

**METHOD OF IMPROVING POOR QUALITY LEAD-LINE.**

(Extract from a letter from W. J. CHOVAN, Jr., H. & G. Engineer, U. S. Coast and Geodetic Survey, published in the *Field Engineers Bulletin* No. 7, U. S. Coast and Geodetic Survey, June 1934.)

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I was in charge of a chartered launch hydrographic sub-party this season on the outside coast of California and considerable difficulty was experienced during the first part of the season with wire core sounding line, although the lead-line was prepared according to Hydrographic Manual instructions.

The irregular shrinkage and protruding of wire core made the lead-line useless after about two days' usage. It was thought at first that this particular lead-line was just an inferior piece of cordage, so another line, called lead-line No. 2, was prepared and found to act in a similar manner, being unfit for further use after only two days of service.

The irregular shrinkage of the lead-line put doubt on the accuracy of the soundings and the protruding of the wire core raised havoc with the leadsmen's hands. In order to protect their hands, the leadsmen would snip the protruding wires, and at such spots the cordage would stretch enough to produce a gap of one full inch in the wire core. This is partly the cause of the irregular shrinkage.

I decided that if the cordage could be shrunk before being made into a lead-line it might hold its length. Accordingly, a line was boiled for about five hours, then laid loosely on deck until it was thoroughly dried. The line was then immersed in cold water for one hour and marked.

This line was called lead line No. 3. It was used steadily for over two months and finally discarded as worn out. During this period a morning, noon and evening test on each working day showed the line correct. During the balance of the season all lead-lines used were prepared as outlined above, and the results were uniform in each case, the lead-line retained its true length during its entire useful life.

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**PLOTTING THREE POINT FIXES WITHOUT THE USE OF A PROTRACTOR.**

by

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Although several reports on this same subject have been previously submitted, this method does not yet seem to be in general use. Many field officers are unfamiliar with the details of plotting the position arcs under various conditions, such as when one or more of the signals fall beyond the limits of the sheet, and also fail to realize the value of this method due to never having seen it in actual operation. Owing to the accuracy of this method, and the fact that stronger fixes are available by using signals beyond the limits of the sheet, this method of plotting should find a much wider use in the field.

For these reasons I am submitting, in considerable detail, methods used by us on the southwest coast of Palawan during the season of 1933, where shoals abound for a distance of some twenty miles offshore and detailed development was required at that distance.

Due to distortion of the boat sheet after it had been in use a short time, we found it advisable to compute all distances and not to scale any distances of over a foot on the sheet. To accomplish this it is necessary to compute two or more points on the locus of centers. This is explained in detail later.

*Caution.* — Do not confuse  $\alpha$  in Fig. 1, the observed angle, with  $\alpha$  on Form 662, inverse position computation.

The following method is applicable when the signals fall beyond the limits of the sheet, but a portion of the line  $AD$  (Fig. 1) crosses the sheet. This method may also be used to advantage when the signals are on the sheet as it eliminates errors of distortion in long scaled distances.

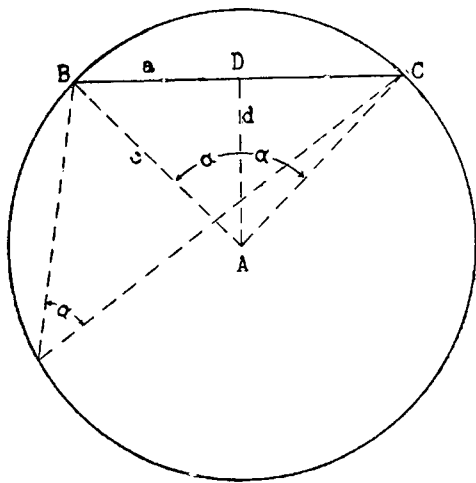


FIG. 1.

- $B$  and  $C$  = control points or signals ;  
 $a$  = distance between signals  $B$  and  $C$  ;  
 $\alpha$  = observed angle between  $B$  and  $C$  ;  
 $A$  = center of circle which is locus of all points where angle  $\alpha$  can be observed ;  
 $d$  =  $AD$ , perpendicular bisecting  $BC$  ;  
 $c$  = radius of circle ;  
 $d = \frac{a}{2} \cot \alpha$  ;  
 $c = \frac{a}{2} \operatorname{cosec} \alpha$  .

FIRST. — Make Inverse Position Computation on Form 662 for distance  $BC$  (Fig. 1). The mean of the latitude and longitude of  $B$  and  $C$ ,  $\varphi_m$  and  $\lambda_m$ , gives the position of  $D$  as accurately as can be plotted, and  $\alpha + \frac{\Delta \alpha}{2}$ , Form 662, equals the azimuth from  $D$  to  $B$  within one or two seconds. (This applies to distances up to 25,000 meters and low latitudes. If in doubt compute them geodetically and compare).

