Magnetic Compass Meets Sun Dial
The Spherograph and Hyatt's Celestial Coordinator

Erwin Wechsler (La Crescenta CA)

Fig 1

Today, when we carry a GPS receiver in our pocket, we might think - as I did - that the compass in the iPhone is also GPS driven, but it is not. It is true that some GPS units can tell direction of movement by comparing successive readings as we move in a constant direction but if you stop moving they are lost. The iPhone compass still uses for orientation that old dependable magnetic field of the Earth. The sensor is now electronic, not a magnetized needle, but still has the same problems magnetic compasses always had: the poorly known and time variable direction of the magnetic field as well as suffering from the influence of iron objects in the proximity.

Using the Sun for the correction of compass errors goes back to an age before the sextant and the marine chronometer. The man on deck duty during the sunrise or the sunset, had to log the compass bearing of the sun in addition to speed, compass reading and changes of direction. Knowing the approximate latitude and date they deducted the correct azimuth of the sun so they could figure the compass error and, interestingly enough, these old naval records are now used by scientists studying the historical changes of the Earth's magnetic field.

The sextant and marine chronometer allowed the sun dependent correction to the compass to be made at any time during the day and even during the night using celestial bodies for reference. Comparing the compass indicated bearing of the sun azimuth with the calculated one gave the needed compass correction. (Ref 7 &Fig 1)

However, the process required complicated calculations in spherical trigonometry that only highly trained naval officers could do. Around 1850, Stephen Martin Saxby, a British naval officer, tried to solve the problem by inventing an easy to use calculator for solving spherical triangle problems in celestial navigation (1).

The basic idea was to represent the celestial sphere in projection and superimpose the projections of the celestial sphere in the Horizon System and in the Equinoctial System and correlating them by rotating the projection in the Equinoctial System until the polar axis pointed to the correct latitude indication of the projection in the Horizontal System.

The device, called a Spherograph had two concentric diagrams that could rotate around a common center and was patented in 1856. (2)

The 1868 article from the English Cyclopedia is the most detailed description I could find and is a bit confusing when it comes to defining the type of projection used. The drawings suggest a stereographic projection since parallels are represented as circle segments, but towards the end of the article an orthographic projection is mentioned.

It turns out that any type of projection would do, provided both systems use the same type. As we'll see later on, the successor of the Spherograph which was used in the 1940s and was called Hyatt's Celestial Coordinator, used the orthographic projections.

I suspect that in 1850 it was easier to produce graphics using circles rather than draw the ellipse segments needed for the orthographic projection.

As a funny note, even in 1856, an obviously prescient astronomer concerned by the invention of the Spherograph, was quoted as having said that "By and bye we shall have a class of men to conduct our ships, who from want of practice, will become unable to calculate at all". (3) How true!

The Spherograph did not have the success it deserved and was superseded by the use of the Weir diagram. However, in the 1940s a new device, called Hyatt's Celestial Coordinator was reinvented. (Ref 6 & Fig.2). It was manufactured by the Felsenthal Co. and the Smithsonian has one of them. (4)

