

Fig. 3

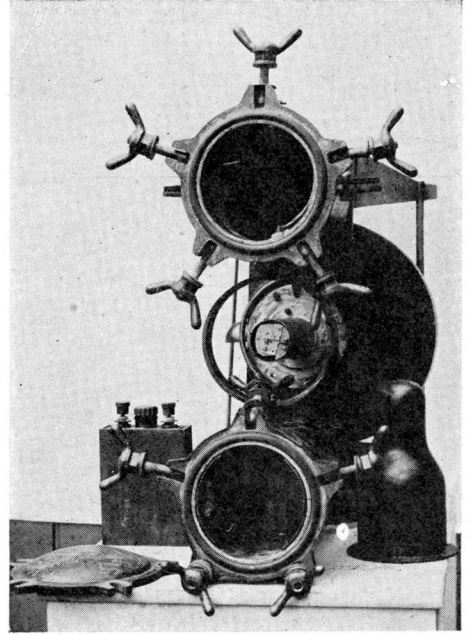


Fig. 5

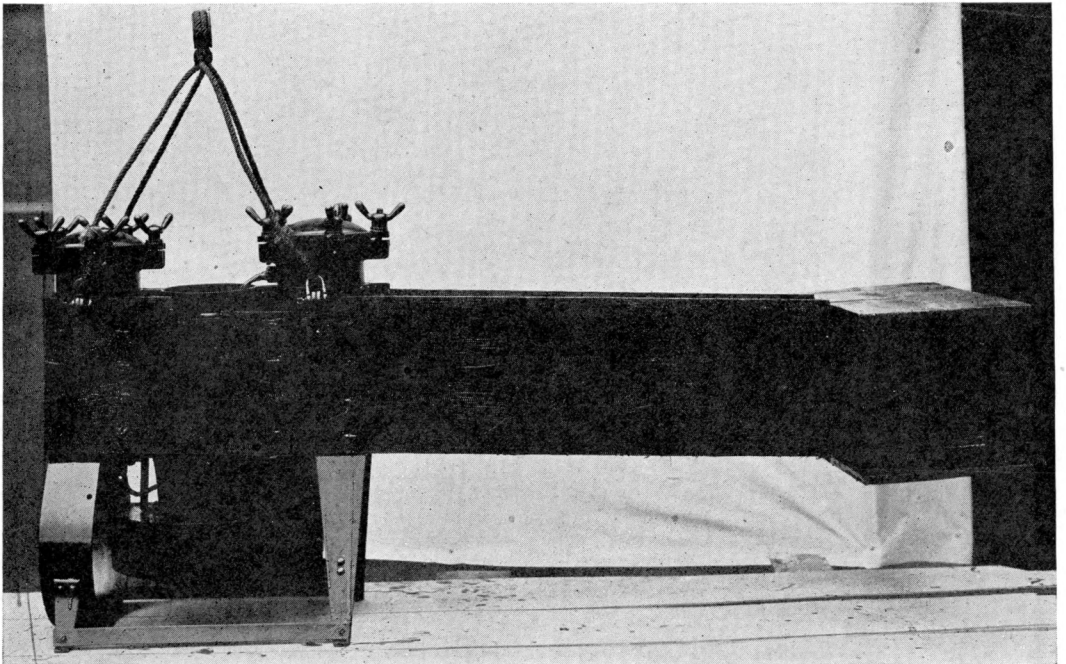
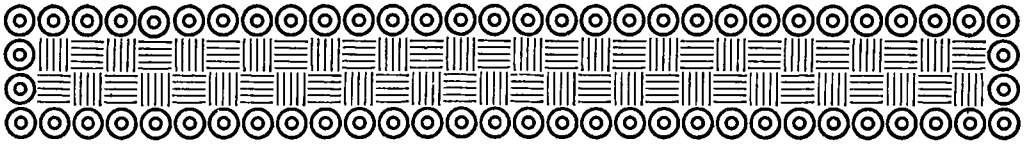


Fig. 4



## NEW SPEED AND DIRECTION RECORDER FOR SUBMARINE CURRENTS

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It is of great value in the study of the circulation of sea water to obtain a continuous record of the direction and the speed of currents below the surface with an apparatus which may be left several hours, or even several days, unwatched. It is with this in view that I constructed the appliance described below which registers the currents, at different depths, with reference to a fixed point (a float attached to a grapnel) or to a movable point (a vessel) the drift of which is known.

