ECHO-SOUNDING

by

REAR-ADMIRAL J. D. NARES, PRESIDENT OF THE DIRECTING COMMITTEE.

My object in writing this article, in which I have attempted to describe in simple language the principal problems met with in Echo Sounding, is to encourage a close study of the very much more detailed and technical articles which have appeared from time to time in the *Hydrographic Review*, especially those on page 50 of Vol. VII, N° 2, November 1930 and page 124 of Vol. VIII, N° 1, May 1931. In those articles will be found, amongst other valuable data, the latest information received regarding the instruments at present in existence both sonic (when the echoes are audible) and ultra sonic (when they are inaudible to the human ear), also regarding the various tables of velocity of sound in sea water which have been compiled from determinations made in France, Germany, Great Britain, the United States of America an other countries.

It is of course a well-known fact that sound transmitted from a ship strikes the bottom of the sea at the nearest point and is reflected back; if the bottom of the sea is flat this nearest point will be vertically under the ship and the echo distance, i.e. half the elapsed time between the transmission of the sound and the reception of its echo multiplied by the velocity of sound through sea water, will be equal to the sounding at that spot. Should, however, the bottom of the sea be sloping this echo distance will be less than the actual sounding in the position of the ship and in order to obtain the exact depth, *such as is necessary when using this method for carrying out a marine survey*, either this echo distance must be corrected for the slope of the bottom or the position of the sounding must be moved in a direction up the slope of the bottom until the actual depth at the new position equals the echo distance originally obtained, or a double correction emboyding both of these must be applied.

Thus, in Fig. 1, if A is the position of the ship when the echo sounding is taken, AB represents the echo distance obtained (at right angles to the slope of the bottom). This echo distance has either to be corrected for slope to obtain the true sounding AC vertically below the ship at A, or the position of the sounding must be moved to A' where $A'C' = AB$. Therefore in order to obtain exact depths by means of echo soundings it is necessary to first determine whether the bottom of the sea in the vicinity is flat, and if not, its angle of slope. This can be simply done by provisionally plotting sectionally (at right angles to the contour lines) the series of echo distances obtained and measuring by means of a protractor the angle of slope, if any, and using this angle either for converting these echo distances into true soundings or for obtaining the amount of displacement to be applied to the positions of the soundings. Whether this is necessary depends of course on the size of the angle of slope and the scale of the chart or survey on which the

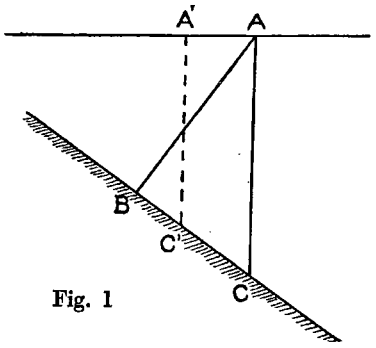

Fig. 1

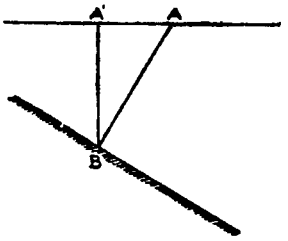

Fig. 2

navigator is working, for if, in the first case, the slope of the bottom is small the correction to the echo distance in comparatively shallow water will be negligible or secondly, if the scale of the chart or survey is small, the amount of displacement may be too small to plot. On page 88 et seq. of *Hydrographic Review*, Vol. VII, N° 1, May 1930, will be found Tables showing the amount of displacement to be applied for various slopes and for different scales, and facing page 165 of *Hydrographic Review*, Vol. V, N° 1, May 1928, will be found a useful diagram for obtaining the correction to be applied to the echo distance in order to obtain the true sounding at that position for various angles of slope of the bottom.

