SERIAL TEMPERATURES BY BATHYTHERMOGRAPH.

by

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Emphasis is often placed upon efficiency of survey to the extent that hydrographers, although they recognize the need for more complete velocity-of-sound information, may be reluctant to take sufficient time from actual sounding to obtain adequate velocity data. The Bathythermograph promises to be the answer to most of these problems. A preliminary form of the instrument was developed by Professor A.F. SPILHAUS of New York University in cooperation with Woods Hole Oceanographic Institution. One was built for the Coast and Geodetic Survey by the Submarine Signal Company, and it was used on the "*Oceanographer*", F.S. BORDEN, commanding, during the season of 1939. A brief description of the instrument and a preliminary summary of the results are given here pending a more complete report which may be compiled after the analysis of velocities is made.

With this instrument it is possible to obtain a continuous serial temperature record up to depths of 75 fathoms while the party is performing other routine tasks, for example, picking up a buoy. Ample time is afforded, since experience indicates that the speed of lowering or raising the instrument may be as much as ten fathoms per minute. While it is a very practical and simple device, producing results of an accuracy adequate for determining velocity of sound for use in radio acoustic ranging or echo sounding, it is still necessary that the vessel be stopped to use the Bathythermograph described in this report. It is understood, however, that a more recent development by Professor SPILHAUS may be used while the vessel is underway at moderate speeds. We shall await details of this new improvement with interest, but, meanwhile, the existing instrument has an important advantage in shoal water echo sounding surveys, or in areas where large and abrupt regional temperature variations are encountered.

Referring to Figure 1 it may be seen that the Bathythermograph is essentially a metal tube containing a pressure element and a bimetallic reed fitted with a stylus which makes contact with a piece of special smoked glass. The lower half of the tube contains the pressure element which is made up of a series of metallic bellows enclosing a spring and guide mechanism. The lower end of this pressure element is secured to the lower eye-casting while the upper end is fitted with a plunger having a serrated periphery, making a water-tight assembly.

The upper half of the Bathythermograph permits the free entry of sea water through perforations. This part contains the bi-metallic reed and recording mechanism. The lower end of the reed is attached to the pressure element through heat insulating material while the upper end is fitted with a light cantilever spring carrying the stylus. The slide holder is placed opposite the stylus and contains the smoked glass on which are recorded the elements of depth and temperature. The cam is a simple device used to lift the stylus clear while the glass is inserted or removed. The cam lever, attached to the cam on the outside of the tube serves also to indicate that the stylus is clear when the lever is at right angles to the axis of the instrument. When the lever is turned to snap into the opening in which the glass is inserted, the latter is locked in place. The special tool for disengaging the glass is screwed into the tube near the top so as to be readily accessible. To remove the glass the tool is inserted through a small slot diametrically opposite the slide opening, slight

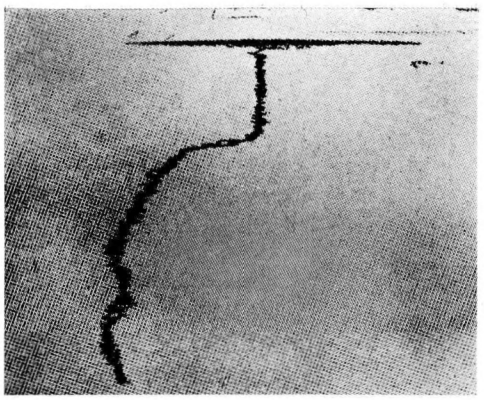


FIG. 2.

Normal record under good conditions. Maximum depth 65 fathoms. Temperature range 9.4° C. to 18.6° C.

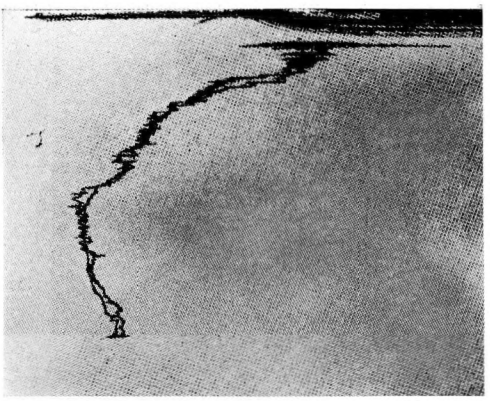


FIG. 3.