The record is obtained photographically in the inside of the instrument on an ordinary commercial film which unwinds at a fixed speed.

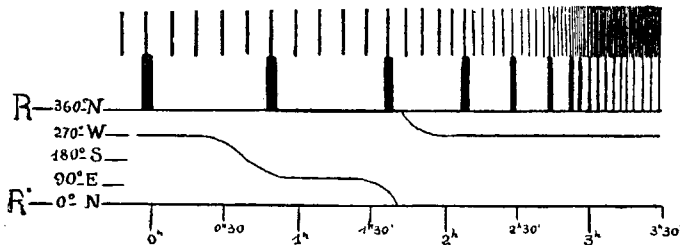


Fig. 1

The upper part of the film contains the record of speed which appears as a series of vertical lines (figure 1) which lie closer together and are narrower the stronger the current. The number of such lines per unit of length ( $\frac{\%}{m}$  or  $\frac{m}{m}$ ) gives the speed of the current directly in knots (or sea-miles per hour) by means of a table attached to the instrument. This part of the film may be divided into two if desired (as shown in the attached diagram) in order to obtain two different degrees of sensitiveness for high and low speeds.

The lower part of the film records the direction of the current. This record takes the form of a curve (contained between two fixed straight lines R and R1) the abscissae of which are proportional to the time and the

ordinates to the angle at which the direction or the drift of the current lies from North (1).

For example, in the curve shown here diagrammatically, the current runs first to the West from 0 h. to 0 h. 30, then between 0 h. 30 and 1 h turns from West to East through South, remains at East from 1 h to 1 h. 30, then 1 h. 1.30 and 2 h. goes back from East to West through North and remains constant at West until 3 h 30.

With reference to speed in this example, at first it is weak and steady from 0 h. to 1 h 30 gradually increases from 1 h 30 to 3 h. and remains constant and strong from 3 h to 3 h 30.

The whole of the apparatus is enclosed in a system of water tight compartments suitably shaped, on the rear of which there is a rudder and on the lower part of which there is a vane which is caused to turn by the current (figures 2, 3, 4 and 5).

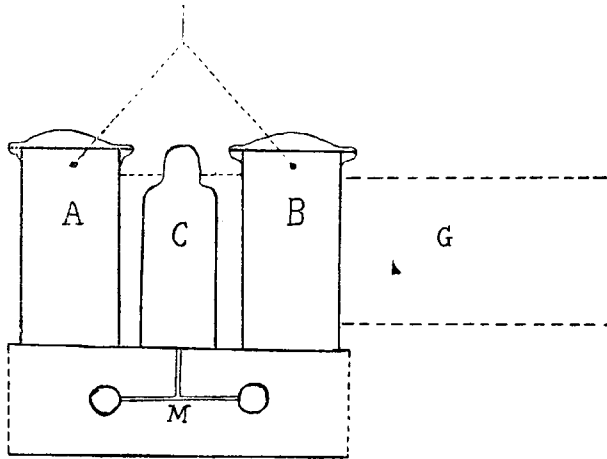


Figure 2 schéma de l'Appareil

The instrument consists of a cylindrical brass box *A* which can be closed hermetically by means of a cover. This contains the recording devices which consist of :—

(1) An interchangeable photographic loader which contains the film and the clockwork.

(2) The direction recorder which consists of a liquid compass the card of which has been replaced by a blackened dial on which are white marks illuminated by an electric lamp. A system consisting of a narrow slit and a lens throws an image of part of this dial onto a part of the film in the form of a luminous point which traces the direction curve.

(3) The speed recorder, which consists of another electric lamp controlled by a contact connected with the vane, and lights up a white line intermittently. The image of this line appears on the film.

(1) Passing through East; in other words, the current running to the East will read 90, to the South 180, to the West 270 and to the North 360 or 0.