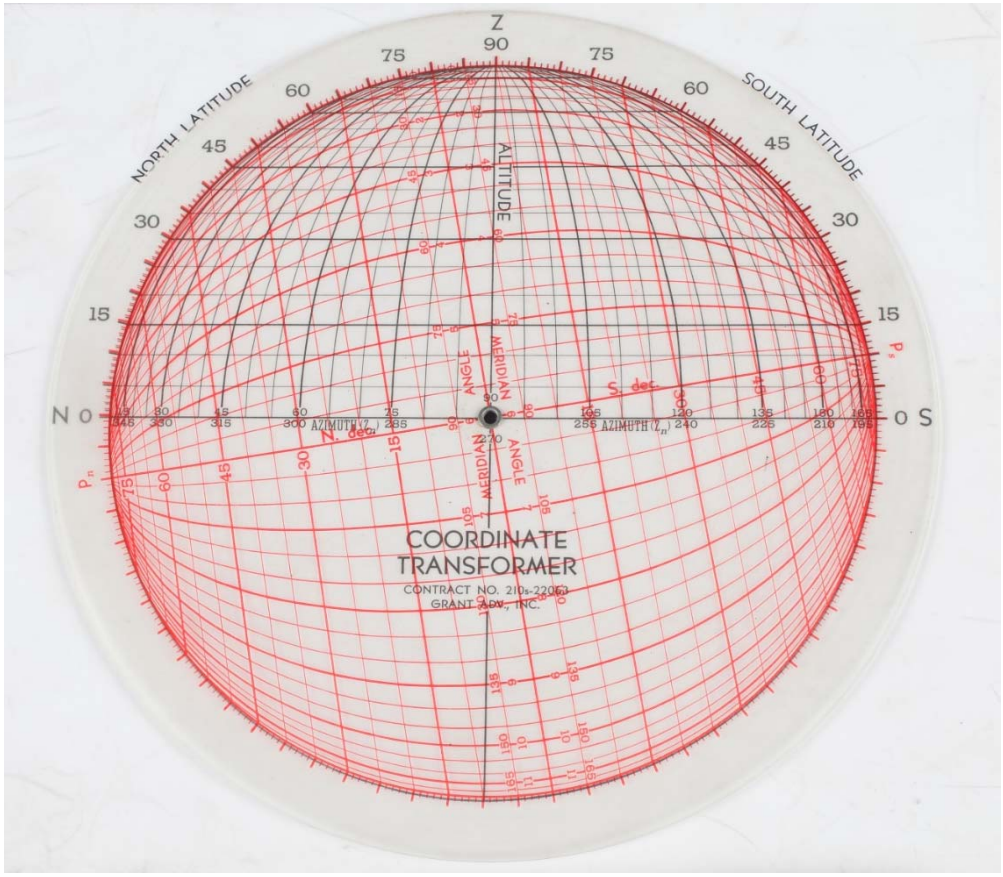

Fig 2

Looking at pictures of such instruments I remembered I had seen them before in my copy of the 1942 Dutton's (5). It briefly explains the use of the coordinator and very helpfully, provides drawings of both orthographic projections in color. (Fig 3)

