NEW NAUTICAL TABLES

I. TABUAS DE ALTURA E AZIMUTE — by FONTOURA & PENTEADO — Lisboa 1936 — 15 × 24 cm. — 26 pp.

In 1932 Commander A. FONTOURA DA COSTA and Captain F. PENTEADO of the Portuguese Naval Academy had already published a very interesting pamphlet dealing with the use of the various nautical tables for calculating the position. Entitled : *Instruçoes para uso das principais tábuas do Ponto Auxiliar,* they contained a comparative study of the following six tables of that period.

1) S. OGURA — *New Altitude and Azimuth Tables* — Hydrographic Department, Tokyo, 1924.

2) J.Y. DREISONSTOK — *Navigation Tables for Mariners and Aviators* — Hydrographic Office, H.O. N° 208 — Washington, 1928.

3) J.E. GINGRICH — *Aerial and Marine Navigation Tables* — New York and London, 1931.

4) RADLER DE AQUINO — *Newest Sea and Air Altitude and Azimuth Tables* — Rio de Janeiro and London, 1924.

5) J.A. NEWTON & J.C. PINTO — *Navegaçao Moderna* — Tábuas — Lisboa, 1924.

6) G.W. LITTLEHALES — *The Sumner Line of Position furnished ready to lay down upon the chart* — Hydrographic Office H.O. N° 203 & 204 — Washington. 1924, 1925.

Since that time various specialists have been engaged in improving the navigation tables to meet the requirements of modern high speed navigation and also to meet the desiderata of astronomical aerial navigation. For this purpose an effort has been made to reduce the volume of the tables as much as possible, because it is impracticable to take aboard surplus weight in aircraft in general and airplanes in particular, and the total weight allowance for instruments, documents and navigational accessories must be very strictly limited.

Special mention should be made of the work accomplished in this direction by the Research Division of the Hydrographic Office of the United States of America and by the following authors :

WEEMS — *Line Position Book* — Annapolis, 1927.

PIERCE — H.O. N° 209 — *Position Tables for Aerial and Surface Navigation* — Washington, 1930.

T.L. GATCH — *The Complete Navigator* — U.S. Naval Institute Proceedings — Annapolis, October 1931.

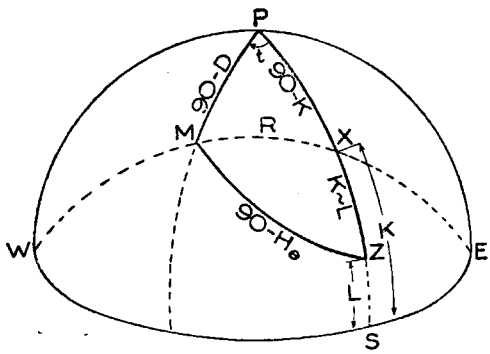
AGETON — H.O. N° 211 — *Dead reckoning Altitude and Azimuth Tables* — Washington, 1931.

CARLOS PINTO — *Simplex, Táboas de Navegaçao e Aviaçao* — Faial, Azores, 1933.

Aeronautische Hilfstafeln (Table 4 : Höhen— und Azimuttafel für die Luftfahrt) — Deutsche Seewart — Hamburg, 1934.

The tables compiled to-day by Commanders FONTOURA and PENTEADO are remarkable for their conciseness. For the computations of the D.R. Altitude and the D.R. Azimuth, the tables make use of the logarithms of secants and cosecants only and are constructed after the pattern of the AGETON tables with but slight modifications in the subdivision of the triangle of position — an explanation of which will be furnished later on. From this there results a perfectly symmetrical arrangement of the tables, and the rules for their practical application are very simple. The volume of the tables is reduced by half with respect to the Ageton tables by giving the functions of the log. secants and cosecants from minute to minute instead of for each half minute, since the accuracy thus obtained is quite sufficient for the purposes of aerial navigation. The principle of the Ageton Tables has

been expounded by the author in the U.S. Naval Institute Proceedings, Vol. 57, October 1931, pages 1375 to 1385. The method known as the "The Secant-Cosecant Method" derives from the resolution of the triangle of position into two well-known right triangles, already utilized in the Tables of the *Point Auxiliaire* of F. Souillagouët (Paris, July 1891) as well as in the Tables of Radler de Aquino.



