

# Hour Angle Observation of Polaris by Daylight

By Robert V. R. Reynolds, Forest Examiner 1915

OBSERVATION OF POLARIS BY DAYLIGHT.

It has been recognized by surveyors for a number of years that it is possible to observe Polaris by daylight through the telescope while it is still invisible to the unaided eye. The methods set forth for this purpose have not been used extensively, however, because of difficulties in getting the star within the field, and also in finding it when it is known to be there. The required computations of azimuth and altitude of Polaris are often inconvenient and sometimes uncertain for a busy transitman. It is believed that the previous troubles will be overcome if the following table is used and the subsequent directions noted.

TO FIND POLARIS BY DAYLIGHT.

Add to Latitude for hour angles less than 6  
Subtract from Latitude for hour angles exceeding 6

Hour Angle of Polaris	Azimuth Setting	Altitude Setting
Approximate* (Use suitable interpolations)	NE or NW depending upon position of Polaris E. or W. of Meridian	Latitude plus or minus the tabulated quantities
0.0 or 12.0	° 00'	1° 08'
0.0 or 11.5	° 12'	1° 07'
1.0 or 11.0	° 24'	1° 06'
1.5 or 10.5	° 36'	1° 04'
2.0 or 10.0	° 47'	1° 00'
2.5 or 9.5	° 57'	° 55'
3.0 or 9.0	1° 06'	° 50'
3.5 or 8.5	1° 15'	° 43'
4.0 or 8.0	1° 22'	° 35'
4.5 or 7.5	1° 27'	° 27'
5.0 or 7.0	1° 30'	° 18'
5.5 or 6.5	1° 33'	° 09'
6.0 hours	1° 35'	° 00'

\*The hour angle used as the argument in this table needs only to be approximate. If it is correct within five minutes sufficiently accurate settings will be indicated provided interpolation is made. Hence there is no need of correcting for longitude until the surveyor has made the observation and is preparing to enter the table of Azimuths of Polaris.

Polaris may always be found in clear weather as soon as the sun has set, and very frequently for five or ten minutes before sunset or after sunrise. It is stated on good authority that under very favorable conditions the observation has been successful as late as 10 o'clock A. M. In the northern United States the cross wires may remain visible for a long time after sunset.

For the novice it is often difficult at the first few attempts to see Polaris while the sky is still bright, but after once having found the star, which appears as a small white dot in the field, he will never thereafter feel in doubt. Granted that the tabulated settings are sufficiently accurate to bring the star in the field, there will still remain several factors which must be given suitable consideration before success can be definitely assured:

1. A slight haziness, which may hardly be obvious to the eye, is sufficient to conceal the star until darkness comes on.
  2. The telescope must be in exact focus for celestial objects. This may be accomplished either by focusing at night upon the moon and making a slight scratch upon the objective slide, to show the point to which it should be extended, or the surveyor may focus at the time of observation upon a well-defined object 3 or 4 miles distant, which focus will usually be found sufficiently close. Accurate focusing is one of the most important factors in finding the star, but one that is too often neglected.
  3. For the purpose of cutting off objectionable light, the sunshade should always be attached. Additional certainty of finding the star is rendered by throwing a coat or other dark cloth over the head when searching through the telescope, as a photographer uses a focusing cloth.
  4. An approximate meridian must be had, from which the azimuth settings are turned off. Commonly the surveyor will already have such a meridian from his backsight. Otherwise, a meridian determination from a solar attachment in reasonable adjustment will suffice. Sometimes, when the magnetic declination is closely known, it will even be possible to turn upon the star from the needle. A reference meridian which is true within 05 minutes or 10 minutes will be precise enough to locate the star when the table of approximate settings is used.
- The use of a reference mark is contemplated, such as another station of the survey, or a hub, or a distant, well-defined tree or snag on the skyline. Polaris having been found, the angle from the reference mark to the star should be measured twice, the second time with the telescope inverted. The mean time of observation and the mean angle are then used to find the azimuth of the mark by the simplified hour-angle method. There is practically no chance that any other star will be seen and mistaken for Polaris.

## THE SIMPLIFIED METHOD OF COMPUTING HOUR ANGLES OF POLARIS.

The hour-angle method as set forth in the General Land Office Manual of 1902, was too complicated, on

account of the required change into sidereal time, to be commonly and confidently used.

The admirable Ephemeris now issued by the General Land Office tabulates, for every day of the year, the Greenwich mean time of the upper culmination of Polaris. The possession of these data in the field makes it possible to easily compute the hour angle of the star at any desired time of observation by simply taking the algebraic difference, in hours, minutes, and length of minutes, between the local mean time of upper culmination and the local mean time of observation. The change into sidereal time is not required.

The following steps are necessary:

1. The tabulated Greenwich mean time of upper culmination must be corrected to the corresponding LMT on the meridian of observation by subtracting from it the following correction for longitude:

Longitude  
360  
3.9 = correction.1

2. If the star when observed is west of the meridian the corrected time of upper culmination, for the civil date of observation, is subtracted from the LMT of observation. If the star when observed is east of the meridian the LMT of the observation is subtracted from the corrected time of upper culmination for the civil date succeeding the observation. The result in either case is the exact hour angle of Polaris.2

3. Using the exact hour angle as an argument, the azimuth of Polaris is derived from the table of Azimuths of Polaris (Ephemeris pp. 14 and 15), interpolation being also made for the declination of the star and for latitude.

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\*An hour angle correct within five minutes is sufficient for the purpose of this table. Hence there is no need to correct the time of upper culmination for longitude until the Azimuth of Polaris is looked up in the Ephemeris.