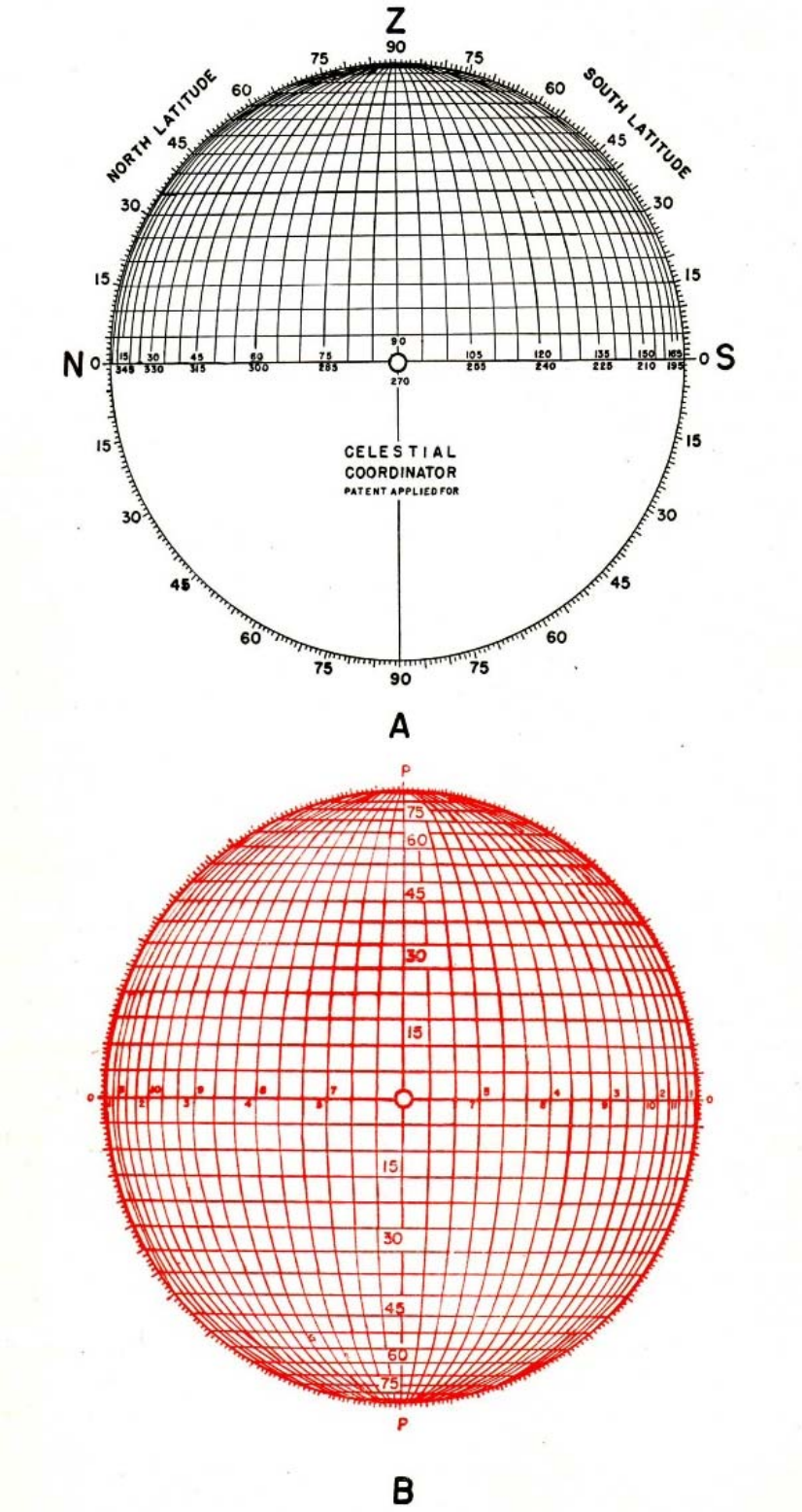

Fig 3

From this, there was only a short step to making a simple model. (Fig 4).

I copied the drawings on paper in black and white and in color on an ink-jet printer using a plastic slide for overhead projectors. Cutting the top half of the paper and the bottom half of the slide provides a poor-man's Celestial Coordinator which I used to do the exercises in the book. The Dutton pages of interest are attached in pdf format.

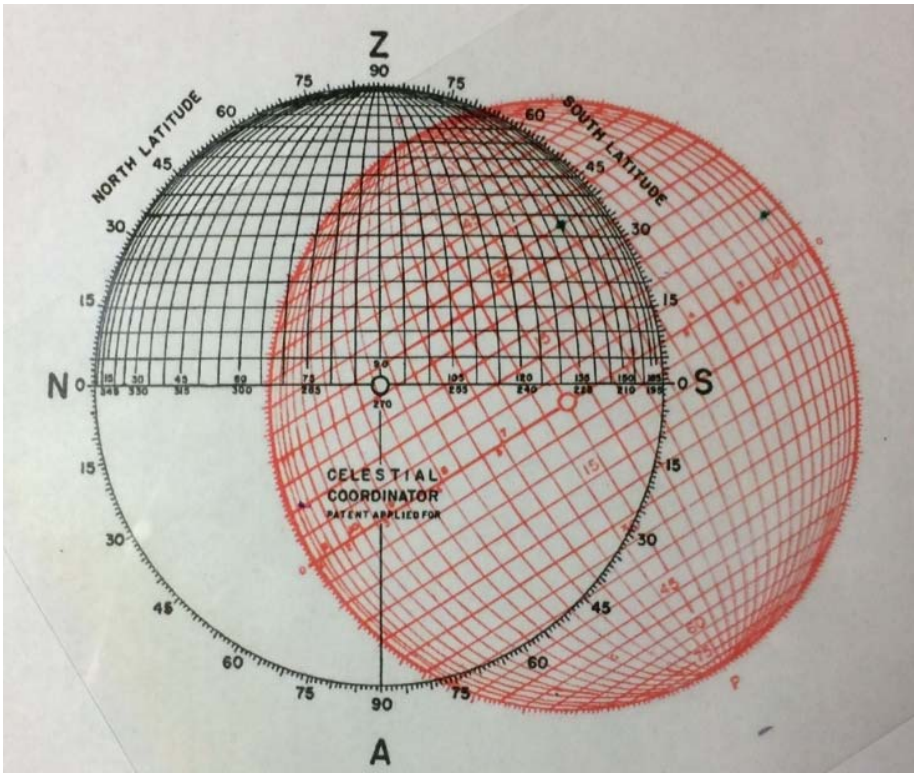

Fig 4

References:

(1) Stephen Martin Saxby; Edward J Powell; Sailor's Institute. Spherograph Office.; Great Britain. Hydrographic Department. Publisher: London : Spherograph Office at the Naval Study for Navigation, Seamanship, &c., Sailors' Institute, [approximately 1850]

(2) Communicated to me by Fred Sawyer. The English Cyclopedia (Arts and Sciences - 1868) Part 4, Vol. 7, pp.715 – 720 http://bit.ly/2p2AtHP

(3) Communicated to me by Fred Sawyer. The nautical magazine and naval chronicle for 1856, Cambridge University Press, 2013. Cambridge library collection. http://bit.ly/2qr6XMR

(4) Computer, Celestial Coordinate Transform, Felsenthal.
http://s.si.edu/2ppiX33 https://www.learninglab.si.edu/resources/view/1021216

(5) Navigation and Nautical Astronomy 7th Edition, U.S. Naval Institute, Annapolis, Maryland, 1942 – original edition (1926) by Commander Benjamin Dutton

(6) Manual of the Celestial Coordinator, Lieut. Comdr. Delwin Hyatt, U.S. Navy Weems System of Navigation, Annapolis, Maryland, 1943. (The manual in pdf format is attached)

(7) AMEE & Co. – Marine Survey & Compass Adjustment http://www.compassadjustment.com/

Erwin Wechsler *erwmew@charter.net*