THE PERFECTED FORM OF THE SURFACE WATER SAMPLER OF O. SUND

by

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With the increase in the size and speeds of modern ships the measurement of surface temperatures and the collection of samples of sea-water while underway become increasingly difficult.

The canvas bucket, which possesses the sole advantage that it can be left to drag for any length of time and is easily hauled in, has to be abandonned. Unless special precautions are taken errors as great as 1° must be expected, without mentioning the possible errors in salinity measurements due to residues which are difficult to avoid.

To collect adequately large samples of water in a zinc bucket, which is the best procedure, necessitates considerable skill on the part of the seamen on vessels steaming at 10 to 12 knots, and this is not always found; but the attempt is even less likely to be crowned with success when it is performed by an observer who has to shift for himself without the aid of a seaman.

Opinion is divided regarding the scoop thermometers of the navy (1) and the confidence which can be placed in them. H. THORADE, comparing the results obtained with these thermometers and with samples collected in zinc buckets in the waters about Iceland, found the first mentioned to be on the average about 1° too low in reading. E. KUHLBRODT (2) in discussing the measurements of the German Atlantic Expedition and the subsequent comparative measurements, arrives at the conclusion that "the temperature of the air determines in a very preponderant manner the temperature of the scoop thermometer itself before measurements are taken, and that the error of the scoop thermometer with regard to sign... is determined by the sign of the difference between air-water temperatures (and even with regard to the order of magnitudes)". According to KUHLBRODT the error amounts to only —0.1° on the average in all the tropical and subtropical latitudes. Individual values are not given. On a voyage towards South America, when the difference in temperature of air and water lay between —0.6° and —1.5°, the value obtained with the scoop thermometer was, on the average, about 0.3° lower than that obtained with the zinc bucket. KUHLBRODT concludes therefore that in order to obtain a temperature measurement which is above criticism, one should leave the thermometer several minutes on the surface of the water to permit it to fully attain the temperature of the water. But this is not practicable with the ordinary type of scoop thermometer in use, quite aside from the fact that the paper scale, graduated in whole degrees; will hardly serve for accurate scientific observations on a thermometer with full scale.

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(1) H. THORADE. *Report on the observations on the dip of the horizon on board the research vessel* "Meteor" *during the voyage to Iceland on 27 July to 26 September 1929 in* "*Measurement of the dip of the horizon made on board vessels of the German Navy*", *published by the Naval Observatory at Wilhelmshafen,* Berlin 1930, pages 20/21.

(2) E. KUHLBRODT and J. REGER : *Meteorological Observations etc... Scientific Results of the German Atlantic Expedition on the* "Meteor" 1925/27, Vol. XIV, First Fascicle, Part A, Berlin-Leipzig 1936, p. 24-27.

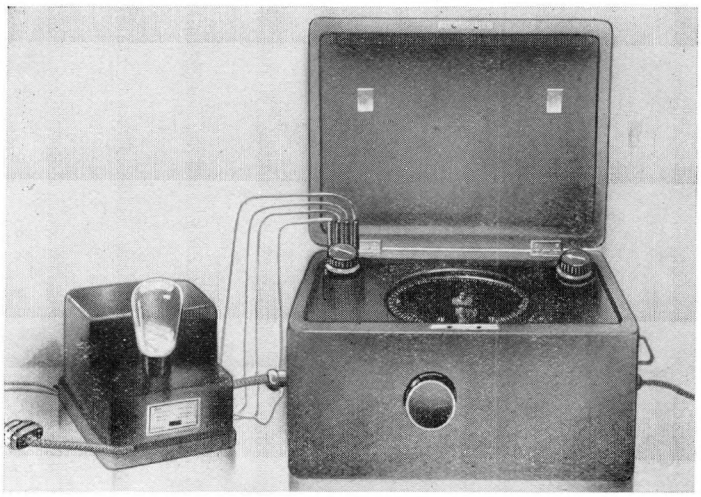


FIG. 2. — *The Comparison apparatus* (measurement device).

