CURRENT RECORDER

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INTRODUCTION

The current recorder studied and produced by the « Service des Etudes et Recherches Hydrauliques de l'Electricité de France » was originally intended for the carrying out of a single series of current recordings in the estuary of a port for which this information was urgently required. Consequently, it was designed with the dual purpose of enabling the economical reconversion of the component parts and of requiring noly a very short time for adjustment.

From the very first tests carried out, the electro-magnetic part of this apparatus proved to be sturdy and easy to handle. The only adjustment necessary was the replacement of a master clock equipped with an electric-impulse distributor, as the type manufactured was not suitable for the purposes required. As the « Service d'Etude de l'Utilisation des Marées » (The Department of Studies of the Use of Tides) has had occasion to test this material and subsequently to put it to frequent use, certain modifications have been considered for increasing the watertightness of the hull and for facilitating the analysis of the results.

The apparatus described in this paper is the original model.

I. — GENERAL DESCRIPTION OF CURRENT RECORDER

The apparatus consists of:

— a watertight cylindro-conical shell of aluminum alloy ending in a crossed tailpiece (Fig. 1, Pl. I).

— two hydrometric vanes placed one at each end and protected from impact by strong rings (Figs. 1 and 3, Pl. I);

— a drawer enclosed in the central compartment of the current recorder and containing the electro-magnetic recording equipment as well as the storage batteries (Fig. 2, Pl. I).

The speed of the current is recorded by means of hydrometric vanes connected with a standard type of chronograph recorder.

The set of the current is recorded on the same apparatus from data transmitted electrically by a compass.

The current recorder floats freely and the tailpiece sets it in the direction of the current (1). It is attached to a mooring block by swivels, and the distance of the current recorder to the bottom is naturally adjustable (Fig. 5, Pl. II).

(1) Its total length is 2 m., its diameter 0.40 m. and its weight 80 kgs. ; it also has a buoyancy reserve of about 80 kgs.

II. — RECORDING OF SPEED

(a) *Vanes and polarized relays* (2).

The speed of the current is measured by means of two vanes, each of which controls a chronometric type of polarized relay.

These relays consist of a ratchet-wheel which moves forward one tooth per pair of impulses (positive and negative) transmitted by the vane. This ratchet-wheel, through two electric contacts, actuates two recording electro-magnets of the recorder in such a way that the styluses of these electro-magnets mark the recording tape every ten and sixty pairs respectively of impulses of the vane, i.e. for a vane with a 1/20th reduction every 200 and 1200 revolutions.

(b) *Recording*

The recorder used (« Brillié » manufacture) consists of 12 recording electro-magnets, 4 of which are used for recording speed (two for each vane) and 8 for recording direction.

The recording tape is of waxed paper, 120 mm. wide and about 25 m. long. It unwinds at a speed of 120 mm. per hour, which permits an independent working period of about eight days. The tape is actuated by a spiked wheel controlled by a polarized electro-magnet which receives every ten seconds a pair of electric impulses transmitted by a robust clock mechanism. In this way, the the speed of the current is:

(c) *Analysis and Errors*

If L (in millimetres) is the distance on the recorder of N consecutive pips, the speed of the current si:

$$V = K \frac{N}{\frac{L \times 3\,600}{120}}$$

the constant K depending on the stylus used.

The stylus attached to the first impulse reducer (N = 200) allows for the convenient measurement of the intervals between successive impulses at speeds of between 10 and 50 cm/s (the intervals being of about 4 mm. for the latter speed). Beyond that point the additional reduction is made by multiplying by 6 the intervals between impulses.

This method of measuring speeds allows for the elimination of most of the random causes of error because

— the comparison of the speeds indicated by the two vanes enables the proper functioning of the vanes, polarized relays and recording relays to be checked; it also enables the possible slowing-down of one of the impellers by an extraneous body (e.g. seaweed) to be detected;

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(2) The vanes manufactured by the « Compagnie des Compteurs » are particularly well suited to this use on account of (a) their complete watertightness (magnetic transmission), (b) their reverser contact which eliminates the error due to the swing of the impeller, (c) their interchangeable impellers (in moulded plastic), and (d) the fixing of the impeller in a Rilsan bearing which gives an excellent performance, even in lime-impregnated water, without servicing.

