(3) The vessel's Longitude 18°21'East

Part B: Star Identification

(1) Time of civil twilight after sunset:
Greenwich Mean Time 1812
Zone Time 1912

(2) The star is Arcturus

HISTORY OF NAVIGATION

ON THE ASTRONOMISCHES RECHENGERAT ARG1

By David Charlwood

Introduction.

There have been many and varied attempts in the past to solve the PZX navigational triangle utilising graphical-mechanical solutions. The great majority, however, have not possessed sufficient accuracy and ease of use to make them capable of supplanting and superseding other established methods. This paper seeks to combine and present all the relevant reports and documentation pertaining to the origin, the development and the operational history of the Zeiss ARG1. Information recently declassified and released to the general public by the relevant authorities has been included.

Origins.

Perhaps the most immediate predecessor of the ARG1 was the Bastien-Morin Type 12 calculator. This instrument was originally conceived by Professor A. J. Bastien for Air France and produced by H. Morin in Paris, France in the late 1930's. This device comprises two superimposed circular concentric transparent engraved plates based on an orthographic projection. The fixed upper plate comprising a graticule of parallels and meridians with minimal divisions is used to give an idea of the measurements carried out. The lower rotating graticule is identical to the upper, but with much more detailed engraving of which the divisions are not visible to the naked eye, but only by means of three microscopes, two of which are mobile and allow complete exploration of the grid, and a third fixed microscope which enables the latitude rotation to be accomplished. It was heavy and expensive and although the accuracy of the instrument was professed to be in the order of one minute of arc, the accuracy attained was, however, reported to be insufficient.

Operational Requirements

The Luftwaffe had decided by the early 1940's that the further development of calculated altitude and azimuth tables was virtually concluded, and that use of the German copy of the Bygrave slide rule manufactured by Dennert & Pape, at Altona, and known as the HR1, possessed difficulties for the observer when used in poor light and when subjected to aeroplane vibration.

Their new requirement was for an instrument with the following properties:

- The solution of the spherical triangle must be so simplified that, by a single insertion of the three known quantities (Time Angle, Declination and Latitude), the two required quantities (Altitude and Azimuth) will be shown directly, without intermediate quantities and without rules concerning plus and minus signs, with an accuracy of about ±1' of altitude and ±1° of azimuth.
- It should be suitable for use in all latitudes and for all heavenly bodies.
- It should make the smallest possible demand on precision engineering capacity in obtaining the desired accuracy.
- There should be direct reading of all values and scales.

The method finally chosen was spherical co-ordinate transformation. Mechanical rotation is both simple and reliable, and in addition, the whole hemisphere can be represented without troublesome distortions.

Principle Of The Instrument

The basis of the ARG1 is a grid inscribed with an equatorial stereographic diagram of a hemisphere, projected on to a plane parallel to the plane of the observer's meridian.

Consider the following two diagrams:

In the polar mode (Latitude – + 90°) the grid represents the celestial equator system, and is made up of lines marking Hour Circles and Parallels of Declination.

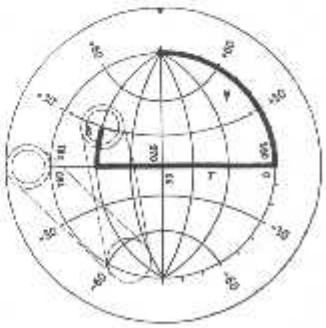

Figure 1 - ARG grid at celestial equator position in polar mode
Latitude – + (N) 90°
Time Angle = 150°
Declination = + (N) 30°

By rotating the grid from the polar mode to an angle equal to the co-latitude, the point previously marking the