The brief summary of the principle of the instrument and the above example show the great value of the device for aerial navigation over great distances. In a great number of cases, and in particular when using the current astronomical methods of navigation, it does away with all difficult calculation and makes it possible for all the personnel engaged in aviation to take part in the navigation without going through the discouraging preliminary study required for the uninitiated in navigation.

SETTING OUT DEEP SEA TIDE GAUGES

by

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(Translated from the German.)

(Extract from: "Bericht über die zweite Teilfahrt der Deutschen Nordatlantischen Expedition des Forschungs- und Vermessungsschiffes "Meteor", Januar bis July 1938".)

During the second part of the 2nd Partial Cruise of the German North Atlantic Expedition, deep sea tide gauges were set out, pursuant to a series of experimental tests lasting several years. Thus, for the first time, it was possible to set out these devices in a depth of 300 metres in the high seas. This was on the southern Echo Bank:

Lat. 25° 23' N. and Long. 19° 26.4' W, from 19th to 22nd May 1938 (312 m.)

A second tide gauge station was made off the Cape Verde Islands. Here, there is a depth of about 100 metres and two deep sea tide gauges were used for purposes of comparison and in order to check the accuracy of the devices.

a) 15° 40.05' N. 23° 16.2' W. from 25th to 28th May 1938 (depth 94 m.)

b) 15° 39.45' N., 23° 15.95' W., from 25th to 28th May 1938 (depth 95 m.)

In the past, observations on the height of water have generally been connected directly to the coast, since the usual tide poles and recording gauges could be installed nowhere else. For tidal investigations, however, the necessity for observations in the open sea has always existed, in order that the phenomenon might be comprehended, not only linearly but over a surface area, and for the purpose of testing the present theories from all aspects and improving them through the supplementary data thus obtained. Since in the open sea, the variations in the height of water cannot be directly determined by means of the usual tide poles, resort was had to indirect methods by setting out the so-called "deep sea tide gauges," which record photographically the changes in the pressure of water and thus permit the calculation of the heights of water. (For this it is necessary to know the function giving the density of the column of water and its hourly variations).

....

The first tests were conducted in the shallow and then the deeper water of the North Sea, and finally in the Norwegian Fjords, which were chosen particularly on account of their expanse of deep and quiet water. It is evident that the use of heavy and at the same time ultra-sensitive recording devices would meet with difficulties in a rough sea.

At first the pressure measuring element employed was the Bourdon tube. The technical difficulty here was that the tubes, which must necessarily be exposed to the total pressure of water from the surface to the bottom, required a greater sensitivity, the greater the depth of ocean at the place used, since the pressure changes become constantly smaller in relation to the total pressure, the greater the depth.

This difficulty was overcome by the use of compressed air by means of which a counter-pressure was generated corresponding to the mean height of water. Under these conditions, the tubes are exposed only to the pressure differences which correspond to the variations in the height of water. For such a purpose, the usual type of instrument on the market is sufficiently sensitive and serviceable.

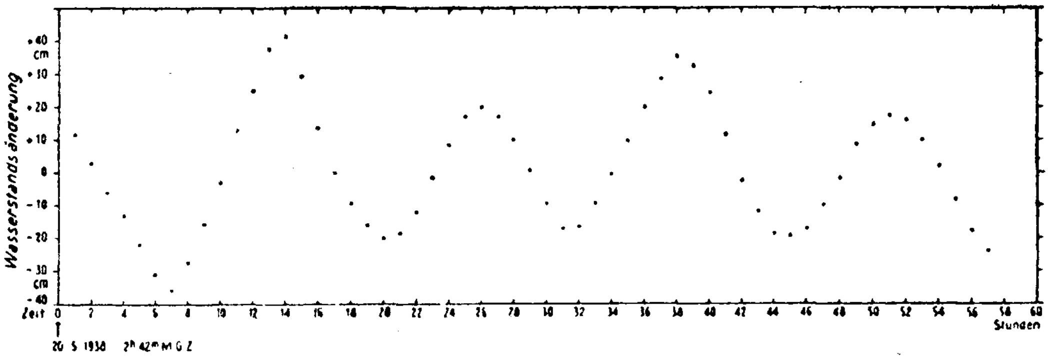

Fig. 1. — Curve of sea level of Southern Echo Bank.

