POLAR NAVIGATION WITH H.O. PUBLICATION 214.

by

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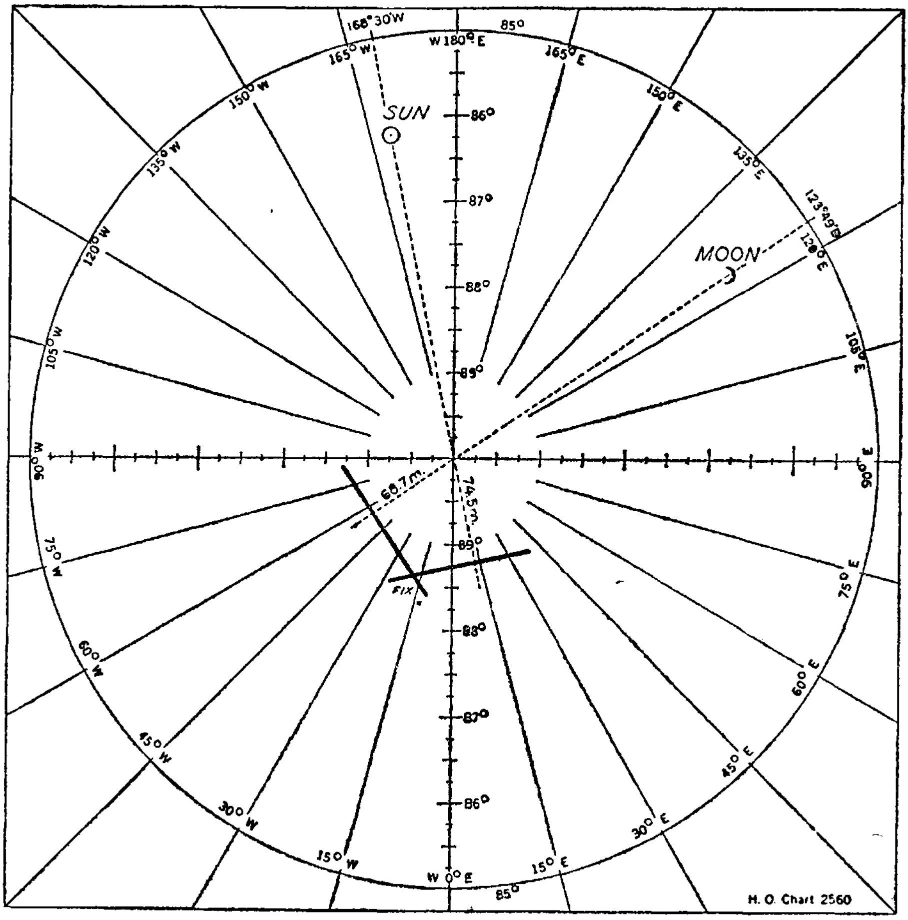
During the period of the search for the North Pole by PEARY, it is doubtful if the general run of navigators had any clear, detailed conception of the kind of navigational methods needed when approaching the pole. All knew that the many meridians rapidly converged to a point and that local time and longitude tended to become very indeterminate, hence any resultant fix appeared to be most uncertain. At this time there seemed to be few published reports from which they might learn the difficulties and details of polar observations. By far the most detailed and complete one was a discussion in 1892, by Professor GEELMAYDENS of Christiania, Norway, on the astronomical results of Nansen's expedition concerning the winter drift of the vessel "Fram", wherein he mentioned a graphic method of plotting Sumner lines on a stereographic projection for use in the polar regions. In January, 1910, however, it remained for another, Professor Emeritus Fielding REID, an American geographer and geologist of the John Hopkins University, Baltimore, to point out clearly for the first time to English-speaking navigators the special facility and simple application of the Sumner line in the vicinity of the pole. He gave the necessary details for the method of observing and plotting, eliminated the use of local civil time and the dead-reckoning longitude. His only equipment was one table — the Nautical Almanac — also a polar chart and a watch set to Greenwich civil time. He demonstrated that at the pole no computation was necessary to plot the line of position because the transit of the celestial body at the watch time of meridian was always known, and that the distance from the pole along this meridian to the point where the position line, or circle of equal altitude, cuts the celestial body's meridian, is equal to the difference between the body's observed altitude and its declination. Since that time, others have given modified descriptions of this same simple process, as first outlined by REID.

The Hydrographic Office has completed the tremendous job of computing nine volumes of Publication N° 214, for values of altitude and azimuth of celestial bodies by one uniform process, from the equator to the poles, for both the north and south latitudes. These books contain the values for belts of latitude of 10 degrees each. To the Hydrographer of the Navy, the greatest credit is due for zeal in promoting, completing, and furnishing to the maritime world a worthy undertaking that will go a long way toward lightening the work of navigators over sea and land. However, the present Hydrographer states that he will be unable to publish at this time the final book of the series, Vol. IX, which is that belt of latitude near the pole, or in that locality included between the limits of 80° and 90° north or south latitude. Due to the considerable expense involved for the printing of Vol. IX, and also the very limited demand for navigational tables in the immediate vicinity of the pole, the publishing of this volume will be deferred until some time in the distant future.

