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Front cover: Captain, later Rear Admiral, Ammen Farenholt at his desk as commanding officer of U.S. Naval Hospital Mare Island, undated.

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SUNDIALS FOR STARTERS – TIME AND TIME AGAIN

Robert L. Kellogg (Potomac, MD)

Today is a bright, sunny day … a good day for using sundials. Many times, we disparage mass-made commercial sundials, but I was particularly struck by the commercial dials from Cave Hill Cemetery in Louisville, KY, photographed by Robert Manning as part of the gravestone project for genealogy sites. (Fig. 1, NASS Registry #1029).

These dials stand over the graves of those that have passed, marking remembrance for those still living. These dials have stood the test of time. But there is a different story behind these dials as well.

Fig. 1. Rae Memorial: Cave Hill, KY. Photo: Robert Manning.

Tom Peretti registered a classic cast iron sundial that sits in his yard (Fig. 2, NASS Registry #1075). The dial sits on a graceful pedestal with a circular top that has been designed to hold the circular 9½ inch (24 cm) sundial. This classic dial has a chapter ring at the edge of the dial marking the hours with Roman numerals from V to VII (catering to mid-US latitudes). The style shadow counts time by hour lines and quarter hour marks radiating toward the gnomon's foot. At 12 p.m. there is an 'O' symbol, but no noon gap to accommodate the width of the gnomon. The gnomon itself has a style supported by the profile of a metal-cast bird. The bird has a short beak and a top knot that reminds me of a California Quail.

Fig. 2. Metalcasters Dial. Photo: Tom Peretti.

I analyzed the photos of Robert Manning who has taken excellent top-down photos of sundials and gravestones. The Rae Memorial dial, which is at 38°N, showed what was suspected: using Serle's ruler to measure hour lines on the dial face gave the generic mid-US latitude of 40°N.

At the south end of the sundial is a classic hour glass surrounded by angel wings (symbolizing 'Time Flies') with the motto beneath 'I COUNT NONE BUT SUNNY HOURS.' Other classic mottos on other similar dials include 'GROW OLD ALONG WITH ME THE BEST IS YET TO BE', 'WE LIVE IN DEEDS NOT IN YEARS,' and 'I MARK ONLY SUNNY HOURS.'

Fig. 3. Metalcrafters Dial – Detail from Reverse. Photo: Tom Peretti.

Many of these dials were cast in the 1930s in a variety of sizes from 9½ to 11½ inches (24 – 29 cm) and new ones are available from a few on-line vendors today (e.g., https://www.gardensundials.com). Tom's 9½ inch dial was cast by Virginia Metalcrafters in Waynesboro, VA, as part of a series 'No. 23-2' (Fig. 3.)

The company began as a stove manufacturer but as electric appliances took over, Virginia Metalcrafters changed its approach. In 1936, it began selling unique household items in both iron and brass to the newly formed Virginia attraction, Colonial Williamsburg. They expanded their product line selling reproductions and adaptations (that is, in the style) of items such as trivets, candlesticks, irons and trays. They survived until 2012. Variations in the exact design of the chapter ring, the bird profile of the gnomon, and the substitution of angel wings for an old man holding a scythe (e.g. NASS Registry #1046) were part of the change to meet the sundial market.

All these dials were cast as 'No. 23-1' or 'No. 23-2'. Fig. 4 shows a Metalcrafters dial from a sale on the web. Note that the gnomon is held firmly with a mortise and tenon. The mortise is on the bottom of the gnomon and the tenon is a slot on the front of the sundial. Only one screw is needed through the mortise and tenon to hold the gnomon aligned to the noon mark.

Fig. 4. Metalcrafters No. 23-2 Obverse-Reverse.

Fig. 5. A Griswold Dial.

Perhaps more famous was Griswold Manufacturing, makers of cast iron kitchenware. Founded in Erie, PA, it was in business from 1868 until 1957. The foundry started by making butt hinges, and quickly became locally known as the Butt Factory. It became the Selden and Griswold Manufacturing Company in 1873, casting griddles, skillets, and kettles. Then in 1885, after the passing of Selden and a fire that destroyed most of the foundry, the company re-emerged as Griswold Mfg. Principally known for high-quality cast-iron cookware, they had a sideline of casting iron sundials (Fig. 5).