(1) $\text{cosec } R = \sec D \text{ cosec } t$

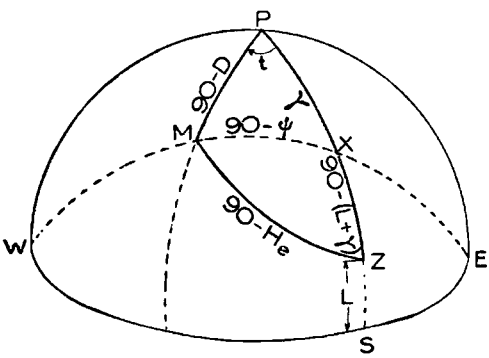
(2) $\text{cosec } K = \dfrac{\text{cosec } D}{\sec R}$

(3) $\text{cosec } H_e = \sec R \sec (K \sim L)$

(4) $\text{cosec } Z = \dfrac{\text{cosec } R}{\sec H_e}$

FIG. 1

Figure 1 shows this method of resolution obtained by drawing from the point M, which represents the heavenly body, the great circle perpendicular to the D.R. meridian PZ. The notations in fig. 1 are those employed by Ageton. The first set of equations 1, 2, 3, 4 corresponds to them. In figure 2 we give the new notation introduced by Fontoura and Penteado. From this there results a second set of equations 1', 2', 3', 4' by the introduction of the new parameters $\psi = 90° - R$ and $\gamma = 90° - K$. We shall not enter into detail here with regard to the computation of the formulae by means of these tables; a sample of the computations is furnished by the authors in the work itself. The solution is short, simple and uniform for all conditions. The interpolations are reduced to a minimum and the use of voluminous tables of logarithms has been eliminated.



(1') $\sec \psi = \sec D \text{ cosec } t$

(2') $\sec \gamma = \dfrac{\text{cosec } D}{\text{cosec } \psi}$

(3') $\text{cosec } H_e = \text{cosec } \psi \text{ cosec } (L \pm \gamma)$

(4') $\text{cosec } Z = \dfrac{\sec \psi}{\sec H_e}$

FIG. 2

The new tables include the conversion tables for time into arc, tables of correction for the observed altitudes of the Sun, the Moon and stars, especially arranged for the use either of bubble sextants or the sea horizon. In the latter case the tables have been extended to very great heights in view of their use by aviators. One table gives the distances of the sea horizon up to an altitude of 1,500 metres (5,000 ft. approx.). Another table gives the distance covered for the high speeds attained by airplanes.

II. TABLES OF COMPUTED ALTITUDE AND AZIMUTH, Latitudes 30° to 39° inclusive — H. O. N° 214 — U. S. Navy Department — Washington, 1936 — 24 × 30 cm. — 262 pp. — Price : $ 2.25.

As N° 214 of the Publications of the Hydrographic Office of the United States of America, there has just appeared a set of tables giving the D.R. Altitude and D.R. Azimuth fully calculated for the integral latitudes comprised in a 10° zone extending from 30° to 39° for the latitudes both North and South.

For several years an effort has been made to supply navigators with fully-calculated tables for a practical solution of the problem of determining the position at sea. These tables, in which the result can be read at a glance (inspection tables) or where use is made of a very simple interpolation to obtain the calculated results, dispense entirely with the use of logarithms. For finding the D.R. Altitude, they solve the same problem which the older ordinary tables of navigation solved solely for the azimuth of certain celestial bodies. Since the computation of the D.R. Altitude requires a much greater degree of accuracy, the tables become rather voluminous as a result of this fact alone; therefore, for purposes of practical convenience, it is more suitable to use regional tables.

Since the year 1919, when the Hydrographic Office of Washington started its publication N° 201 entitled : *Simultaneous Altitudes and Azimuths of Celestial Bodies,* many improvements have been effected in this type of table. In 1924, under the direction of Hydrographic Engineer G. W. LITTLEHALES, the personnel of the Research and Computation Division of the Hydrographic Office of Washington completed two important works bearing the numbers H.O. 203 and 204 of that Office, containing 700 to 800 pages and entitled respectively : "*The Sumner Line of Position furnished ready to lay down upon the chart by means of Tables of Simultaneous Hour Angle and Azimuth of Celestial Bodies*" and "*The Sumner Line of Position furnished ready to lay down upon the chart by means of Tables of Simultaneous Hour angle and Azimuth of Navigators' Stars*".

The first includes the declinations from 27° N. to 27° S. and the second the declinations comprised between 27° and 63° N. and S. In these two books, for each degree of latitude and the declinations for each degree, there is furnished the hour angle and the corresponding azimuth for each integral degree of true altitude.

