# TRANSPOLAR CELESTIAL FOR HIGH SPEED NAVIGATION

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As of the present, the mainstay of navigation in the polar area is celestial navigation, supplemented by some such combination as the astro compass and directional gyro for dead reckoning.

In addition to observational difficulties, the chief weakness of celestial navigation at high speeds has always been the time required to determine position from the observations. At speeds of aircraft already in service, it is easily possible to travel 100 miles between the time of observation and the final fix of position on the chart.

Until recently, one of the fastest methods of translating observations into position was provided by the Weems Star Altitude Curves. It was recognized, however, that these were subject to several limitations, and recently Captain Weems brought out an adaptation of the method in the form of a celestial computer, eliminating most of the objections. Even in the new form, however, the method is still limited to use with the three stars for which it was prepared. It cannot be used with the Sun, Moon, or planets, nor for any of the other stars.

The writer had been associated with the Star Altitude Curve project almost from the beginning, and was in charge of the actual construction of the entire project. Partly as a result of this connection, and partly as a by-product of other cartographic work, I have long had under consideration a celestial computer not subject to these limitations. The method described herein is readily adaptable to any star, or to any body of the solar system - Sun, Moon, or planets. Its chief limitations as to accuracy are (1) the limitation imposed by the scale selected for the work ; and (2) the mechanical accuracy with which the various parts are assembled.

Basically, the device consists of a chart of the polar area on the stereographic projection. This projection was also used as the basis for the polar star altitude curves, since it has the desirable property that all circles on the earth are represented by circles on the projection. Circles of position are therefore all represented accurately on this projection.

Over (or under, if preferred) the stereographic chart there may be fitted two or more templates - one for each of the bodies observed. By reference to the Air Almanac, each template may be set for the GHA of the observed body at the moment of observation, after which the two (or more) curves representing the observed altitudes are noted, and their intersection is the desired position. No computation whatever is required, and no laying off of intercepts or other plotting on the chart. If the chart is isued *above* the templates, the usual dead reckoning plotting may be continued from the new fix by conventional methods or by the methods of grid navigation. If the chart is used *beneath* the templates, the position will probably be pricked through to the chart, after which the templates may be returned to their carrying case, or used again.

If desired, a separate template may be prepared for each of the 22 stars listed in the Air Almanac, although not all of these would be considered suitable for use in the polar area. In addition, two templates, adjustable for the declination of the Sun, Moon, and Planets, suffice for these bodies. If preferred, about 6 additional templates, adjustable in the same way, could be used for all the stars and planets, and the individual templates for the stars would not be required.

Obviously, the outfit might take any of several final forms. The chart may be fixed or rotatable, on the surface of the carrying case, with a small pivot through the center of the chart (the pole).

The templates should be on transparent plastic, with a small hole, accurately centered, to fit over the pivot at the center of the chart. In the case of the two templates for use with the Sun, Moon, and Planets, a narrow central slot replaces the small central hole, providing for the adjustment for the declination of the observed body.

In use, the star templates are adjusted simply by setting the setting-arrow against the GHA scale of the chart. For the other templates, an additional adjustment consists simply of sliding the template until the altitude curve corresponding to the declination of the observed body passes through the pole of the chart. This makes use of the well known principle that at the pole the computed altitude of a body is the same as its declination. These simple adjustments represent all the « work » that must be done. Once adjusted, small pieces of scotch tape will hold the templates in position until the fix has been marked on the chart.

Figures 1, 2, and 3 are small scale reproductions of a set of demonstration drawings which were prepared at a scale of 1 : 10.000.000, extending from latitude 70 degrees north to the pole.

Figure 1 is simply a conventional stereographic projection of the area, and would probably require the addition of grid meridians and other scales for complete navigation.

Figure 2 is a template for the star, Vega ; purely for demonstration purposes, different intervals were used for the curves between whole degrees in different parts of the template. In actual production, of course, a uniform interval should be used. In any case, it is apparent from the demonstration drawings that the curves can easily be read to an accuracy of 5 miles or better.

In figure 3, one of the templates for use with the Sun, Moon, or Planets, only the curves for whole degrees are shown. They should be at the same interval selected for the other templates.

If desired, all curves could be displaced to allow for standard refraction. The writer believes, however, that it might be more desirable to apply the refraction to the sextant observations directly, rather than to include a standard correction, with the probable requirement of applying additionnal corrections for other-than-standard conditions likely to exist at the time and place of observation.

By way of summary, the method proposed is fast, and requires no computation or plotting. Instead, it results directly in position on the navigator's working chart. It is as accurate as the limitations of scale and manufacture permit - and it is universal.