The above assumes that the slope of the bottom *BC* is regular, but if this is not the case the resulting depth *AC* would be incorrect as explained in Fig. 4 and an alternative method of combining corrections for both depth and position, taking into consideration the slope of the bottom at one point only, would give a more accurate result. In Fig. 2, if *A* is the position of the ship and *AB* the echo distance, using the angle of slope of the bottom as determined by the first method and applying it at the point *B* only, a true sounding *A'B* and the displacement *AA'* can be easily calculated. This true sounding *A'B* will always be less than the echo distance *AB* and thus this method has an additional advantage over the one first-described where the echo distance had to be *increased* to obtain the true sounding at *A*.

It may be argued that even applying this method a possible wrong angle of slope of the bottom has to be used, but it will be seen from the article on page 41 by Director DE VANSSAY that even if the true slope of the bottom is different to that assumed from the echo distances the amount of displacement *AA'* can still be exactly calculated.

Other corrections that are necessary if exact soundings are required are (1) that for the depth below the surface of the water of the Transmitter and Receiver (this is a constant correction in any one ship), (2) that for the distance, if any, between the Transmitter and Receiver. A Table showing this correction for various depths will usually be supplied by the makers after the instruments have been installed in the ship, or if not they can easily be calculated on board. This correction except for very shallow depths is usually small or negligible, and (3) that for the difference between the velocity of sound for which the instrument is calibrated and the actual velocity at that position.

Looking at this question *from a purely navigational point of view* the echo distance may generally speaking be assumed to be the actual sounding,

as in making a landfall the navigator is primarily interested in knowing whether his ship has reached the continental shelf, or whether she has passed from deep water to shallow water or *vice versa*, and after the vessel has reached comparatively shallow water the corrections for slope, which are in proportion to the depth, are entirely negligible.

Echo soundings will always give the shoalest water in the immediate vicinity of the ship, but it by no means follows that the deepest water will always be found by this method. The echo distance is always obtained from the nearest point of the bottom of the ocean, so should the vessel pass over a narrow deep concavity the echoes might be obtained from the two sides only.

Fig. 3 shows a case in point. A ship proceeding along the line *ABC* would obtain echo distances *Aa* at *A*, *Bb* or *Bb'* at *B* and *Cc* at *C*, no echo being received from any part of the sea bottom between *b* and *b'*, however closely the echo soundings may have been taken; therefore in cases where very steep and narrow un-evennesses in the bottom may be expected the ordinary method of sounding by line or wire must be resorted to.

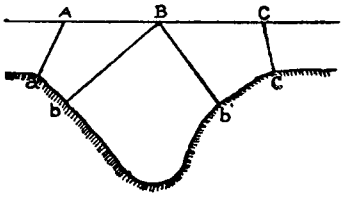

Fig. 3

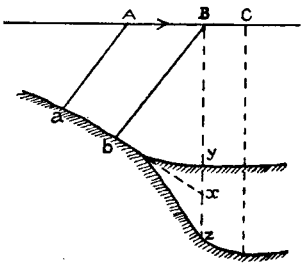

Fig. 4

There are also cases where the ordinary methods of correcting echo distances may give erroneous results, for instance where the slope of the bottom is not regular. In Fig. 4 a ship proceeding in the direction *AB* and obtaining echo distances at *A* and *B* might assume the slope of the bottom to be the line *abx* and the corrected sounding at $B = Bx$, whereas in reality the slope of the bottom may be the curve *aby* or *abz*, in which case the actual sounding at *B* would be *By* or *Bz* respectively. If, however, another echo distance had been taken at *C* and plotted in profile it would have at once shown that the bottom slope was not regular and that a different slope correction must be applied to the echo distance at *B* to obtain the correct depth. This emphasises the necessity of plotting a sufficient number of echo distances to enable an accurate estimate of the slope of the bottom to be obtained before proceeding to carry out the necessary corrections.

Soundings obtained by the echo method have the effect of smoothing the actual declivities or reliefs of an un-even bottom as the deeper soundings may not always have been obtained. Figs. 4 and 5 on pages 56 & 57 of *Hydrographic Review*, Vol. VII, N° 2, November 1930, show typical cases of this. As before stated, however, the shoalest soundings will always have been obtained and for this reason alone, apart from many others, the Echo method of sounding has a very great advantage over the ordinary ones by line or wire.

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