In the new publication edited to-day by the Research and Computation Division of the Hydrographic Office of Washington, the data are furnished for each integral degree of latitude and for the declinations for each 30'. The D. R. altitude expressed in tenths of minutes, and the azimuth furnished to a tenth of a degree are given as functions of the hour angle, the latter being expressed in degrees and given for each degree. The tables apply indifferently to any star; they supply the navigator (by inspection) with the D. R. Altitude fully computed, as well as the azimuth. They do not necessitate the use of any particular rule and their arrangement makes the interpolations especially easy.

For each full degree of latitude the data are contained in a special chapter containing 24 pages, and two additional pages furnish convenient tables for star identification. In the columns, in addition to the computed altitude and the computed azimuth, there are given two factors, one for the increase in the declination and the other for the increase in the hour angle. The first represents the change in altitude due to a change of one minute of arc in declination, and the second represents the change in altitude due to a change of one minute of arc in the hour angle. The interpolations are readily made by inspection by means of a table of proportional parts supplied at the end of the volume. By using a very simple rule, the table may be made to apply equally to the solution of the problems of great circle navigation. The argument for the hour angles being given in degrees of

arc ,the table is preceded by one for the reciprocal conversion of arcs and times. It also contains a synoptic table giving the corrections to be applied to the observed altitudes for the sun, the moon and the stars, whether the altitudes are observed with the artificial horizon of the bubble sextant or above the sea horizon.

This volume, which bears the number IV in the series, is the first Part of a series of six volumes which will cover the entire range of latitudes from 0° to 60° N. and S., in ten degree zones. It was compiled by Commander Richard H. KNIGHT and Lieutenant Robert E. JASPERSON, U.S. Navy. The computations were performed in the Research and Computation Division of the Hydrographic Office of the United States of America, under the direction of Lieut.-Commander John E. GINGRICH and Mr. Elmer B. COLLINS.

III. AZIMUTY SVETIL — *Tables of true azimuths,* in 9 volumes — 17 × 26 cm. — 190 pp. each vol. — by A. YUSTCHENKO, published by the Hydrographic Department of the U. S. S. R., Leningrad, 1935. Price : 10 R.

The Russian Navy formerly utilized the tables of true azimuths of the Sun compiled by M. JDANKO giving the computed azimuths for the latitudes comprised between 61° and 75°. These tables being now out of print, the Naval Academy has decided to proceed with a new publication of greater scope giving the azimuths to tenths of a degree for all the stars having a declination comprised between 0° and 30° at time intervals for each ten minutes of time, the tables being restricted, for the rest, to the altitudes of stars comprised between less than 1° and more than 30°. The tables will be published in 9 volumes, each serving for a zone of 10° in latitude, the mean latitude of these zones being respectively 5°, 15°, 25°, 35°, 45°, 55°, 65°, 75° and 85°. The azimuths entered in the tables are computed for the mean latitude of the zone. In each volume the first part applies to the latitudes and declinations of the same name, while the second part is devoted to the latitudes and declinations of contrary names. One enters the table with the declination, which is given for each half degree, and with the hour angle of the star, given for each minute. For passing from the mean latitude to any latitude comprised within the zone, one corrects the value given in the table by means of an azimuth correction determined by a factor corresponding to the variation in latitude equal to $\pm$ 1 degree. The azimuth tables also provide for the solution of the problems of great circle navigation.

In addition, the Hydrographic Service of Leningrad has just published a new nautical table entitled : *Morekhodnye Tablitzy* comprising about 170 pages in a volume of 17 × 26 cm. at a price of 3 Roubles.

These tables have been compiled by Professor V. V. AKHAMATOV. Russion nautical tables had already been published in 1903. These are now out of print. Since the year 1911, Professor N.N. MATOUSEVITCH had been in charge of the task of correcting these tables in accordance with data furnished by the Nautical Commission. The work of remodelling the tables was interrupted in 1914. This idea was again brought forward in 1930 and a new Nautical Commission laid out a programme for the revision of these tables. The tables appeared in 1933 and the reception accorded them by Russian navigators obliged the Leningrad Hydrographic Department to proceed in 1934 with the printing of a second edition. The tables have been carefully checked by computation and by calculating machines and then compared with the data contained in various foreign manuals. They comprise the logarithmic tables to 4 decimals; tables of ordinary trigonometric functions for each minute of arc and each 4 minutes of time; the table of the 1/2 versine; various tables for the correction of altitudes and for the dip of the horizon; tables for rising and setting of the celestial bodies; tables for circummeridian observations; tables for dead reckoning; tables for meridional parts; the various tables ordinarily used in navigation for bearings on terrestrial objects and for the compass corrections. Tables are also included for the conversion of the various Russian units of measurement to the metric system.

H. B.
