RECENT NAUTICAL TABLES

An all Log Tangent $\pm$ Log Secant Navigation Table

by

Captain RADLER DE AQUINO
BRAZILIAN NAVY.

In the Supplement of the Sept.-Oct. 1933 number of the *Revista Maritima Brasileira,* Captain Radler de AQUINO has explained a uniform method for calculating the astronomical triangle by utilizing solely the log tangents and the log secants of the arcs.

This small pamphlet which gives the tables of log secants and log tangents in a particularly convenient form, does not exceed 18 pages, and has run through many editions, especially in the years 1934 and 1935. The tables themselves have been printed in Rio de Janeiro and are sold at the modest price of R : 10,000 or about 2 shillings (fifty cents).

In an article published recently in the United States Naval Institute Proceedings of May 1937, Captain Radler de AQUINO gives a new explanation, in English, of the use of these tables. We give here a brief summary of the article.

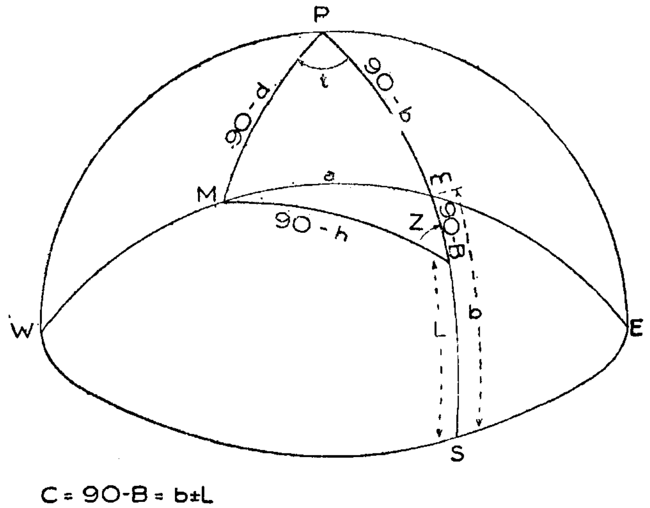

FIG. 1.

Figure 1 shows the classical method of dividing the astronomical triangle into two right triangles by dropping from the point M, representing the heavenly body, the arc perpendicular to the local meridian. The following well-known formulae then give the different relations between the elements of the triangles :

1)
$$\sin d = \cos a . \sin b$$
$$\sin h = \cos a . \sin B$$

2)
$$\sin a = \cos d . \sin t$$
$$\sin a = \cos h . \sin Z$$

3)
$$\cot t = \cot a . \cos b$$
$$\cot Z = \cot a . \cos B$$

4)
$$\cot b = \cot d . \cos t$$
$$\cot B = \cot h . \cos Z$$

make the calculations even more accurate the author advises the selection of an auxiliary estimated position (assumed D. R.), i. e. a longitude which will yield a value of t rounded off to the nearest minute of arc and a latitude that will give a value of C also rounded off to the nearest minute of arc, so that for t and C one will obtain values of the log tan and log sec. which are absolutely accurate. This will improve the calculation of the final altitude.

The author remarks that aviators desiring to apply this method are not obliged to have special tables but may use any logarithm table giving the values of the log tan and log sec.

H. B.

ALTITUDE TABLES FOR MARINERS AND AVIATORS

by

E. TILLMAN

(Annals of the Lund Observatory (Sweden) 1936).

These tables are constructed in accordance with the principle of the resolution of the astronomical triangle into two right triangles as pointed out by Lord KELVIN (Sir William Thomson) in 1876.

The first part of the TILLMAN Tables comprises a series of tables for the conversion of times into arcs and for the correction of the altitudes measured either with the ordinary sextant or with the sextant having an artificial horizon. Further, the second part, entitled :

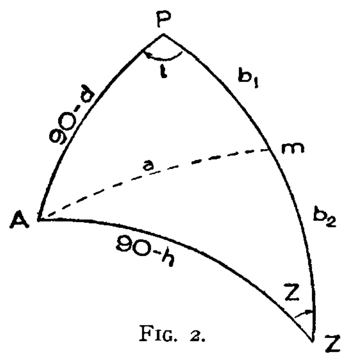

FIG. 2.

Altitude Tables, VII, VIII, IX, comprises the Tables for the calculation of the altitude and the azimuth based on the resolution of the spherical triangle mentioned above; it yields the following group of formulae :

1) $\sin a = \cos d \sin t$

3) $\cos b_1 = \sin d \sec a$

2) $\sin a = \cos h \sin Z$

4) $\cos b_2 = \sin h \sec a$

The first part of the TILLMAN Tables comprises a series of tables for the conversion nearest degree for the instant of taking the sight. From this a is obtained to the nearest degree (Formula 1). Table IX is then entered with a and the declination nearest the calculated value. One obtains a value for the angle at the pole slightly different from that calculated, the tabular differences Δd and Δt, and the value b_1 (see figure) in degrees. Table IX gives the values of d and t for the arcs a and b_1 to the nearest degree.