In order that a reliable and accurate supplementary means may be now available to the navigator for work within 10 degrees or less from the pole, the following alternative process here given is convenient, accurate, and simple of application, for finding by inspection and without interpolation, the computed values of altitude and azimuth for any celestial body in the heavens, together with a simple means for the plotting of the lines of position to give the final fix. The chart used for plotting is a polar chart constructed between latitudes 80° and 90° with the pole located at the center of a circle, and the radiating lines are the different meridians east and west of Greenwich. It is seen that near the poles the many meridians converge very rapidly toward the pole; therefore any observer's particular meridian is very difficult of determination because a departure in position of but 5 miles or so may change the resultant longitude by as much as 20 degrees or more.



In the process that follows of fixing position near the poles the navigator has no immediate concern whatever with the deadreckoning position of the vessel either as to the latitude or the longitude. In the polar regions whenever observations are taken of the sun, moon, planets or stars, the observer's "assumed" position is always regarded as being located directly at the pole. In this locality the navigator will invariably use an accurate timepiece always set to the Greenwich civil or sidereal time. When an observer is located at either of the poles of the earth, the observer's zenith and the elevated pole coincide, the plane of the horizon coincides with the plane of the equator, hence all vertical circles of azimuth cutting the horizon coincide with all hour circles or meridian circles of longitude cutting the equator, then all parallel circles of altitude coincide with similar parallel circles of declination. It is at once seen that altitude is always equal to declination and azimuth is always equal to hour angle or, what is the same thing, it is the longitude of the celestial body's meridian as measured from Greenwich. Since every assumed position used in the process is located directly at the pole, then in lieu of H.O. Publication N° 214, Vol. IX, the "Nautical Almanac" is substituted and now becomes the new and complete navigational table to find directly the computed altitude and azimuth, because every celestial body in the heavens has accurately recorded in the "Almanac" the true value of its co-ordinates-declination (altitude), and Greenwich hour angle (azimuth) for any given instant of Greenwich civil time (G.C.T.). It has already been shown that the declination of the celestial body is the computed altitude (Hc) with respect to the horizon, while the Greenwich hour angle indicates the true value of azimuth as measured from the prime meridian. The radiating lines on any polar chart are azimuth lines and are also the meridians on which the celestial body is located, or transits at any particular instant, and upon which the intercept is measured "toward" the celestial body if the observed altitude is greater than the declination (computed altitude) or "away from" the celestial body if the observed sextant altitude is less than the declination. The radiating meridian lines from the pole are azimuth circles indicating true directons, and are measured from the initial point, which is longitude 0° (Greenwich).

The procedure here then is as follows and differs in no particular essential from any ordinary sight observed anywhere on the earth. The "assumed position" is always the elevated pole. When the celestial body is observed, note the exact G.C.T. From the "Nautical Almanac" find the proper declination and Greenwich hour angle of the body for the exact G.C.T. of observation. When the true observed altitude (Ho) is greater than the declination (Hc) go from the pole "towards" the celestial body; along the azimuth (G.H.A.), or what is the same thing go along the meridian upon which the celestial body lies. If the observed altitude is "less" than the declination, go from the pole "away" from the celestial body along the azimuth, or longitude equivalent to the Greenwich hour angle.

Two sights on well separated bearings give as good a fix close to the poles as anywhere else on earth. For example: Near the pole, about midnight, on June 29, 1940, the true observed altitude of the moon by bubble octant was 9° —48'.3 corrected G.C.T. 23 h. 15 m. 12 s., and the true observed altitude of the sun 21° —57'.7 and the corrected G.C.T. 23 h. 17 m. 24 s. Find the position of the airship.

SOLUTION

Moon		Sun	
G.C.T.	23 h. —15 m. —12 s	G.C.T.	23 h. —17 m. —24 s.
G.H.A.	236° —11'.0 W.	G.H.A.	168° —30'.6 W.
or,	123 —49.0 E.		
declination	10° —57'.0 N.	declination	23° —12'.2 N.
Hc	10° —57'.0	Hc	23° —12'.2
Ho	9 —48.3	Ho	21 —57.7
Alt. Int.	1° —08'.7 or	Alt. Int.	1 —14.5 or

68'.7 away from moon along azimuth or longitude 123° —49'.0 E.

74'.5 miles away from sun along azimuth, or longitude 168° —30'.6 W.

On any polar projection such as H.O. chart N° 2560; plot the meridian of 123° —49'.0 E. Since this is the moon's G.H.A., that body is located on this meridian. Plot the meridian of 168° —30'6. W. Since this is the sun's G.H.A., that body is located on this meridian. Lay off a point 68.7 miles away from the moon, then draw the line of position at right angles to the azimuth 123° —49'0 E.; again lay off another point 74.5 miles away from the sun and draw a perpendicular to the azimuth 168° —30'.6 W. The intersection is the fix of position.

Thus it is seen that any vessel can navigate safely and with accurate results in and about the pole over the belt from 80° to the pole, without utilizing Vol. IX, H.O. 214.

MAP PROJECTION USED NEAR THE POLES.

When navigating within 10 degrees or less of the pole, the best projections to use are the Polar Gnomonic Chart (H.O. 5405-1), the Azimuthal Equidistant Chart (H.O. N° 2560 or 2560 A), or any stereographic projection chart. On any of the above charts, the straight line track joining any two points is practically a great circle. The distance can readily be measured along the chosen track, and the true course and the various changes of course as the different meridians are crossed can be readily found with an ordinary protractor when placed between the indicated track and any other selected meridian.

Circles of equal altitude for the sun near the poles are of very large radius as the sun is always low. Within 5° of the pole the correction for a line of position does not exceed 3'; hence the position line is correct when used as a straight line, but when stars are of high declination the position line is curving and this curve should be taken into consideration when plotting a straight line of position.