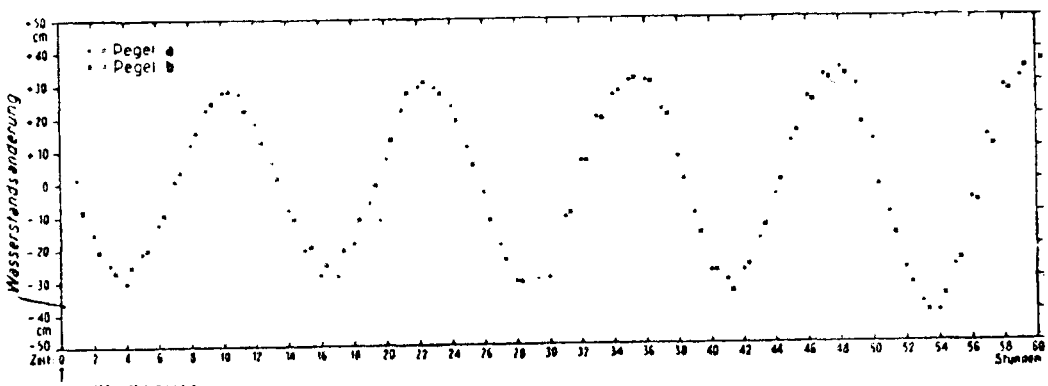

Fig. 2. — Curves of sea level of tide-gauge station off Cape Verde Islands.

However, Bourdon tubes possess in themselves some qualities which are unfavourable for accurate measurement. The entire apparatus mounted in metal is naturally very sensitive to temperature variations and also to the slightest bending, while independently thereof, the hysteresis and the elastic after-effects give rise to further perturbations. Therefore, H. Rauschelbach abandoned the Bourdon tube in favour of the "air spring"; i.e. in the type of tide gauge developed by him, the volume of a constant mass of air, dependent upon pressure and temperature, is photographically determined and since the apparatus records the temperature simultaneously, it is possible to calculate the pressure. (1)

This type of gauge was first tested by the Deutsche Seewarte and was later given thorough trials by the Marineobservatorium and found serviceable. It has

(1) H. Rauschelbach. "Grundlagen für einen neuen Hochseepegel". *Ann. d. Hydr.* 1932, p. 129. — H. Rauschelbach. "Die Hochseepegelbeobachtungen im Südlichen Kattegat im August 1931". *Ann d. Hydr.* 1934, p. 177. See also *Hydrographic Review*, Vol. IX, N° 2, page 231.

been provided with a number of technical improvements by J. GRAAFEN and could be used satisfactorily this year on the *Meteor* cruise, when opportunity offered, under the most severe conditions of service; i.e. in the open sea at great depths. The device proved fully serviceable.

The results obtained from the gauges set out were satisfactory.

In order that an immediate insight might be obtained into tidal conditions prevailing at that locality, and in order to check the functioning of the apparatus, the writer made a preliminary analysis of the results aboard ship, obtaining a series of points at hourly intervals (the apparatus gave readings every five minutes).

The results have been plotted in Fig. 1 and 2. Fig. 1 shows the heights of water on the Southern Echo Bank, which may be subject to slight changes in the ordinates after final calculations have been effected. The diurnal inequality is clearly marked. In Fig. 2, the curves have been drawn for the two apparatus set out on the Cape Verde Bank, plotted independently and superposed on the same coordinates. There is close agreement between the two curves. Here we see clearly the semi-monthly inequality while the diurnal inequality is much less pronounced.

A SOLUTION TO THE PROBLEM OF ADJUSTING THE COUNTERBALANCE OF A SHIPBOARD THEODOLITE

by

A.R. STICKLEY (WEATHER BUREAU, WASHINGTON, MAY 1938.)

(Extract from *Monthly Weather Review* — Washington — Dec. 1938, p. 401)

The usual shipboard theodolite is essentially a sextant mounted on gimbals and equipped with a horizontal circle. In order to keep the sextant upright in the gimbal mounting, a shaft with a heavy weight or counterbalance on it is rigidly attached to the outer spindle of the horizontal circle assembly. On some types of instruments, such as that shown in figure 1, this weight or counterbalance may be adjusted vertically. In the use of such an instrument, then, the problem naturally arises as to what is the optimum counterbalance adjustment for a given set of conditions aboard ship.

As far as can be learned, the only reference to any attempt to solve this problem is that contained in an article written by F. Eredia on the "Exploration of the Atmosphere by Means of Pilot Balloons on Board Merchant Vessels", which was published in volume IV the "Annali dell'Ufficio Presagi" appearing in 1932. A translation (1) of his remarks regarding the problem of offsetting the effects of the motion of the ship is as follows :

"This problem has been solved by supplying a Cardan suspension (gimbal mounting) with a pendulum rigidly attached to it (the theodolite) — giving the pendulum sufficient mass since the center of gravity should be rather low. The length of the pendulum may be varied continuously in such a manner as to modify the period of oscillation so that it avoids resonance with the period of oscillation of the ship. Moreover, three springs notably reduce the oscillation of the pendulum itself,

(1) Furnished by Carl Russo of the Aerological Division