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THE BATHYKYMOGRAPH, A DEPTH-TIME RECORDER

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ABSTRACT

A device (bathykymograph) is described which records pressure (depth) on a time scale. It is inexpensive, rugged, and easily calibrated. Operation, construction, and limits of accuracy are discussed.

INTRODUCTION

Tuna frequently escape under the leadline of a purse seine (McNeely, 1961). To understand this problem and perhaps to increase seining success it is necessary to know the depth of the leadline at any time during the fishing operation. A device which records pressure or water depth on a time scale was developed to provide this information. This instrument is called a bathykymograph due to its ability to sense and record changes in pressure with time. A patent application has been filed by the U. S. Department of the Interior for the senior author, who conceived the device and was responsible for its development.

CONSTRUCTION

The BKG (bathykymograph) consists of four assembly groups, three of which are shown in figure 1. They are A - the pressure sensing piston assembly, B - the piston housing, and C - the case. The fourth group, the recording assembly, is shown mounted on the piston housing group (fig. 2). This construction is illustrated in section in figure 3. The key to figure 3 follows:

1. A protective cover which guards the threads on the end of the piston housing. Holes allow the water to enter and leave freely the space between the cover and the face of the piston. This cover can be seen in place in figure 2. For calibration purposes it is replaced by a cover equipped with an "O" ring seal and a fitting for a pressure line and gauge.

2. "O" ring sealed piston. The diameter of the piston depends upon the depth requirements of the instrument. Standard tolerances for a reciprocating "O" ring seal are used.

3. "O" ring seal between the piston housing assembly and the case.

4. Paper clamp.

5. Pressure sensitive paper. This paper is on a roll inside the recording drum concentric with the piston housing. The free end passes through a slot in the recording drum and is wrapped once around the drum. The paper is secured by tightening the wing screws as illustrated.

Note.--Frank J. Hester, *Fishery Research Biologist*, and Donald C. Aasted, *Able Bodied Seaman*, Bureau of Commercial Fisheries Biological Laboratory, U. S. Fish and Wildlife Service, San Diego, California; and Robert W. Gilkey, *Senior Laboratory Mechanician*, Scripps Institution of Oceanography, University of California, La Jolla, California.

Figure 1.--Three assembly groups for the bathykymograph. A - the pressure sensing piston assembly, B - the piston housing, and C - the case.

Figure 2.--Assembled bathykymograph with cover removed.

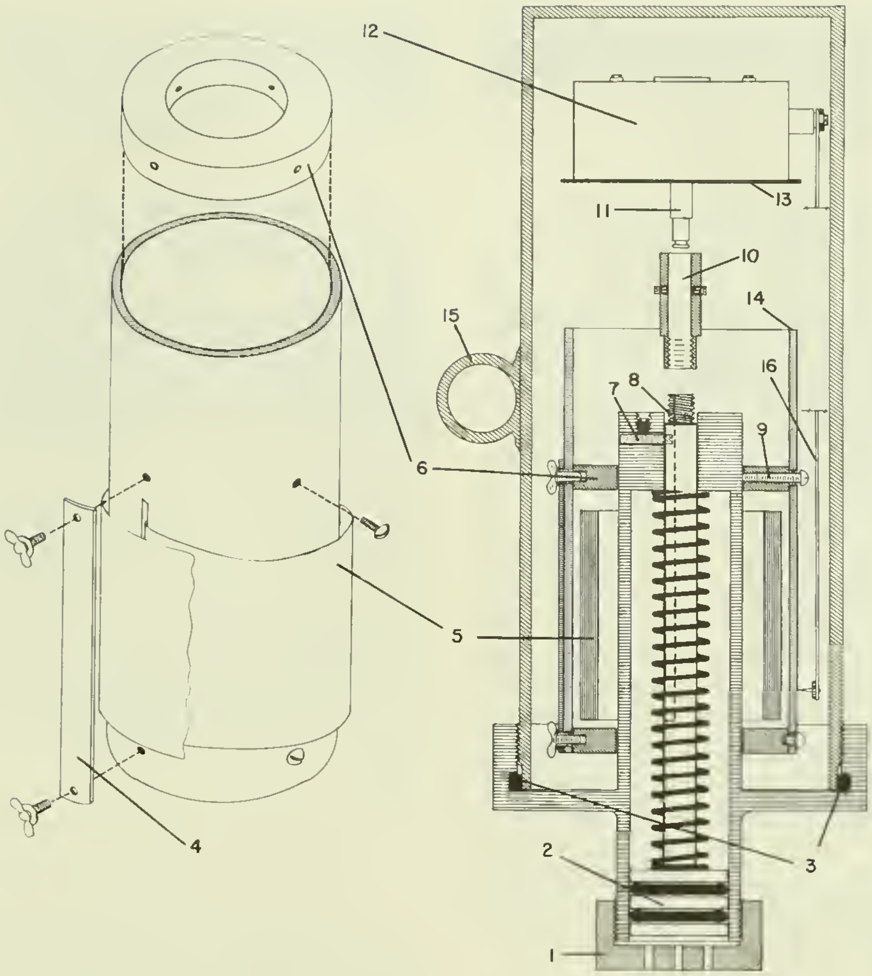

Figure 3.--Sectional view of bathykymograph. See text for explanation.