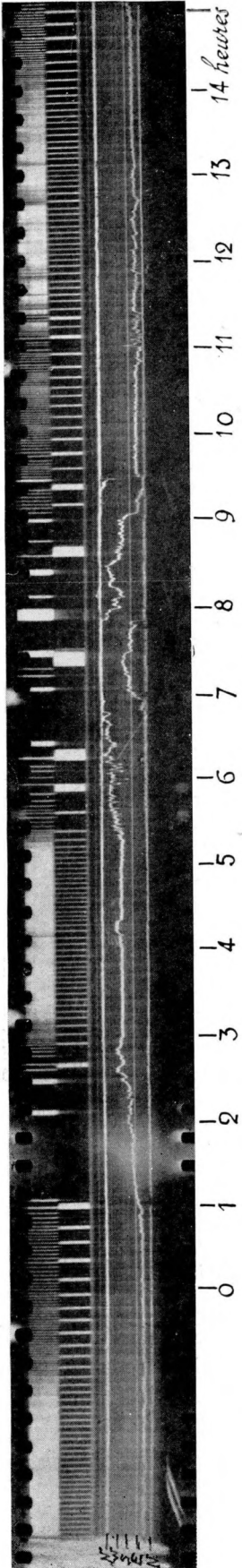


fig. 6

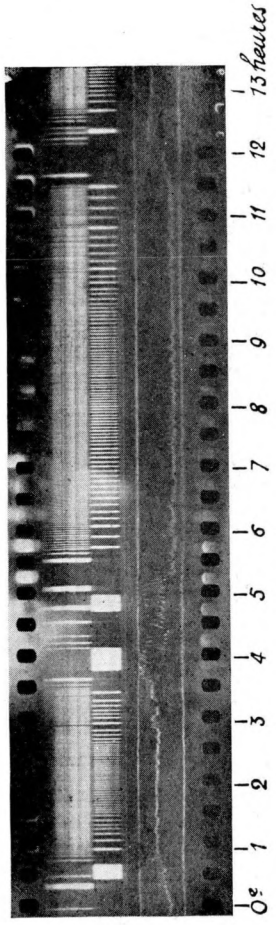


fig. 7

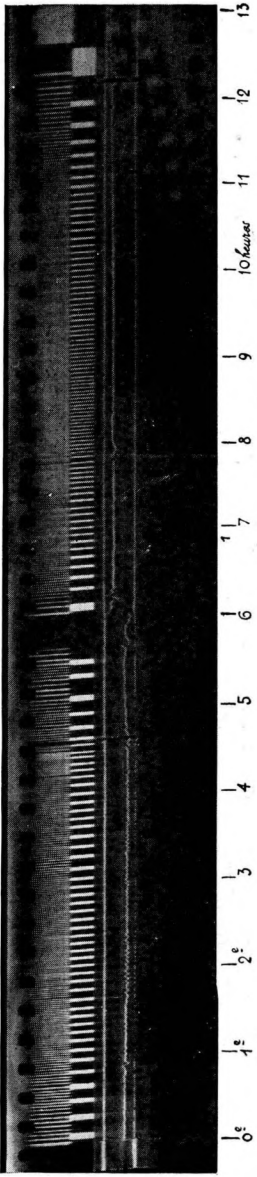


Fig. 8

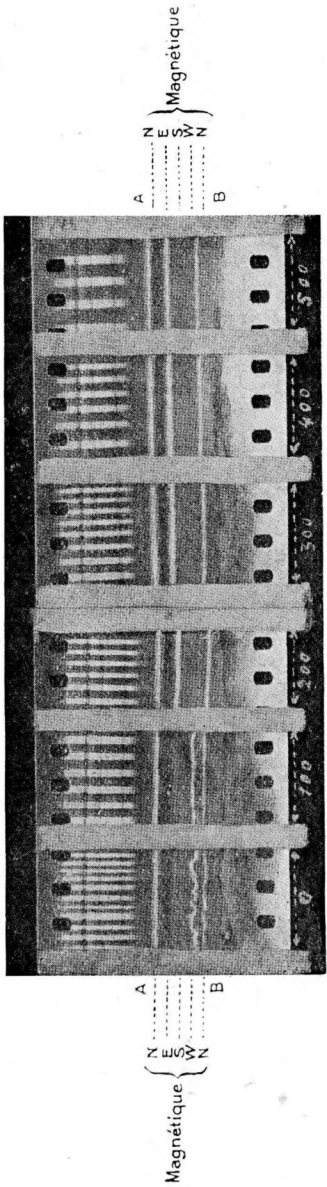


Fig. 9

A second cylindrical box *B* contains the accumulator for lighting up the electric lamps for the direction and speed recorders respectively.