Table VII gives the factor $F = \dfrac{\delta d}{\Delta d}$ in functions of Δd and δd (δd is the difference between the calculated declination and the declination value inscribed in Table

By taking the inverse functions of all the terms in these formulae, and applying logarithms to all formulae we have :

1)	log cosec a	=	log cosec t	+	log sec d
2)	log cosec b	=	log cosec d	—	log sec a
3)	log cosec h	=	log sec a	+	log sec C
4)	log cosec Z	=	log cosec a	—	log sec h
5)	log tan b	=	log tan d	+	log sec t
6)	log tan a	=	log tan t	—	log sec b
7)	log tan Z	=	log tan a	+	log sec B
8)	log tan h	=	log tan B	—	log sec Z

In the first group of formulae we recognize the expressions in secants and cosecants, of which we spoke in the Hydrographic Review of May 1937, Vol. XIV N° 1, in connection with the tables of AGETON and of FONTOURA & PENTEADO. In this logarithmic form the formulae show clearly the sequence of operations to be followed in order to pass from the equatorial coordinates d and t to the auxiliary goniometric coordinates a, b, and C, thence to the final horizontal coordinates h and Z which are desired. We begin by evaluating the Greenwich hour angle computed from zero to 360° in degrees and minutes by the formula :

$$\text{G.H.A.} = \text{G.C.T.} - 12^h - \text{Eq. T. for the sun}$$

by the formula : G.H.A. = G.S.T. — R.A., for the stars, moon and planets, formulae in which :

$$\text{G.S.T.} = \text{G.C.T.} + (\text{R.A.M.S.} + 12^h) + \text{Correction for G.C.T.}$$

(It should be noted that the American Nautical Almanac gives the hour angle West of Greenwich directly in arcs as a function of the G.C.T. for the sun, the moon, the four principal planets and 55 stars used in navigation. Other Ephemerides, such as the British Ephemerides, the German Ephemerides, the Japanese and Argentine Ephemerides give the auxiliary quantities R and E) :

$$R = \text{R.A.M.S.} + 12^h \qquad E = 12^h \pm \text{Eq. T.}$$

Further, if one uses the sidereal chronometer, the calculation of the hour angle West of Greenwich is greatly simplified, as this angle is always equal to G.S.T. — R.A. regardless of the heavenly body observed.

In the second place the hour angle West of Greenwich thus obtained will be corrected for the estimated longitude which one can then modify slightly to obtain the local hour angle (L.H.A.) reckoned from zero degrees to 360° and expressed to the nearest minute of arc.

Entering the table with the declination, one finds the value of log tan d; entering the table with t one finds the value of log sec t and at the same time log tan t. The addition of the first two logarithms enables b to be calculated (the *Augmented Declination* of Towson) for which one then picks out also the log-sec from the table. b takes the same sign as the declination. From b one passes to C by the formula :

$$C = b \pm L$$

(L being the assumed latitude).

The last two formulae in tan Z and tan h indicate the operations necessary to find the calculated altitude and azimuth.

This method has the advantage over the greater number of the modern abridged methods in that the estimated position itself is used as the assumed position and since the D. R. position is rarely more than 10' in error, one obtains thus an altitude and an azimuth which are accurate to within about one minute of arc. The method does not involve any interpolation, has no limitations, no rules, or signs and names which are difficult to remember. The azimuth is determined without ambiguity, and with an accuracy which permits the compass to be checked. The use of the tangents in the perfectly uniform tables furnishes a better determination of the arcs than does the use of cosecants. In order to

IX). The angle at the pole given by Table IX is corrected by the product $F\Delta t$ and we thus obtain the value of *Pr.* the angle at the pole which corresponds to the calculated declination for the instant of observation and to the value of a as obtained from Table VIII. From *Pr.* we proceed by the usual method to the calculation of the longitude $\lambda\ r$.

We next determine the element b_2 (of the figure) by combining, according to certain rules given in Table IX, b_1 with the estimated co-latitude taken to the nearest degree. Finally, Table IX, with the arguments a and b_2, enables us to obtain the altitude h and the azimuth Z with their tabular differences, which, multiplied by the factor F, enable us to interpolate the values of h and Z for the calculated declination d. The coordinates of the point which is referred to the Saint-Hilaire line of position are $\varphi\ r$ and $\lambda\ r$.

These tables constitute a very marked improvement over the original tables of Lord Kelvin as a result of their more compact form and the simplicity in their use, but they suffer from the disadvantages of all tables which require the knowledge of a tabular estimated position for plotting the line of position.

(Summarized from the article by G. Simeon in the *Annali del R. Istituto Superiore Navale* - Napoli, 1936).

TAVOLE FONDAMENTALI PER LA RIDUZIONE DEI VALORI OSSERVATI DELLA GRAVITA

(*FUNDAMENTAL TABLES FOR REDUCING OBSERVED GRAVITY VALUES*)

by

G. CASSINIS — P. DORE — S. BALLARIN.

(22 × 32 cm. - XXVII + 119 pp. — Publication N° 22 of the *Istituto di Topografia e Geodesia* - Milano 1937).

This publication, based on the decisions of the International Association of Geodesy and Geophysics, contains the fundamental tables for the computation of the reduction to the geoid of observed gravity values, according to the different hypotheses. The tables are preceded by instructions for their use drawn up in Italian and in English.

ANNALI DEL R. ISTITUTO SUPERIORE NAVALE

Volume V. Fascicle II. Naples 1936.

This issue of the *Annali del Istituto Superiore* of the Royal Italian Navy contains a great number of interesting articles, among which we note the following :—

Drifting ice and the code for the transmission of observations made from vessels.

The radiogoniometric line of position considered as an azimuthal bearing.

The " Bresca " multi-station-pointer.

Remarks on the Azimuthal Correction.

The Centennial of the Position Line.