# AN IMPROVED TYPE OF CURRENT METER (*)

by

V. WALFRID EKMAN, LUND.

(Extract from the *Journal du Conseil Permanent International pour l'Exploration de la Mer*, Vol. VII, N° 1, Copenhagen, April 1932, p. 3).

---

In connection with preparations for an oceanographical expedition, organised in co-operation with B. HELLAND-HANSEN, I have endeavoured to construct a new current-meter on the same principles as an instrument which was already supplied 27 years ago by the Central Laboratory at Christiania (1). The velocity of the current is calculated in the usual way from the number of revolutions of a "screw" or gauge wheel after the pattern of a screw propeller; and the direction of the current is repeatedly recorded by means of bronze balls dropped from the south end of a compass-needle down into numbered sectorial compartments at the bottom of the compass-box. The measurement is begun on the arrival of a messenger and is finished on the arrival of a second one.

Some years ago the writer invented on the same principles a larger instrument, the *Repeating Current-Meter*, with 47 messengers, for the purpose of taking at one haul a large number of consecutive, complete current-records (2). On the above-mentioned expedition this instrument proved to be invaluable for the investigation of currents at several hundred metres below the surface. But for investigations in the upper water-layers a less complicated and more easily handled single-record instrument is sufficient. As the result of successive improvements of the Central Laboratory type, Alfred MERZ has described two such instruments (3), differing slightly, one for weak or moderate currents and one specially for very strong ones up to 3 metres per second.

In the new instrument here described — which may be called the *Protected Current Meter* — I have used some of the characteristic features of the MERZ current-meter; but it cannot replace the strong-current type of the latter instrument. The alterations from the original type of 1905 have been made with the object of attaining the following requirements, viz :—

1. More solid construction and more reliable functioning.
2. Easy reading of the instrument and saving of time in taking measurements.
3. Protection of the screw from drifting sea-weed and other clogging material till the very moment when measurement begins.

Figures 1 & 2 do not represent the very latest type, but the differences are insignificant. These figures show the instrument before and after arrival of the messengers.

The main part of the instrument turns as usual in ball-bearings round its vertical axle. The upper end of the latter, or the "head" *H*, to which the sounding-line should be attached, is made after the simple pattern which was described in connection with the Repeating Current-Meter, although with an extra device for securing. The loop at the end of the sounding-line must not exceed 4.5 $^{c}/_{m}$ in length, the knot included; it is intended, however, to get rid of this inconvenience by making the head considerably larger.

The direction of a weak current will be wrongly recorded, if the plane of symmetry of the current-meter is not exactly vertical, and if at the same time the tail and the front part of the instrument do not balance one another. I have endeavoured to avoid *both* causes of error. To secure as far as possible the vertical adjustment of the axle, the rope carrying the sounding-lead is not attached directly to the eyelet but to an

---

(*) *See also* Hydrographic Review, 1927, *Vol. IV*, N° 2, pp. 207, 208; 1928, *Vol. V*, N° 2, p. 155; 1929, *Vol. VI*, N° 1, pp. 157, 231; 1930, *Vol. VII*, N° 1, pp. 115, 238; 1931, *Vol. VIII*, N° 1, p. 271.

(1) V. Walfrid EKMAN. Kurze Beschreibung eines Propell-Strommessers, *Publ. de Circons. N° 24, Copenhagen*, 1905.

(2) V. Walfrid EKMAN. On a New Repeating Current-Meter, *Publ. de Circons., N° 91, Copenhagen*, 1926.

(3) Alfred MERZ. Stark- und Schwachstrommesser. *Veröffentl. des Inst. für Meereskunde, N.F., Reihe A, Heft 7, Berlin*, 1921.