Finally, between the two boxes, *A* and *B*, there is an air bell *C* which contains the reduction system and the electric contacts protected from sea water. These electric contacts are those for the speed record and are controlled by the vane *M* which is a vertical and is placed at the bottom of the instrument.

The whole is contained in a stream-lined case onto which is attached the rudder *G*.

The instrument, the first form of which is shown in the figure was constructed with the assistance of the "*Office National des Inventions*". It is patented in France and in foreign countries and is now made on a commercial basis by Messrs. BARBIER, BENARD & TURENNE, lighthouse constructors of Paris.

This type, which is intended for use in shallow water (up to 100 m.) will work for several consecutive days without being brought to the surface. Another type intended for use in deeper water (up to 2,000 m.) is now being constructed, but it will only work four and a half hours on end.

Various records have already been obtained with this instrument. Originally experiments were made in 1927 by the "*Pourquoi Pas*" for the study of certain currents in the English Channel and the Bay of Biscay. These experiments showed definitely that the currents in the Channel are mass currents and not surface currents (2) and that there is a break generally speaking (i.e. that the reversal of the surface and submarine current is not simultaneous).

Thanks to the kindness of the harbour engineers of the self-governing port of Havre and particularly of Monsieur TESTE which allowed me to adjust my original instrument, we have been able more recently to make some trials of long duration at this port. Two diagrams (figures 6 and 7) are reproduced here which were obtained in the Outer Port last month. These show, particularly in figure 7, a series of pulsations or of alternating variations of the current (changing from East to West and from West to East with a period of about five minutes) at the time of slack water which, as far as we are aware, were unknown before these experiments made with Monsieur TESTE. They are probably due to the phenomena of resonance in accordance with the proper period of oscillation of the basins in the port.

Another diagram (figure 8) which includes, as do the others, two successive tides, was obtained near Villerville in the estuary of the Seine.

Finally I constructed a very light instrument on the same principle which will act for two hours only, but which can be used at depths of from 500 to 1,000 metres for the purpose of exploring the Straits of Gibraltar where, as is well known, a strong current, which is frequently an annoyance to

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(2) This is in accordance with theory and had been demonstrated by the work carried out in the Channel by Monsieur Courtier.

sailing vessels, runs from the Atlantic towards the Mediterranean. The work of Dr SCHMIDT on the salinity and the temperature of the waters of the Straits caused him to predict that there would be a counter current in the lower strata, though its existence has often been disputed.

The new photographic current recorder which I tested last summer on board the "*Pourquoi Pas*" made it possible for me to obtain records of current during the month of March at a point to the South of Tarifa, which is the narrowest part of the Straits, down to a depth of 500 m.

It was possible to use this instrument, which is very portable, on board an ordinary rowing fishing boat starting from the beach at Tarifa, which is the point of Spain which projects most towards the middle of the Straits. The instrument was lowered by means of a Warluzel winch which was specially built for the purpose and which was not bulky and was easy to use. By this means I was able to take soundings in the Straits to a depth of 500 m. with very simple appliances which had not been used until then.

Thus, below a depth of 150 m. I always found the counter current running from the Mediterranean to the Atlantic at a speed which sometimes exceeded that of the surface current.

As an example a reproduction is given here of a record obtained in about 600 m. of water at each 100 m. of depth, on the 13th March at 14 hours to the southward of Tarifa at a point lying in latitude  $35^{\circ} 57.9'$  North, longitude  $5^{\circ} 36.1'$  West. It will be seen from the record reproduced (figure 9) that the surface current (in which there are some irregularities on account of the movement of the boat due to the sea) runs from South West  $\frac{1}{4}$  West at a speed of 1.4 knots at the surface and of 0.8 knots at 100 m. Then it turns sharply to East  $\frac{1}{4}$  South and remains there right to the bottom running at a speed of 1.1 knots at 200 m., 1.2 knots at 300 m., 0.9 knots at 400 m. and 0.5 knots at 500 m.

These then are the first results obtained with these instruments at the very outset and we hope to extend them shortly by making closer study of coastal currents and those in the open sea.