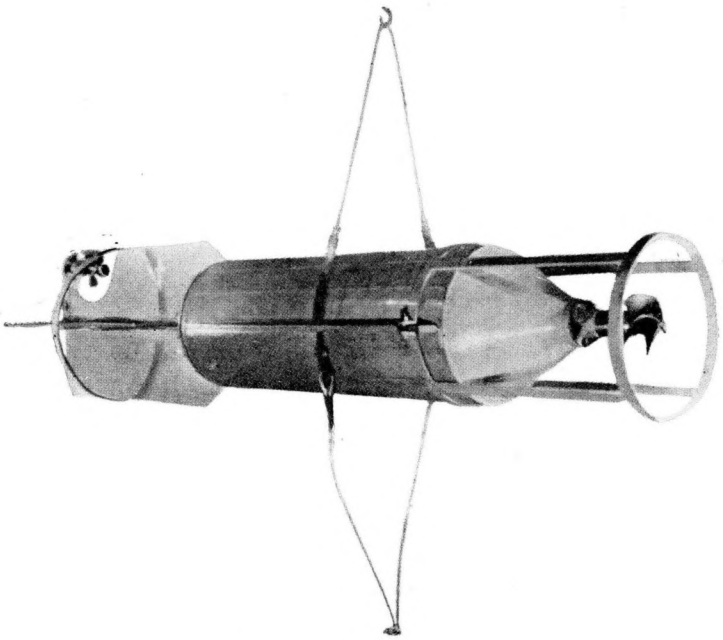

Fig. 1
Currentmeter in working order.

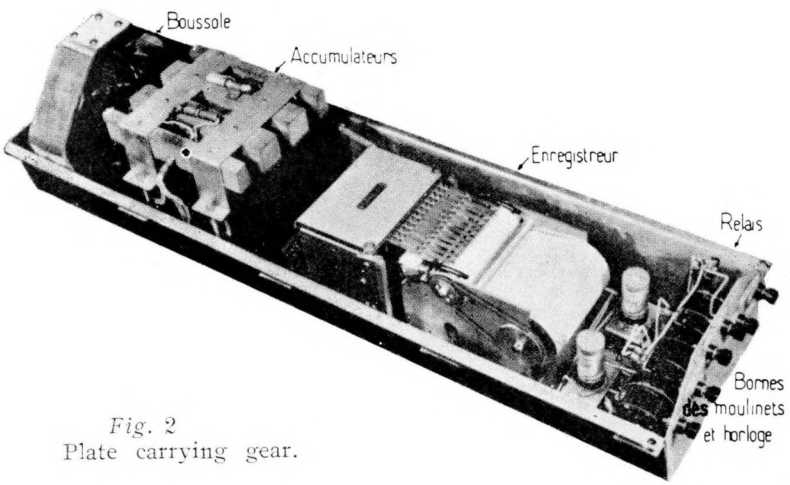

Fig. 2
Plate carrying gear.

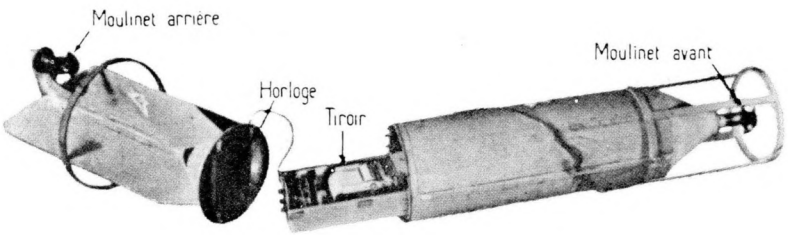

Fig. 3
Currentmeter (open).

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Fig. 4
The electrical transmission compass.