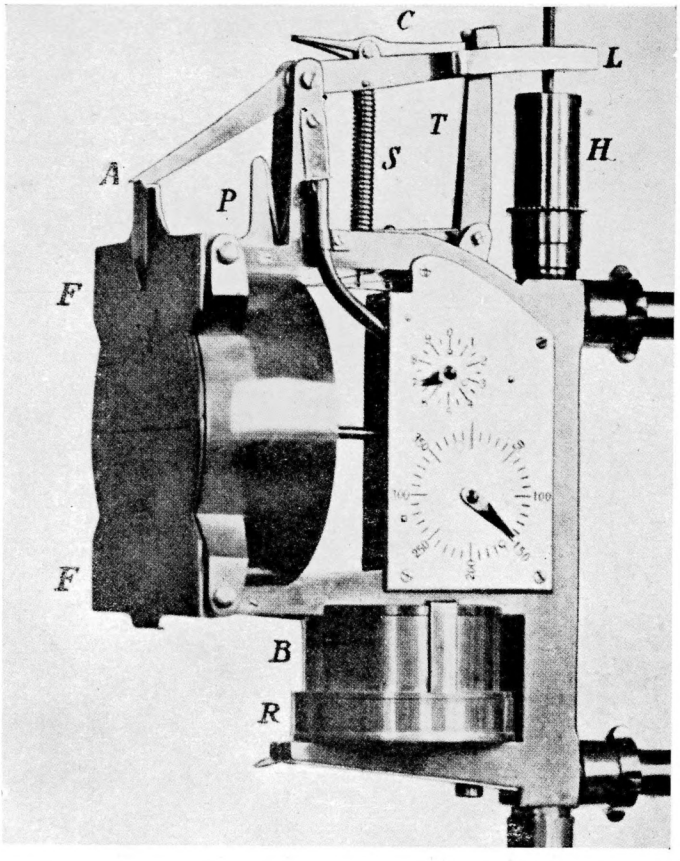


Fig. 1

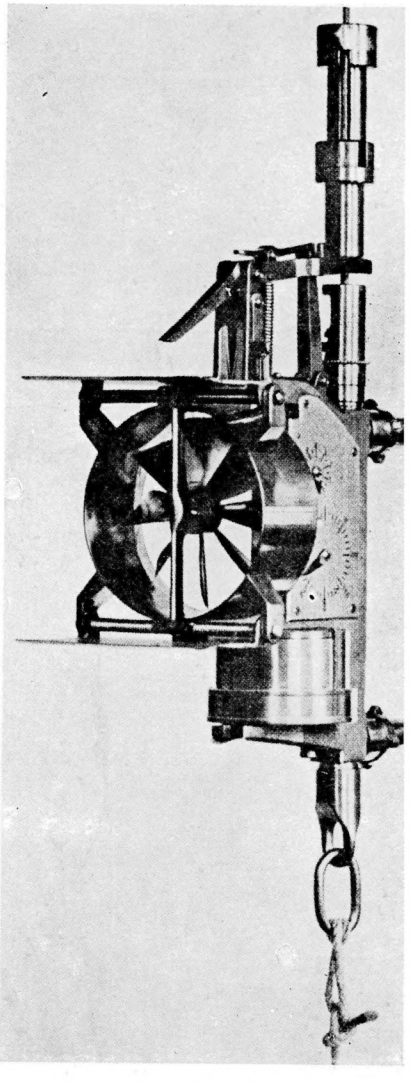

Fig. 2

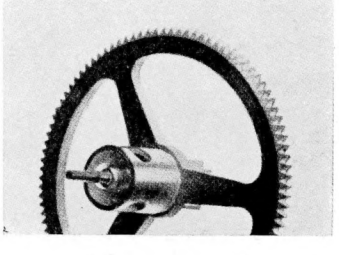

Fig. 3

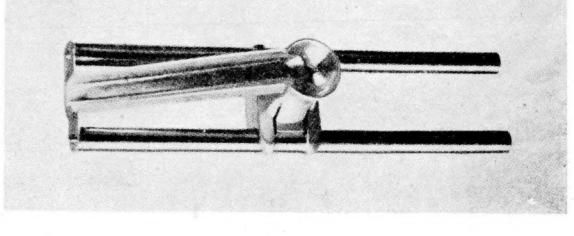

Fig. 4

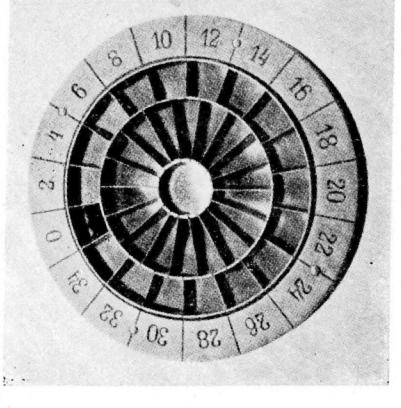


Fig. 6

extra link below it (Fig. 2). Furthermore the instrument (with its axle horizontal) is equilibrated in water.