6. One of two spacer rings used to mount the recording drum to the piston housing.

7. Pin.

8. Keyway in piston shaft. This keyway and pin 7 prevent the piston from rotating in its housing.

9. Setscrew to clamp the recorder drum to the piston housing.

10. Clock to piston coupler. One end is threaded to the piston shaft; the other is bored to receive the clock shaft which is secured by the two setscrews. The coupler has been drawn detached for clarity. It can be seen in position in figure 2.

11. Clock shaft.

12. Clock housing.

13. Lower edge of clock housing. This is notched or knurled to fit the upper edge of the recording drum.

14. Upper edge of the recording drum.

15. Ring for attaching the case to the net.

16. Stylus assembly. This consists of a spring arm (broken in figure 3) and a recording point. The arm and point can be swung aside while changing paper.

Most of the metal parts are 6061 T6 aluminum. The drum and spacer rings are plastic. The clock used is from a kitchen timer and runs for 55 minutes.

OPERATION

The clock is wound by turning its housing clockwise 350°. The recording drum is adjusted by loosening its setscrew (9 in fig. 3) until its notched rim engages the lower rim of the clock housing and the paper clamp bar is in the position shown in figure 2. The setscrew is then tightened, the case screwed on, and the assembled BKG, padded as necessary, is tied to the net by means of a line through the ring welded to the case. As the BKG enters the water, the water pressure moved the "O" ring sealed piston in its housing compressing the spring. This movement carries the lower rim of the clock housing away from the upper rim of the recording drum and allows the clock to start. This rotates the clock housing counterclockwise about its shaft. As it rotates, the clock housing carries the stylus, which provides a time mark. The excursion of the piston in the piston housing moves the clock housing and stylus, making a trace on the depth-time scale of the recording paper. A typical trace is shown in figure 4.

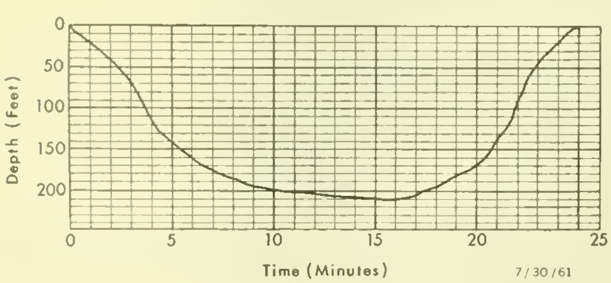

Figure 4.--Typical trace obtained from a purse seine. The abscissa is in minutes and the ordinate is depth in feet. (Hester, 1961.)

CALIBRATION

Calibration of the BKG can easily be accomplished by replacing the protective cap by a calibration cap and applying fluid under measured pressure to the face of the piston. The clock can be calibrated by reference to a known standard.

ACCURACY

The strength of the spring and the diameter of the piston were chosen to give a full-scale deflection equivalent to approximately 100 meters in sea water. Combined errors give a usable accuracy of ± 2 percent of this full-scale deflection. These errors arise from friction losses between the piston and the walls of its housing, internal air temperature changes, changes in water density, and free-play losses including that incurred through the necessity of unseating the clock housing from its notch on the recording drum. The latter error can be reduced by using knurling instead of notches. The friction loss is minimized by maintaining a high polish on the piston housing bore and lubricating the "O" ring with a good grade of silicon grease. A single "O" ring on the piston was found to give a satisfactory seal.

COST AND CONSTRUCTION NOTES

The dimensions of the device will vary with the application. The model described can be constructed for about $130. The cost of materials is low per unit. The total cost varies more with labor than with construction materials. Corrosion resistant aluminum is satisfactory for most of the parts. Machining is minimized by having the case constructed of pipe or tubing. The piston housing may be cast, but this can result in a porous bore which requires sleeving.

The diameter of the piston and the strength of the spring depend upon depth requirements. The spring should compress linearly with depth over its useful range to facilitate calibration.

The clock is from a standard kitchen timer. Timers are usually shrouded in some sort of decorative shell which, when removed, leaves the clock mechanism mounted by bolts in a metal case. The clock housing can be constructed by attaching the stylus to this case as in figure 2 and notching the rim. For use on fishing gear, care should be taken that the weight supported by the clock shaft (the clock housing and stylus) is kept as light as possible.

ACKNOWLEDGMENTS

Suggestions by George Hammond of Scripps Institution of Oceanography, Jack Chaffey of Chaffey's Machine Shop in San Diego, and Marine Advisers, Inc., of La Jolla concerning design and construction problems are gratefully acknowledged.

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