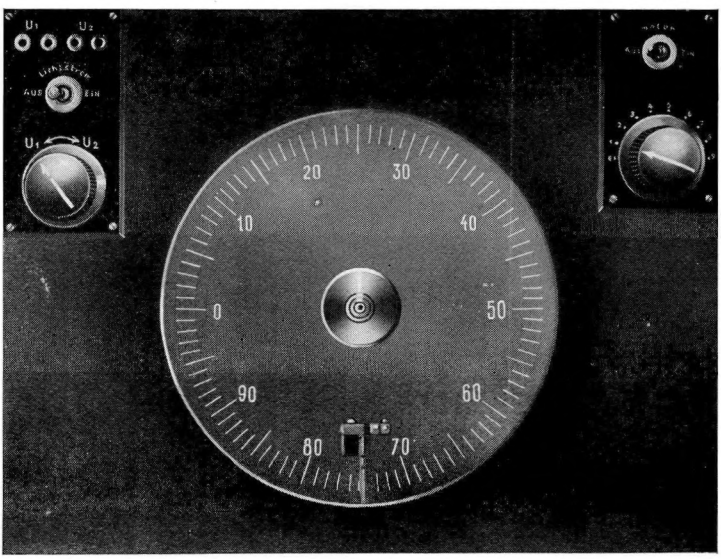
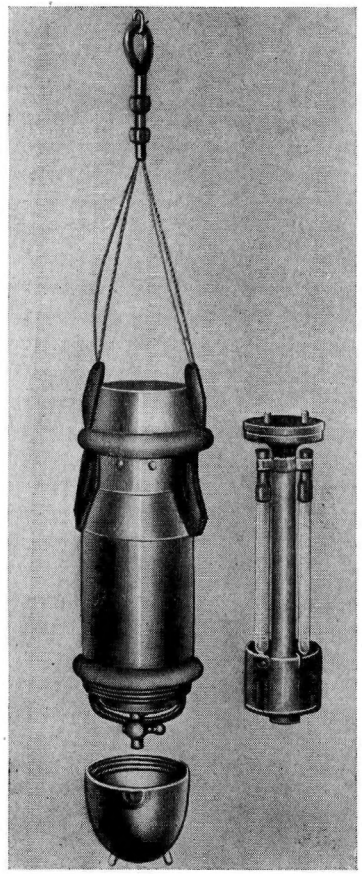
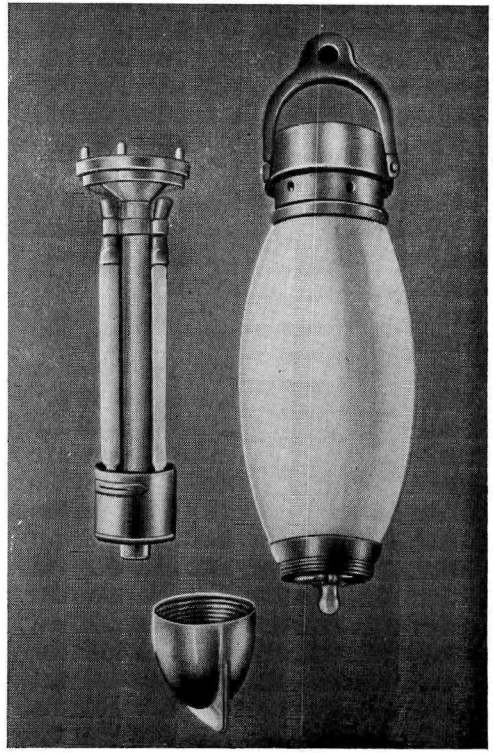


FIG. 3. — *The Comparison apparatus* (from above).



Old type.



New type.

Surface water sampler.

In conformity with the above mentioned principle of obtaining equalization of temperatures by towing the thermometer for some time on the surface of the water, O. SUND (3) has succeeded, for some time past, in obtaining with his scoop apparatus excellent samples of sea-water for the measurement of the salinity. This apparatus was described briefly in the "Annalen" some years ago by the author of this article (4).

On the basis of the overwhelmingly excellent results obtained with the scoop thermometer brought out by the Norwegians, apparatus of this kind have been constructed subsequently, for the primary purpose of developing an instrument which is easy to handle and which could be entrusted to the hands of volunteer observers. The apparatus which has been furnished for several years by the firm of W. Friedricks of Lokstedt-Schmelsen, near Hamburg, has undergone several modifications designed to remedy the faults sometimes found in the older model. (Compare the figures of page 352 of this article with fig. 1 of page 334 of 1933).

The external protection against shocks on striking the hull no longer consists in the cordage, which soon loses its elasticity, but in annular rubber rings. In order to still further diminish the resistance caused by them in towing, the scoop itself, which is maintained in its original size, is fitted with a stream-lined case, by the addition above of an obtuse cone, the insertion of a cylinder between the rubber rings, and finally, at the lower end by screwing on a cap which approaches a hemispherical shape, which serves at the same time as protection for the drain cock and which must be unscrewed each time the sample is removed. The casing between the two rings is also tapered in conical form at its upper end as far as the discharge orifices. These openings, which, in the original model were near the upper edge, are now placed just below the upper ring.