The tail is made, in essentials, after the pattern introduced by MERZ (in his weak-current type of current-meter), and consists of a celluloid-painted aluminium plate, 2 m/m thick, attached to the main part of the instrument by means of two stout brass tubes The latter are screwed to the plate (N.B. left-handed screws!) and afterwards fixed to the main part of the instrument by means of right-handed unions, which are pulled tight with a key.

The screw, with 8 blades of elastic sheet-bronze, 0.25 m/m thick, is of the same light pattern as in the Repeating Current-Meter. It runs inside a strong protecting ring, to which the two front shutters $F$ are hinged. By pushing the catch $P$, the upper end of the bar, which carries the front bearing (Fig. 2), is set free and can be pulled forward for the purpose of inserting or taking out the screw. In doing this, care should be taken not to injure its Tantalium points; and the screw should never be left in the instrument after work is finished. This is worth emphasizing, since the writer has repeatedly witnessed the rough treatment to which various kinds of current-meters have been exposed, even being transported with the screw resting in its bearings.

Comparatively slow-running screws, *i.e.* with a high pitch, have been found to give the most accurate results. Each screw has been calibrated by towing the current-meter (at velocities between 2 and 80 centimetres per sec.) in a channel of 20 metres length and 1 square metre cross-section. The screws were found to move regularly, even at the lowest velocities used; and the velocities $v$ in cm./sec. could be calculated, with an error not exceeding half a unit, from a linear relationship:

$$v = 0.5 + An,$$

$n$ denoting the number of revolutions of the screw per minute. The coefficient $A$ is about 0.6 and is only slightly different for the different screws. Each instrument is supplied with two screws, one as reserve.

Inside the protecting ring there is a stopper movable vertically. It is connected with the lever $L$, so that the screw is released or arrested according as the lever — or more properly its right arm, which receives the blows of the messengers — has a higher or a lower position. The lever is raised by the pressure of the spiral spring $S$. But it can be kept in its lower position: either as in Fig. 2 by a catch in the shape of a twin-spring $T$, or, as in Fig. 1, by its left arm resting at $A$ against the closed upper shutter, which is in its turn locked by the lever. The instrument should be lowered into the water in the latter state with the shutters closed; furthermore the double spring should be pressed to the right, *i.e.* towards the sounding line, in which position it is then kept by the ratchet $C$ and misses catching the lever.

When hit by the first messenger the lever lets go its hold at $A$, with the result that the shutters fly open by the force of strong spiral springs, and the lever immediately takes its upper position. Then the ratchet lets go the twin-spring, which now resumes its natural position to the left and catches the lever once more when the latter is pressed down by the second messenger. In this way the screw is set free by the first messenger and is once more arrested on the arrival of the second one. Since the connection between the lever and the stopper is an indirect and elastic one, the impact of the messenger cannot be transmitted to the screw-blades.

The exact shape and dimensions of the messengers are of no essential consequence. I have used M. KNUDSEN'S very convenient type, which can be manipulated with one hand, reducing its weight, however, to only 250 gr.

The dial mechanism for recording the number of revolutions of the screw is contained within the dial-box and consists of the worm-wheel and of two cog-wheels, all of them silvered. The worm-wheel and the last cog-wheel carry hands which make one revolution for each 100 and 4000 revolutions of the screw respectively. The hands are adjustable and should be set at zero (= 4000) at the beginning of the work, but they should not be readjusted after each single measurement. The numbers on the dial are in reverse order so as to give *decreasing* readings, which is obviously the most convenient arrangement, when the differences are to be taken.

