% of actual depth in the range of 0–1000 m. Experiment has shown that it is little affected by temperature. A change of 20° C. (27° to 7°) produced a change in response to pressure (depth) that was substantially less than 0.25% (the temperature coefficient is less than 0.012). At a depth of 500 m the error would be less than 1 m.

The instrument may be used as an indicating or recording device. Depending on the circuitry employed, it is capable of operating along single or double conductor cable. A typical circuit is shown in Fig. 2. Here the instrument includes a 1V5 miniature vacuum tube which permits telerecording of data along a single-conductor insulated cable to a Leeds-Northrup Speedomax recorder on deck.

The cable used with this instrument is polyethylene-jacketed steel wire having a breaking strength of more than 2700 pounds (approximately 100 kg). Since this cable is nearly weightless in water by virtue of the buoyancy of the tough plastic jacket, a substantial fraction of the 2700 pounds may be used to support instruments and tow nets. The investigator should use whatever safety factor he considers desirable. There are, of course, some inertia loads that result from ship motion, etc. A simple accumulator, made from several loops of heavy shock cord and installed between the meter-counting sheave and the boom, has been used with this cable to reduce inertia loads experienced on small, active vessels.