

There is considerable difficulty in stating precisely how accurate these circles are. When it is considered that there are 4320 lines on each of these circles and that on these 9-inch circles an angle of one second is about 0.00002 inch, one must have considerable numerical data to support any statement made. These circles certainly are accurate within the tolerance of two seconds of arc given in the specifications. It is believed that they may be within approximately  $\pm 1$  second.

The successful carrying out of this program of preparation, graduation, and calibration of precision-circles at the National Bureau of Standards has involved the fullest cooperation of several technical divisions of the Bureau, particularly the divisions of metallurgy, chemistry, optics, and weights and measures. L. V. JUDSON, chief of the length section, has had the immediate supervision of this program and B. L. PAGE has carried out the actual graduation of these circles.

A paper giving more detailed technical description of this work is in preparation.

## IDRAC APPARATUS FOR MEASURING VERTICAL SUBMARINE CURRENTS.

by

PIERRE IDRAC.

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(See also : *International Hydrographic Bulletin* No. I, 1934, p. 15.

*The Hydrographic Review*, Vol. V. No. 2, Nov. 1928, p. 155.

" " Vol. VII. No. 1, May 1930, p. 238.

" " Vol. IX. No. 1, May 1932, p. 235).

This apparatus is intended for measuring the vertical component of a deep-sea current (submarine or sublacustral).

It consists essentially of a screw on a vertical axis, the blades of which are slightly inclined to the horizontal, the whole being mounted in a specially designed casing, the details of which it would be too long to go into here. The peculiarities of the mounting are such that, due to the perfect symmetry of form about the horizontal axis and a great dissymmetry of weight, the axis of the screw is truly vertical in any current, and this screw, wholly insensitive to horizontal currents, can begin to rotate only if the current includes an ascending or a descending component; the speed of rotation of the screw is very nearly proportional to this component.

The screw operates a revolving contact so designed as not be influenced by electrolytic phenomena, and provided with a make-and-break system arranged to give Morse signals.

The reading device, fitted on board the vessel, consists of a Wheatstone bridge with milliammeter, balanced by means of an adjustable resistance. The breaking of the current destroys the balance of the bridge and causes the pointer to move.

The dissymmetry of the signals selected (*U* or *D*, according to the direction) enables a distinction to be made between the ascending and descending movements, and also obviates doubts arising from the rolling of the ship.

Owing to the clearness of the signals, the insulation need not be perfect, and experience has shown that a well insulated flexible two-core (9/10 gauge) cable, as used in commerce, is sufficient to ensure both the transmission of the electric current and the support of the apparatus, which is of very light weight (about 11 lbs).

This apparatus, which starts giving readings at a vertical current velocity of 3 cm/sec. can easily be used from a small craft and lowered down to several hundred metres depth.

Trials of the apparatus were made last summer in the *Eider*, of the Monaco Oceanographic Museum, with a view to exploring the submarine springs off Cap Martin. It was thus ascertained that the vertical current engendered by the spring furthest off-shore attained 25 cm/sec. in certain places, and that of the spring nearest the coast, 50 cm/sec. This shows the considerable output of these springs, which must be considered as veritable submarine discharges from a small underground river.

The same apparatus has been used in the bay of Villefranche with the assistance of the Zoological Laboratory and of M. TRÉGOUBOFF; the trials are being continued in order to ascertain whether the vertical movements might not, at times, account for the migration to the surface of animals from great depths.