In order to prevent the threads of the thermometer-holder becoming jammed, as sometimes occured when striking against the hull, the funnel has been fitted with a short cylindrical guide near the upper edge of the scoop cylinder. In order the facilitate screwing on and off, the outer case and the protective cap for the drain cock are fitted with two pins firmly soldered on to the metal. (Incidently all parts are well soldered).

The thermometers, furnished by the firm of Richter and Wiese are graduated in tenths of a degree from $-1°$ to $17°$ or, in certain cases between $14°$ and $35°$. Their scales are very carefully and firmly fixed in the tube.

In its new form the scoop when full weighs just under 6 kilograms, or about 1 kg. less than the — much less handy — zinc bucket full of water. The useful contents are reduced to from 750 to 800 cc. owing to the location of the discharge orifices lower down (in the older model the contents were 900 cc.). It might be increased in a new model in which, for the rest, the use of a light metal would result in saving considerable weight, by a change in the location of the discharge orifices. It is however quite adequate for rinsing and refilling the water sample bottles.

The rinsing of the scoop has not suffered in practice by the fact that the discharge orifices have been placed behind the rubber ring and that now there may be a layer of air in the upper part of the scoop. A test of the rinsing carried out with sea-water and with colored water, made in the Elbe, showed that from two to three minutes were required for the river water to completely replace the colored water (salinity 35 ‰). This interval of time is certainly adequate when the instrument is used under normal conditions. It is also necessary that the apparatus take the temperature of the water. With regard to the temperature measurements one might be inclined to fear that the diminution in the volume of water surrounding the thermometers would be detrimental, but it is only necessary to point out the insulating action of the well stream-lined casing.

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(3) O. SUND : *A new high speed surface sampler.* « Journal de Conseil », Vol. VI, 1931, pages 419-20.

(4) A. SCHUMACHER : *Two surface profiles across water to the Northwest of Africa.* « Annalen der Hydrographie »; 61, 1933, p. 333-34.

The scoop is coated with chromium in order to avoid as far as possible the effects of radiation.

The measurement of temperature offered no difficulty except one stormy day on a winter cruise in the North Sea when the temperature of the air was more than 5° lower than that of the water. The thermometer then dropped considerably while it was being read. In such cases it would appear that the stream-lined casing should offer still better protection (the apparatus then in use had the shape of a plain cylinder) and further, in such cases one can make use of a special thermometer graduated from —1° to about 10° at the most. On such a thermometer the distance between the bulb and the zero may be sufficiently great so that even during the reading of low temperatures the thermometer can be kept well immersed in the scoop. Except in the particularly unfavorable case just cited, the numerous comparisons (temperatures in the bucket compared with the scoop) no differences greater than 0.1° were found. These have been carried out in all climates.

In order to keep the scoop well clear of the vessel and the sides, it is well, if possible, to tow it by means of a small outrigger (or a short spar firmly attached to the taffrail). There need then be no fear that the sample will be contaminated by the outboard discharge from the vessel. It is necessary to pay out sufficient line in order that the scoop may ride on the rear slope of the wave generated by the wake and that it may remain constantly in the water. In order to haul it in it is provided with a second line which is shorter and nearly perpendicular above the towing gear at the moment it is close to the taffrail for the purpose of reducing as much as possible the time of its passage through the air.

The scoop has been employed by the author at speeds up to 12 knots; and other observers have reported satisfactory results at speeds as great as 15 knots.

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A further modification has been made in the apparatus and experiments have been conducted. This form differs from the other by its greater solidity. The towing line and the hauling-in line are now well secured to a strong metal gimbal. The protection against shocks on striking the side no longer consists of rubber rings but of a thick white rubber padding which covers the apparatus for two-thirds of its length and at the same time protects it from the sun's radiation.

The contents have again been increased to equal those of the original Norwegian apparatus by moving the discharge orifices further upwards. As a result the head of the apparatus now has a smaller diameter which permits it to be better adapted for streamlining. Finally the lower sealing cap has been made easier to manipulate.

According to a kind verbal communication from Dr. Wüst, of the Institute für Meereskunde, this apparatus proved very successful on the voyage of the steamer "*Altair*" (in 1938). It is also constructed in this new shape by the firm of Friedricks, now the "Hanseatische Werkstätten für Feinmechanik und Optik"; Hamburg-Schnelsen, Oldesloer strasse 59.