Fig. 6 shows a Griswold dial in obverse and reverse. On the bottom in bold letters is ‘THE GRISWOLD MFG CO’ and at south is ‘ERIE PA U.S.A’ followed by the lot number. Lot 357 is the only one I’ve found. Perhaps like Metalcrafters ‘No.23-2’, there really was only one series.

Fig. 6. Griswold Observe-Reverse.

The Griswold gnomon is fastened with two screws. Unfortunately, I’ve seen one dial where the gnomon was installed backward with the gnomon foot on the hour chapter ring (NASS Registry #907). On the underside in the center of the plate, the Griswold dial has a square nub (tenon) for holding alignment. Here, the mortise and tenon system depends on the user to fashion a matching mortise square hole in the dial base.

Despite the simple dial face and generic latitude, the Metalcrafters and Griswold dials have been extremely popular over the years and have stood the test of time. Where to get a classic mass-produced sundial? You can go on the Internet and look at Etsy sales or for auctions of old dials or try the Rome Industries website at http://www.romeindustries.com/brassdials.html.

Fig. 7. Classic Sundial Design from Rome Industries.

Rome Industries' website states,

> *For over 50 years we have been crafting our sundials as Shakespeare wrote in Henry VI, "quaintly, point by point." Each design is individually cast using the traditional sand mold process and then hand polished and buffed…. Most of our sundials are cast in solid brass which we feel is the perfect medium as its heirloom level medium which may be passed down generation to generation. In addition, we offer some designs in cast iron.*

Rome Industries has at least a dozen sundial designs, including the classic design shown in Fig. 7. Remember that although "each design is individually cast", their brass horizontal sundial is not tailored to your latitude, with all using the generic 40°N latitude.

Bob Kellogg *rkellogg@comcast.net*

Steve Lelievre (Victoria, BC)

Bob Kellogg's *Sundials for Starters* column reminds us that decorative mass-produced Horizontal Sundials are still available today. They are not necessarily accurate in their design and most are designed to show Local Apparent Time at either 40°N or 45°N (for buyers in North America). They normally end up being sited at some other latitude and I have been asked a few times how to 'fix' them.

Many dialists are aware that sundials can be set up in a new location by use of a wedge. The dial's original design latitude must be known; Bob suggested using Serle's Ruler to find it. Another method – albeit less reliable due to the results for similar latitudes being fairly close to each other – is to evaluate $\sin \varphi = \tan \theta$ where θ is the angle between the dial's noon line and its 9 a.m. or 3 p.m. line, and φ is the design latitude[1]. For a dial intended to show Local Apparent Time, measuring θ as just under 33° (32.7°) hints at a φ value of 40° whereas a θ that is a bit more than 35° (35.3°) suggests φ is 45°.

To read about the mathematics of the wedge, see 'The Relocation of a Sundial' by Fabio Savian in THE COMPENDIUM 30(1), Mar. 2023, pp.50-68, or dig out Compendiums from the year 2000, which featured a few articles on wedge design e.g., Fred Sawyer's 'Quiz: Nicole's Wedge', The Compendium 7(1), Mar. 2000, pp.10-14.

Although the calculations involved are not particularly complicated, I decided to provide an online calculator to help with the process. It is at https://www.gnomoni.ca/wedge.

Steve Lelievre *steve.lelievre.canada@gmail.com*

[1] This is a just a special case of the formula for the line angles of a horizontal dial. When LAT is ±3 hours, Hour Angle is 45° and its tangent is 1, so the HA term can be simplified out of the formula. This special case is easy to remember, but very slightly better latitude discrimination is achieved using ±3¾ hours (in which case the applicable θ values are 43.8° and 46.4° respectively).

Admiral Farenholt's Sundials

Ron Marcell and Robert L. Kellogg

A uniquely styled sundial was distributed to U.S. Naval Hospitals throughout the United States in the mid-20th century by Admiral Ammen Farenholt. Exactly why he did this is unknown, but we can trace his history. Ammen came from a family whose father, Oscar Walter Farenholt, famously rose from seaman to admiral.