Record showing duplicate trace with excessive vibration of reed near surface due to choppy sea. Bottom depth 54 fathoms. Temperature range 8.2° C. to 21.3° C.

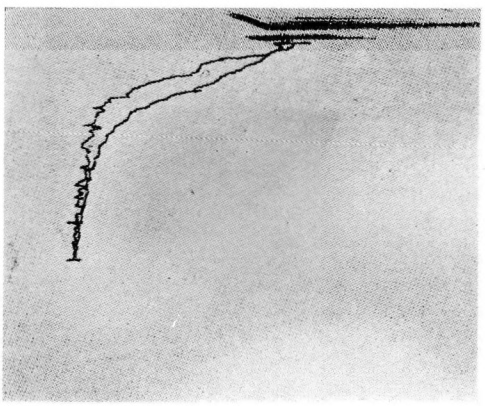


FIG. 4.

Double trace caused by lowering or raising instrument too rapidly. Bottom depth 42 fathoms. Temperature range 7.9° C. to 20.7° C.

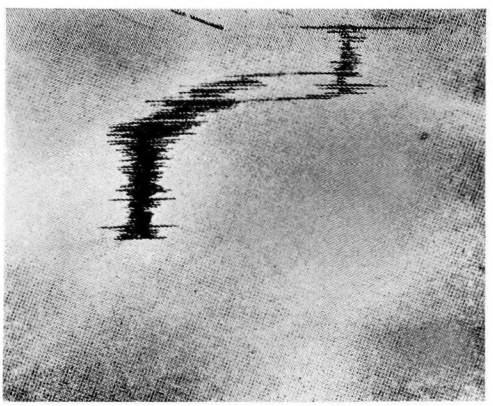
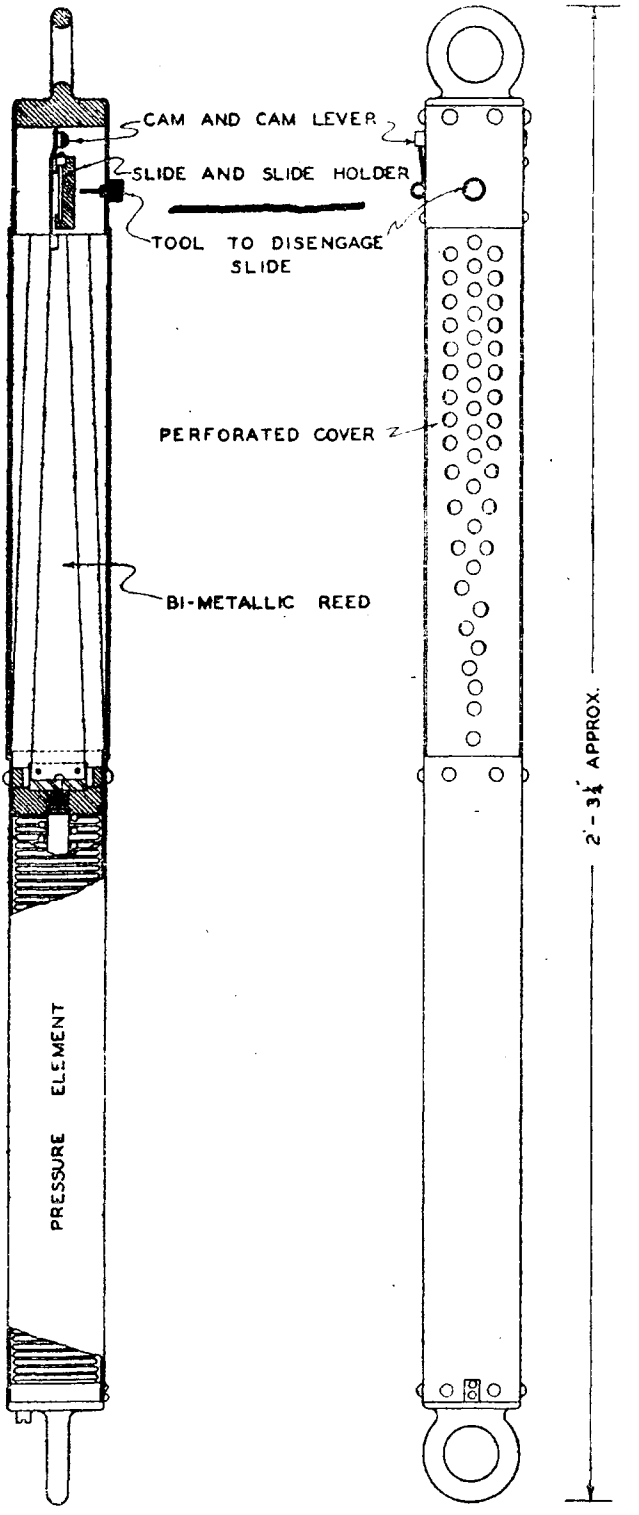


