subsequently served a 35-year career in the regular Navy. Although he had no formal education beyond high school, he became an accomplished astronomical observer. I am enclosing a one-page writeup of Commander Francis Green. If the Foundation has an interest in having the complete autobiography I would be glad to try to arrange for one. It is entertaining reading.

"He includes a description of his youth, running away to join the merchant marine, service in the blockading Union Fleet during the Civil War and his post war assignments in the USN Hydrographic Office. Although he lacked any formal education in the astronomy and math fields it is obvious that he must have been a highly motivated self-teacher." — *Richard C. Gibson*

NAVIGATION NOTES

GREAT CIRCLE SLIDE RULE

By Robert M. Girder

Explanation, With Instructions And Example:

Mathematical Basis

Determination of Great Circle course and distance between two points involves the solution of a spherical triangle whose corners are North pole, Departure point, and Destination. The known values are the Latitudes of these points and the difference in longitude between them. The desired unknowns are the Initial Course and Distance (bottom line of triangle). (Except for the names of the parts, this problem is identical to the finding of the Hc and Z in the reduction of a Calculated Altitude sight to determine a Line of Position)* The Course and Distance can be readily found by spherical trig. calculations, special tables, or by graphic methods. The graphic method, used here, is by far the fastest. In addition, it provides continuous position information along the Track. In brief, this is accomplished by using the meridians and parallels of the stereographic projection to plot the position of the destination. Further rotation of the cursor places the bottom line of triangle along a meridian, thereby making possible the measurement of the desired unknowns: **Initial course** and **distance.**

Preparation

Where marking of the plastic cursor disk is called for, use either a sharp crayon, removable with dry tissue, or a suitable felt-tip pen, removable with moist tissue. After some experience the detailed instructions below can be replaced by following the **Steps**, shown on the face of the instrument.

Course and Distance

Assuming a trip from San Francisco (N38°,W122°) to Tokyo (N36°, E140°). First, determine the difference in longitude by *subtracting* if the direction of the longitudes are the same, or by *adding* if the directions are different. If the sum exceeds 180°, subtract from 360°. In this case: @122°+E140°=262°, 360°-262°=98°.

* **QUIK-DRI Sight Reduction Tables for Marine Navigation, including Celestial Rule** uses the same graphic method to determine the Azimuth and verify the Altitude. Copies are available from the author.

Next, set the cursor line on the rotatable plastic disk to 90° N Lat. Then, dot the intersection of the Diff Long (98°), interpolated between the marked meridians 90° and 100°, (top horizontal row of numbers) and the destination Lat. (N36°, interpolated between the marked parallels N30 and N40, right-hand edge). Circle the dot so it can be found later.

Now, rotate the disk clockwise, to put the cursor line over the Lat. Of Departure on the calibrated right hand edge scale. The new position of the dot will show the **Initial Course**, estimated from the bracketing Meridians on the bottom horizontal row of numbers (56°). The initial course is stated in degrees East or West of North, depending upon the direction of sailing (in this case, West). The compass course, then, is 360°-56°, or 304°.

Likewise, the dot's new position will show the **Distance**, estimated from the bracketing Parallels, evaluated by the miles scale on the left hand edge (4450 N. miles).

Track

To determine the **Track**, proceed as follows: Without moving the cursor, draw a **meridian line** from the dot to its North Point (90°). (Note: All meridian lines are arcs of circles on this stereographic projection. It can be sketched by hand with sufficient accuracy for most purposes. Next, rotate the cursor line back to 90°N. The new position of the drawn line will represent the **Track** from the Point of Departure (on the left hand edge) to the Destination (at the Dot). Waypoints along this line can be evaluated directly from the indicated Latitudes, and the difference in Longitude successively applied to the departure Longitude. These waypoints, conveniently every 10° change in Long. Or Lat., can then be transferred to an actual chart. In doing so, remember that on the "Slide Rule" the track always goes from Left to Right, regardless of the direction of sailing.

New Courses at Waypoints

The cutting angle of the track at each marked meridian or parallel makes possible an estimate of the changing course all along the route (for planning purposes). During the actual voyage, the new course would be recalculated at each waypoint.