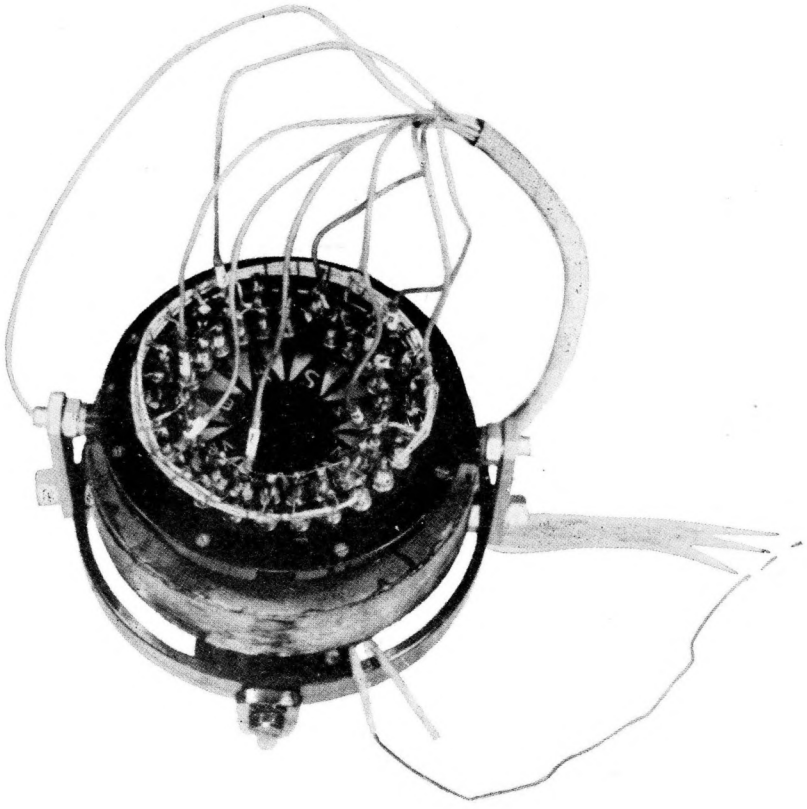
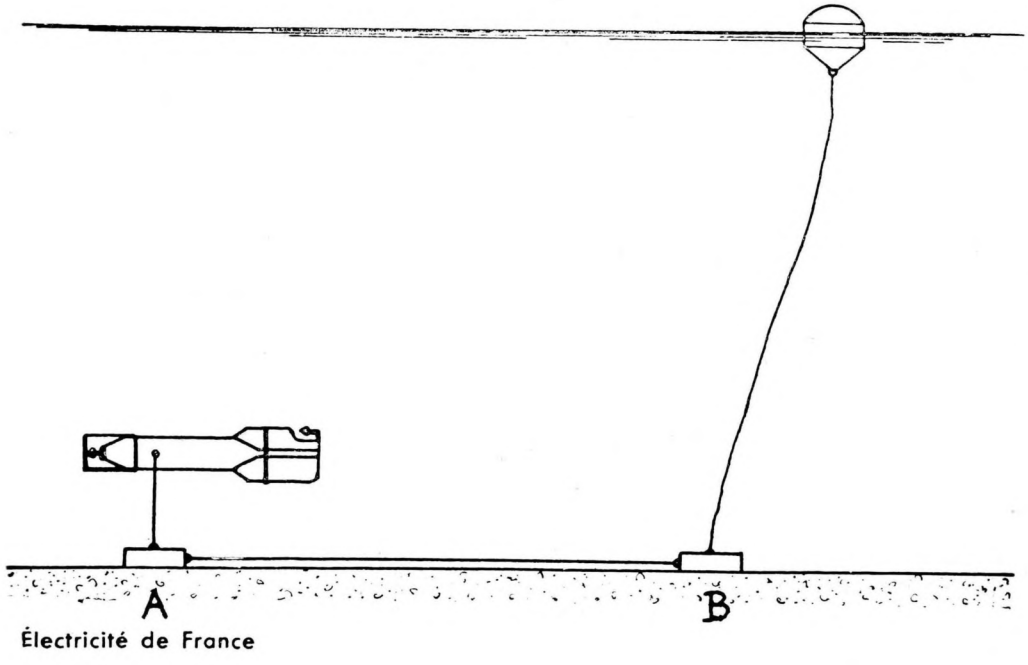


Fig. 5
Currentmeter moorings



— the regular unwinding of the recording tape (which is graduated in hours) is controlled by the length unwound and by the time indicated by the movement of the clock at the moment of hauling.