FIG. 5.

Excessive vibration caused by heavy chop and long swell. Temperature curve obtained nevertheless. Bottom depth 42 fathoms. Temperature range 6.7° C. to 19.5° C.



TYPE 780 B

BATHYTHERMOGRAPH

FIG. I.

Type 780 B — *Bathythermograph.*

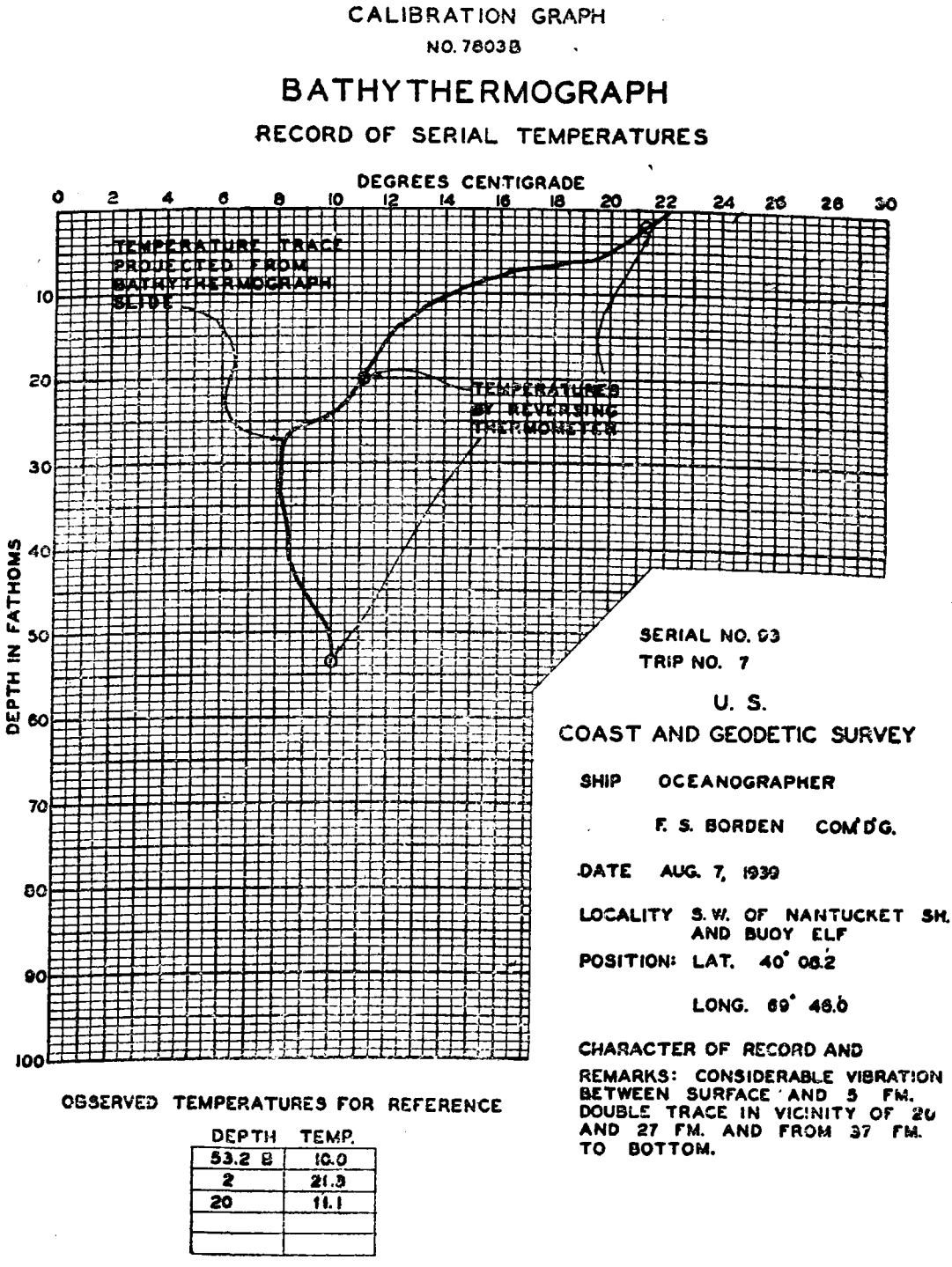


FIG. 6.

Graph traced from projected record.

pressure is exerted, and the glass ejected far enough so it may be grasped between finger and thumb for complete removal.

The principle of operation is simple. When the Bathythermograph is submerged, the water pressure compresses the pressure element and carries the bi-metallic element with it longitudinally along the tube, thus causing the stylus to make a straight mark, parallel to the tube axis, across the smoked glass. The length of this mark is proportional to the pressure acting on the bellows assembly. The bi-metallic element is continually exposed to the water, and as the temperature of the water varies this reed will bend. The amount of bending will be proportional to temperature changes in the water, and the stylus will produce a curve on the glass varying with temperature and depth, the latter being independent of direct measurement once calibration is made.

The range of the instrument is from 0° to 30° C. of temperature and depths between sea surface and 82 fathoms. The record is made on a piece of non-corrosive glass which is one inch wide and 1-21/32 inch long, smoked on one side where the record is traced by the action of the stylus. It is completely exposed to the water which does not affect the coating.