In the first instruments of the present type the wheels ran in ivory bearings, which, however, were soon replaced by stainless metal bearings, since the ivory is hygroscopic and swells in water.

The MERZ current-meter has the advantage that the worm-wheel and the wormed shaft of the screw are always visible for inspection, but at the same time they are, together with the whole gear mechanism, unprotected from drifting matter. Upon mature

consideration I have preferred to have them carefully enclosed in the dial-box, which, for the purpose of inspection, can be opened wide from the back.

The arrangement for dropping balls into the compass-box is made on the same principle as is described in *Publ. de Circonst.* N° 34, p. 41, Copenhagen 1906. An approximately vertical, tin-plated brass tube serves as a magazine for the balls. Its bottom is formed by a drum-wheel, attached to the axle of the worm-wheel. The drum-wheel has along its circumference three pits, each of which, when passing the magazine, carries away the lowest ball and, after half a revolution of the wheel, drops it through a guide tube down into the compass-box. Originally these pits were cut out in the solid drum in the form of hemispherical cups. It has sometimes happened, however, that a ball has stuck to one of the cups, possibly owing to some small airbubble in the latter, and in such cases the instrument is easily put out of order. To remove as far as possible this inconvenience the solid drum is now replaced by a hollow cylinder (of non-tarnishing "Monel Metal") with three circular holes in it, as seen in Fig. 3. A ball, falling down into one of the pits, stops against the axle itself, and there are two single points of contact only; and, further, there is no chance for an air-bubble to stick in the perforated cylinder. It is recommended that silvered bronze balls be used.

The magazine can be automatically loaded by means of a refiller after the pattern introduced by MERZ.

The compass-needle, Fig. 4, is made with exchangeable magnetized rods after nearly the same pattern as has been previously used in the Repeating Current-Meter. The rods are now made of unplated, polished stainless steel (Fried Krupp *V* 3 *M*) and are kept in position only by the friction of a spring.

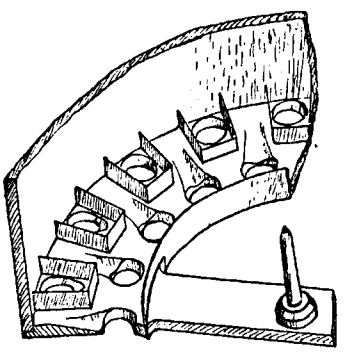

Fig. 5

The compass-box *B*, of which Fig. 5 gives an inside view, is in all essential details copied from the Repeating Current-Meter; and so is the receptacle *R*, though it corresponds only to the "front box" of the larger instrument. The lower part of the compass-box is divided by 36 radial partitions, and between them, in the bottom, are 36 holes each opening into one compartment of the receptacle. These compartments, therefore, and not the compass-box itself, finally receive the balls indicating the directions of the current. They are painted inside with white and red celluloid lacquer.

When the instrument has been hauled up after a measurement, one should close the shutters, remove the messengers and pull the twin-spring to the right. Then read the dial, pull out the receptacle and put it aside, insert another one (its red compartment should point forwards against the current) and, if necessary, load the magazine with balls; whereupon the instrument can immediately be sent down to take another measurement. Meanwhile there is convenient time to record the directions from the last measurement.

For this purpose the receptacle should be placed in the graduated circular frame (see Fig. 6), so that the red compartment has number zero (The receptacle fits the frame, as well as the current-meter, in the correct position only). The compartments in the outer circle have then the even numbers 0 — 34, read on the frame, and the compartments in the inner circle the intervening odd numbers 1 —35. A ball in compartment 0 indicates a current running N., and similarly the compartments 1, 2..... 35 correspond to the directions N. 10° W., N. 20° W..... N. 10° E.

All parts, for which no other covering has been mentioned, are nickelplated. The length and height of the instrument, when ready for use, are 70 and 36 $^{c}/_{m}$, respectively, and it weighs nearly 5 kg. without messengers. It is packed in a case of external dimensions $40 \times 25 \times 21$ $^{c}/_{m}$ and 12 kg. gross weight. It is made by J. & C. LINDELÖF in Lund and can be obtained through the present writer.

▣ ▣ ▣