On the other hand, the systematic errors of measurement are as follows:

— error in the calibration of the vane (1 to 2 %);

— error in analysis: the absolute error in L does not exceed 0.2 to 0.4 mm.

The total error in the measurement of speed, for speeds greater than 0.10 m/s and for a recording interval of from 5 to 10 minutes, is less than 3 % with a minimum of 0.02 to 0.03 m/s in absolute value.

III. — RECORDING OF DIRECTION

Direction is recorded by means of an electrically transmitting compass which feeds 8 electro-magnets of the recorder.

(a) *Description of compass* (Fig. 4, Pl. II)

The compass consists of the following parts:

— on the movable rose: 4 flexible electric contacts;

— on the pane of glass covering the rose: a double crown of contact-studs (48 in all) each connected with one of the 8 electro-magnets of the recorder;

— around the bowl of the compass: a so-called « rocking » coil.

These different parts function as follows:

— under normal conditions, the compass rose revolves freely;

— every 5 minutes, a chronometric relay, controlled by the clockwork which distributes the impulses, actuates the coil for 10 seconds;

— the bar magnets of the rose have a tendency to orient themselves according to the lines of force of the resulting magnetic field, thus causing the rose to rock. This movement is interrupted by the electric contacts which strike against the studs of the upper pane, thus actuating 3 or 4 electro-magnets of the recorder.

A careful selection of the distribution of the studs connected with each electro-magnet enables the recording of 50 distinct positions of the rose in relation to the crown of studs, each position, in fact, being shown by a combination of the numbers of the relays under tension.

(b) *Accuracy of measurement*

The maximum theoretic error of measurement is $\frac{360}{50 \times 2} = 3.6$ degrees, which is easily checked by calibration. However, the recording error is larger at sea, mainly because of the oscillations of the float in a horizontal plane.

It seems that in practice the average error is ± 4 degrees, which is quite acceptable.

Note:

This result is only valid for speeds greater than 0.05 m/s. For lesser speeds, the float does not orient itself well in the direction of the current.

IV. — USE OF THE CURRENT RECORDER

Maintenance of the current recorder normally only requires re-charging the batteries (6 V., 60 Ah) and replacing the recording tape.

However, in view of the special conditions of service at sea, it is necessary (in the case of continuous use) to check up approximately once a month on the correct operation of the various parts.

Experience acquired up to date indicates that the mooring of the apparatus is best effected as shown in Fig. 5 (Pl. II). The current recorder is hooked to a concrete mooring (« A »), weighing approximately 300 kg., which in turn is attached to a second mooring (« B »), weighing about 100 kg. A surface float connected with the latter is designed for hauling up the whole unit.

In its present form, the hull of the float can be used to 50 metres of immersion; however, a study has been made of a reinforced hull for recording to depths of 450 metres.

V. — RESULTS OF USE

Six apparatus were built, three of which were used during the summer of 1953 in the area between St. Malo, Granville and the Chausey Islands.

Several thousands of hours of recording were obtained which enable the Hydrographic Office's records for this area to be verified and determined in greater detail.

The current recorders operated satisfactorily, but in order to allow for longer use of the equipment, it has appeared necessary to undertake a further study of the body, which was first constructed in a light metal and proved to be insufficiently protected against corrosion. A new hull made of plastic material is on trial.

The device controlling the speed-recording styluses will also be slightly modified, but without in any way reducing its strength and reliability. This modification will considerably decrease the relatively long period required for analysis of the recording tape with the standard apparatus.