Reproduced with this report are four enlargements of the original smoked-glass records. (Fig. 2 to 5). The trace obtained on the glass is small, and of course cannot be interpreted conveniently without enlargement. For this purpose a commercial enlarging camera, the type used for 35 mm. film, fitted with a good lens was obtained to enlarge and project the trace. A variety of such projectors will be found in any camera supply store. Each of the records made this season was compared with at least three simultaneous observations made by reversing thermometer. After calibration of instrument and projector, one temperature and one depth would be adequate; for example, surface temperature and bottom depth. These data would provide a satisfactory check on the orientation of the slide on properly prepared graph paper.

The Bathythermograph was supplied without calibration, and before the records were used it was necessary to calibrate it. Eight by 10-1/2 inches was selected as a desirable size for the graph to be prepared for the enlarged trace, and an enlargement of approximately eight times was found desirable. It will be noted from the sample graph, Figure 6, that the abscissa, representing temperature, varies on the arc of a circle. This is due to the bending of the bi-metallic reed with the varying temperature. The radius of this circle on the enlargement is equal to the length of the reed times the amount of the enlargement. For the graph illustrated it is seven feet four inches (eight times the 11-inch length of the reed between fixed base and stylus). With these arcs constructed so as to cover depths up to 100 fathoms, the scale for subdivision of the arcs in degrees of temperature, was determined by projecting a series of 18 or 20 slides for which the ranges of temperature had been accurately determined. Using the mean values the arcs were graduated into the proper subdivisions and the form shown in Figure 6 prepared. It was reproduced accurately to scale by the Division of Charts (Washington, D.C.) and a supply for the season prepared for the "*Oceanographer*".