SECOND. — Erect perpendicular  $AD$ . By referring to the layout of sheets, two points are selected that fall on the sheet. Their distances to  $D$  are roughly scaled off on the layout, and a distance chosen to the nearest even 10,000 meters. Then using Form 27, Position Computation Third Order Triangulation, points are computed from the center  $D$  along azimuth ( $DB - 90^\circ$ ) at the required distances. Since this azimuth differs by  $90^\circ$  from that found in the Inverse Computation, the logs of the sin and cos of  $\alpha + \frac{\Delta \alpha}{2}$  found there may be copied onto sheet  $B$ , by interchanging the sin for the cos and vice versa. More points may be computed if desirable.

THIRD. — Compute the distances  $d$  corresponding to the required angles by the formula  $d = \frac{a}{2} \cot \alpha$  (Fig. 1). These distances are plotted along the line  $AD$  from the nearest computed point. In this way practically all distortion along the line  $AD$  may be eliminated.

FOURTH. — Compute the radii  $c$  by formula  $c = \frac{a}{2} \operatorname{cosec} \alpha$  (Fig. 1) (this is necessary when both  $B$  and  $C$  are off the sheet). Select a point on one of the arcs (or more than one if the sheet is badly distorted) near the center of the work and compute its geographic position. This is readily done from one of the centers, its computed radius and an assumed azimuth. Then compare the scaled and computed radii and apply the differences proportionally to the lengths of the rest of the computed radii. In computing  $d$  and  $c$ , we incorporated a scale factor in the formula so that the results could be scaled directly on a 1:10,000 meter scale. For any scale, the formulae are as follows:

$$d = x \frac{a}{2} \cot \alpha \quad (\text{Fig. 1}) ;$$

$$c = x \frac{a}{2} \operatorname{cosec} \alpha \quad (\text{Fig. 1}) ;$$

$$x \text{ (the scale factor)} = \frac{10,000}{\text{scale used}}.$$

Example : If scale used is 1:40,000,  $x = \frac{1}{4}$ , etc.

FIFTH. — Lay out the arcs with a beam compass using the centers on line  $AD$  and the computed and corrected radii. A table of logarithms of cotangents and cosecants for angle  $\alpha$ , Fig. 1, was constructed, as we found natural functions unwieldy where a computing machine was not available. Arcs drawn for every degree down to  $20^\circ$  and for every half degree to  $10^\circ$  usually give sufficient accuracy. In plotting, small spacing dividers are used to interpolate between the arcs. This can be done more rapidly than the angles can be set on the protractor, and the resulting position is free of all protractor errors and those due to distortion of the sheet. Sheets were prepared in advance with the log cotangents or log cosecants for angle  $\alpha$ , Fig. 1, covering the necessary range, typed in, leaving space below to add log of  $\frac{xa}{2}$  ( $x$  being the scale factor to reduce to 1:10,000). Then as soon as  $a$  was determined, the distance  $d$  and  $c$  could be very rapidly computed.

An excellent check on the construction of the arcs is the fact that the arc of a given angle passes through the center of the arc of half that angle. In other words,  $d$  of the larger circle equals  $d + c$  of the smaller. Distortion in the sheet is also detected by means of this simple fact.

The line of centers can readily be extended some distance beyond the limit of the sheet, by means of a straight-edge. Even if the line of centers lies entirely beyond the limit of the sheet, there is usually a way to get around it. It may fall on the adjacent overlapping sheet. In this case the arcs may be drawn on tracing cloth and transferred to the other sheet. It may be feasible to make a new projection extended far enough to take in the line, and then after the arcs are constructed, this part can be cut off.

This method is ideal for developing a shoal with a launch far from shore and where strong currents may prevail. The lines are run parallel to one of the arcs, and by means of a sextant the launch may be held to the line as easily as with a good range. The launch is then turned on the next line by watching the angle in the sextant. It is possible to thoroughly cover the shoal with evenly spaced parallel lines, without plotting a position until the area is completed. In doing ship hydrography, it is usually possible to tell if a change of course is necessary as soon as the angles are taken and before the position is plotted.



POSITION COMPUTATION, THIRD-ORDER TRIANGULATION

Table with columns for station names (Juan, Trouble, Baptiste), distances (2, 3, 1), angles (alpha, 2alpha), and various logarithmic and trigonometric values.

Table with columns for station names (Baptiste, Trouble, Flores), distances (2, 3, 1), angles (alpha, 2alpha), and various logarithmic and trigonometric values.

INVERSE POSITION COMPUTATION

Formulas for inverse position computation: s, sin(alpha + delta/2) = delta/2 sin(alpha) cos(delta/2); s, cos(alpha + delta/2) = -delta/2 sin(alpha) sin(delta/2); -delta = delta sin(phi) sec(delta/2) + F(delta)^2

Arc-sin corrections for inverse position computations

Main calculation table with columns for NAME OF STATION, angles (phi, phi'), and various logarithmic values (log delta, log delta lambda).

Table with columns for Log s1, Log delta phi or log delta lambda, Log s2, Log delta phi or log delta lambda, Log s3, Log delta phi or log delta lambda, and Log delta phi or log delta lambda.

NOTE.—For log s up to 4.52 and for delta or delta lambda (or both) up to 10', omit all terms below the heavy line except those printed to heavy type or those underscored, if using logarithms to 6 decimal places.