Oscar Farenholt was born on 2 May 1845 to German immigrants who had settled on a ranch on the Salado River, not far from the famous Alamo Mission in the Republic of Texas. Dropping out of school, he became a merchant sailor, and continued to sail until the outbreak of the American Civil War. On 12 April 1861 he joined the US Navy at age fifteen. In a decade Oscar rose to the rank of Lieutenant. His wife, the former Etta Mortimer Ames, gave birth to a son on 9 Dec. 1871 in Norfolk, VA. They named him Ammen, after their friend and benefactor Captain (later Rear Admiral) Daniel Ammen.

Initially seen as just another newly enlisted seaman, Oscar Farenholt's three years as a merchant seaman served him well. He distinguished himself with conspicuous gallantry in the amphibious assault on the Confederates in November 1861 at the Battle of Port Royal, Beaufort, SC. Aided by the influence of Captain Ammen and others, Oscar Farenholt was appointed an acting ensign in 1864, and after the war in 1868, was commissioned as a full Ensign. Farenholt rose to the rank of Captain over his 40-year career, and when he retired on 1 September 1901, a recently enacted law advanced all retiring Civil War veterans by one rank. The result: he raised his final active duty salute as a Captain, and lowered it as a retired Rear Admiral, becoming the U.S. Navy's first ever Seaman-to-Admiral. An article about his Navy career is attached to the NASS Sundial Registry for the sundial at Beaufort, SC: https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1014.

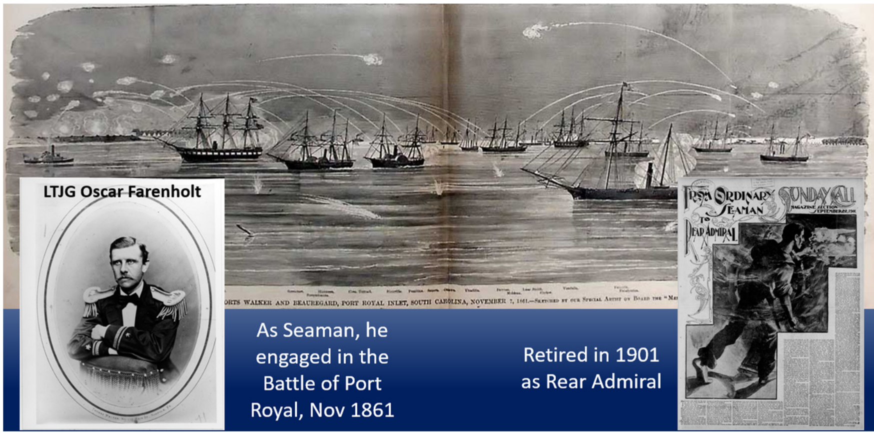

Fig. 1. Oscar Walter Farenholt rose from Seaman to Rear Admiral in the U.S. Navy.

Ammen Farenholt, as son of a U.S. Naval Officer, grew up with more opportunity than his father. In 1894 he graduated from Harvard Medical School, passed the Naval Medical Examining Board, and reported to the U.S. Naval Laboratory in Brooklyn, NY, in May of 1894 as an Assistant Surgeon (equivalent of Ensign). At 23, he was the youngest surgeon in the Navy.

During Ammen Farenholt's 42-year career, he commissioned sundials at a number of U.S. Naval Hospitals and Navy bases. The locations he chose correlate with places he served, visited, inspected, or commanded; others were aligned more closely with his father's history. Even with those connections, one is still left wondering, "why sundials?" That remains a mystery.

We currently know of fourteen Farenholt sundials, and a fifteenth that is little more than an internet rumor. Of the 14, one is known only by a single Navy archival photo and has yet to be accounted for today. As you look at these sundial photos, you'll note details such as the initials 'AF' on some dials (or in two cases simply 'F'), differences in the language used for the motto (English, Latin, French, and Spanish) with some mottos duplicated, the uniqueness of the Mare Island design, and more.