## The Pottery Industry of the United States

A REPORT on the pottery industry in this country has recently been published by the Bureau of Foreign and Domestic Relations of the Department of Commerce that contains much of interest and also some surprising information in regard to manufacturing and commercial conditions, one of the most remarkable of which is that the potters of the United States are without adequate knowledge of the costs of production in their own industry. This is but the natural result of inadequate cost methods, but why such business methods should exist is difficult to understand.

The industry appears to be in a decidedly healthy condition, for it is stated that from 1901 to 1912 the value of pottery products increased 62.5 per cent and profits ranged from 21 per cent to 7.73 per cent, the latter indicating a loss of 4.68 per cent.

Extreme variations in cost of production were found to exist in different potteries, due in no small part to the different conditions in different plants and to the methods of the manufacturers. The successful manufacturers may be divided into three groups: those who have large kiln capacity and market great quantities of excellent ware that is sold direct to large retailers without the intervention of middlemen; small manufacturers who make a white ware of the best quality, well decorated and selling at good prices; the last class produces "scheme" ware, which is sold at relatively high prices to distributors of coffee, tea, cereals, beer, etc.

Large differences in cost of production were found to exist between the potteries of the United States and those of Europe, the level being considerably higher in this country. In fact (except one establishment in Austria), the lowest cost of production in any American pottery exceeded the highest cost of production in any European establishment. This condition will be understood on an examination of the following figures pre-

1 The approximate difference in length between the day of mean solar time and the sidereal day is 3.9 minutes.

2 In order to make sure of sufficiently accurate azimuth determinations the surveyor should be certain of local mean time within one minute. This requirement is particularly urgent near the times of culmination, when the apparent motion of the star in azimuth is at its maximum.

sented in the report: The cost of all materials and expenses, excepting labor, in the manufacture of white ware in the six representative American earthenware establishments averaged 2.05 per cent higher per 1,000 cubic feet of glost-kiln space fired than the cost in English earthenware potteries, 0.25 per cent higher than in Austrian china potteries, 29.2 per cent higher than in German earthenware potteries, and 17.77 per cent higher than in German china potteries. The labor cost for the same unit averaged 81.8 per cent higher in the American potteries than in those of England, 75.96 per cent higher than in German earthenware potteries, 62.9 per cent higher than in Austrian china potteries, and 138.97 per cent higher than in German china potteries. The total cost of manufacturing white ware in the American establishments was 38.43 per cent higher than in the English potteries, 53.65 per cent higher than in German earthenware potteries, 69.15 per cent higher than in German china potteries, and 30.25 per cent higher than in Austrian china potteries.

One of the reasons for high cost of production in this country results from the poor location and bad arrangement of the plants, which have had a haphazard growth. As a rule American potteries have evolved from small plants, and as business increased poorly arranged additions were made, so that only a few establishments have thoroughly modern plants equipped throughout with up-to-date machinery. Many of the establishments are poorly located in reference to transportation, convenience to their supplies of raw materials, and to their markets. The machinery and equipment in use in American and foreign potteries are fundamentally the same, but the American establishments have been slow to improve working conditions and to increase their efficiency by the installation of some improved devices successfully used in foreign factories, and in many cases it would appear good policy to scrap the plants and establish complete modern outfits in suitable locations.

Competitive prices of American and foreign ware in the United States are not determined solely by the difference in costs of production at home and abroad. Other factors, including customs duties, transportation charges, and incidental expenses, are sufficient to offset the difference in cost of production.

In spite of the fact that the average wages paid in American potteries in the different occupations are higher than those paid in European potteries by from 90 to over 600 per cent, the labor cost per unit of product never shows so great a difference as 82 per cent (except in German china plants). This indicates the greater efficiency of the American workmen.

The wages for American skilled workmen in earthenware potteries were from 91.05 to 236.28 per cent higher than in the English potteries, while the cost of labor per unit of product was 81.8 per cent higher in the American potteries. The fact is that, while workmen in foreign potteries receive less in wages than the American, they do not give as valuable a return for their wages. The difference is even more striking in the Austrian and German china potteries. The American wages were from 151.94 to 660.24 per cent higher than in the Austrian establishments, but the labor cost per unit of product was only 62.9 per cent higher in the United States. American wages ranged from 150.99 to 582.8 per cent higher than those in German china establishments, while the difference in labor cost per unit of product was 138.97 per cent. In no case was the difference in average labor cost per unit of product so great as the minimum difference in wages for the same occupation.

It is expected, however, that the American workman shall provide for himself the many benefits which European countries have arranged for him. Included under the general title of social insurance, the European workman is provided against the contingencies of sickness, especially occupational disease, which is unfortunately prevalent in this industry, and accident invalidity, old age, or death, and in some cases of unemployment.

There is a distinct need for more scientific methods of production, which can be brought about only by highly skilled instruction and more scientific research work. There are twenty-two technical schools in Germany and eight in Austria devoted to instruction in ceramics and the development of the pottery industry. England has a number of high-grade schools in which similar instruction is given. In the pottery centers of the United States there are no such institutions, and the average pottery in this country cannot afford to employ a scientific ceramic chemist who is not also a capable practical manager, a combination of qualifications which is rare indeed. The work of the Technical Chemical Research Institute of the German government indicates what might be done in this direction. The practical co-operation of the United States Government, through the Bureau of Standards of the Department of Commerce and other Government agencies, with the manufacturers is accomplishing much in advancing the standard of American pottery.