A PRIMER OF AIR NAVIGATION

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90. Bygrave slide rule.—Attempts have been made to construct logarithmic slide rules for solving spherical triangles. The haversine-cosine formula has usually been favoured, as it is possible to construct a rule for obtaining the altitude from the latitude, declination and hour angle, by which the result is obtained without having to note down any intermediate figures. But it is difficult to obtain a high degree of accuracy owing to the comparatively short length of any one scale.

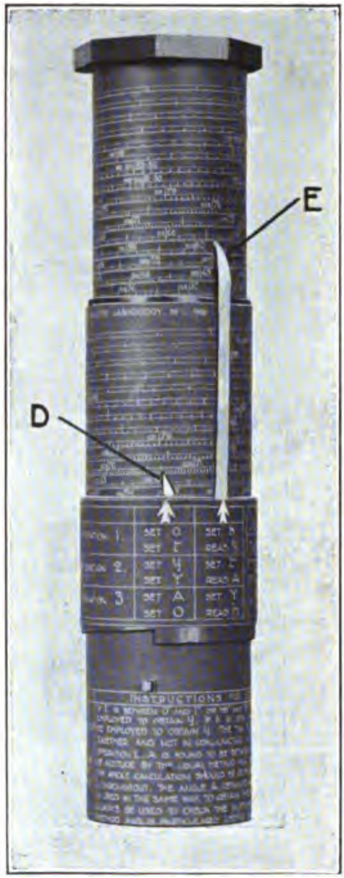

FIG. 51.
Bygrave spherical triangle slide rule.

The rule shown in the photograph (Fig. 51) employs the simple right-angled spherical triangle formulæ and is capable of a comparatively high degree of accuracy. It is necessary to note down an intermediate result, but as the operations are simple and quick, it compares favourably with other methods.

In Fig. 52 the method of dividing up the triangle to be solved into two right-angled spherical triangles is shown, O being the position of the observer, and Z the geographical position of the observed body. The bases of the two right-angled triangles are (90°—y) and (90°—Y), and (90°—y) $\pm$ (90°—Y) is equal to the co-latitude.

The following formulæ, then, connect the parts :—

1. $\tan y = \frac{\tan \delta}{\cos t}$

2a. If λ and δ are same name, $Y = y + 90° - \lambda$.

2b. If λ and δ are opposite names, $(Y = 90° - (y + \lambda))$.

3. $\tan A = \frac{\cos y \quad \tan t}{\cos Y}$

4. $\tan h = \cos A . \tan Y$.

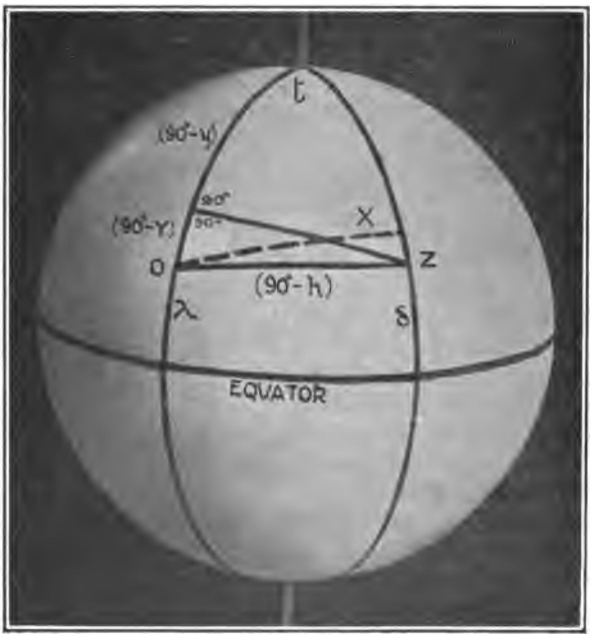

FIG. 52.

For the ordinary determination of azimuth and altitude for plotting the "position line" the procedure is as follows (see Fig. 51) :—

With pointers in the zero position, turn the inner cylinder until the declination is opposite E ; move the ring until D is set on the hour angle and read y at E. If declination and latitude are same name add 90° to y and subtract latitude to obtain Y, or if declination and latitude are opposite names add latitude to y and subtract from 90° to obtain Y. Set D to y, turn inner cylinder until the hour angle is at E, set D to Y and read the azimuth at E. Set D to azimuth, turn inner cylinder until Y is at E, move the pointers back to the zero position and read the altitude at E. The complete operations take but a few minutes and an accuracy of one minute of arc is usually obtained.

A special scale of short length is provided for dealing with hour angles between 89° and 91° and declinations less

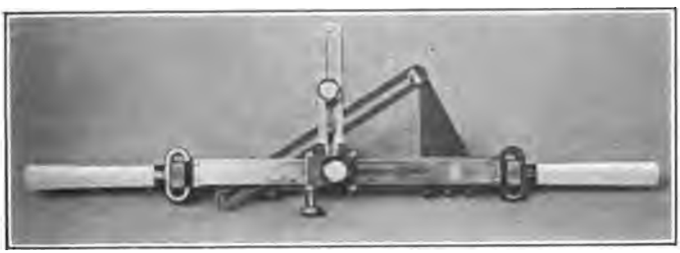

FIG. 53.—Nomogram slide rule.

than 1°. If the azimuth is found to be very near 90° the determination of the altitude by the usual method would not be very accurate, so the operations are repeated interchanging declination and latitude throughout. This is equivalent to dividing the triangle by X, and good results can then be obtained.

The diameter of the instrument is 2 inches—its length 6 inches.

91. Calculating mechanisms.—The d'Ocagne nomogram, since it consists only of straight lines can be made into a "slide rule" mechanism without a great deal of trouble, and such a slide rule is much easier to employ than the nomogram itself and may be expected—if very carefully made—to be more accurate. The uncertain factor is