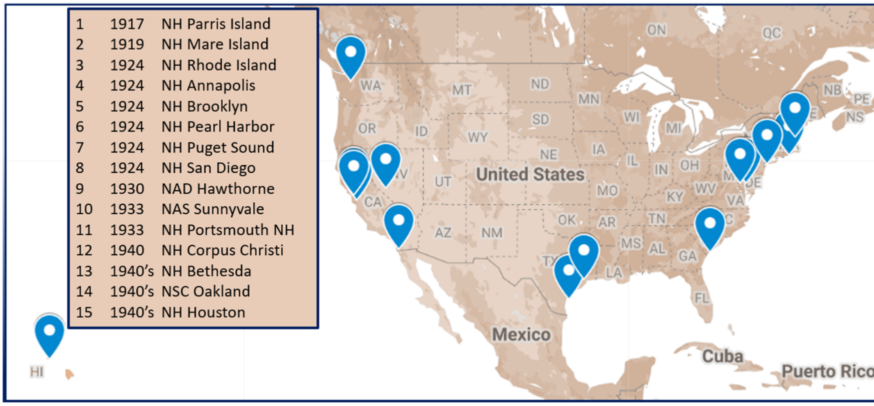

Fig. 2. Location of 14 (+1 Possible) Farenholt U.S. Navy Sundials

We'll start with the 1917 sundial at U.S. Naval Hospital, Parris Island, now placed at Naval Hospital Beaufort, SC. Like many of his dials, this one is placed near the flagpole (used not only for raising the colors each morning, but also the center for navy ceremonies such as re-enlistments and award presentations).

The Naval Hospital Parris Island sundial is the oldest known Farenholt sundial, dated 1917. In that year, Commander Ammen Farenholt was the Commanding Officer of the War Dispensary in San Diego (renamed Naval Hospital San Diego in May of 1919). Perhaps the sundial was in recognition of his father's start in the Battle of Port Royal in the Beaufort Sound.

Parris Island was the central feature occupying Port Royal Sound in coastal South Carolina. Today, it is the site of Marine Corps Recruit Depot Parris Island. The Navy began purchasing land on the island in 1883 to build wharves and shoreside facilities in support of the newly created Naval Station Port Royal. Naval medical personnel have been present on the station since at least 1891, when Assistant Surgeon Lewis S. Young was the first Commanding Officer (CO) of Naval Hospital Parris Island. The Marine Corps took over operations of the base in 1903. Naval Hospital Parris Island remained active and grew as its staff provided medical care throughout World Wars I and II. Decommissioned in 1949, the hospital is now forgotten by most, except for historians and museum visitors. Its functions were transferred to the newly constructed (1949) U.S. Naval Hospital Beaufort, SC. The last CO of NH Parris Island was the first CO of NH Beaufort, Captain Leslie Bert Marshall. From the old hospital, he brought the 1917 sundial, two plaques (lost to history), a bell, and his desk. By tradition, the Parris Island sundial was placed in front of NH Beaufort by the flagpole.

A fine description of Farenholt's sundials was given by Steve Woodbury in *The Compendium* 9(1), Mar. 2002:

> *They are circular, cast, 18 inches [46 cm] in diameter. They have raised lines for the hours, with short lines for the half-hours, from 6 am to 6 pm. An outer circle contains a motto. An inner circle contains Arabic numerals from 6 – 12 – 6.*

Most have the name of the command for which they were commissioned in raised letters centered in the southern half of the inner circle, and below that the year of commissioning. Five dials have the initials AF in raised letters at the bottom of the outer circle, two have only the single initial F, six have no initials, and no pictures have yet been found of the two lost sundial faces.

The motto for the Parris Island sundial is 'Fide Sed Cui Vide,' Latin for 'Trust, but be careful in whom you trust'; alternately: 'Have confidence, but be careful in whom you confide.' Other dials have mottos in Spanish, English, and one in French. A USMC Eagle Globe and Anchor are situated at the left and right positions on the outer circle. (Other dials simply have a star). The name of the U.S. Naval Hospital, in this case, UNITED STATES NAVAL HOSPITAL PARRIS ISLAND SOUTH CAROLINA is emblazoned in the lower half of the dial face. In the chapter ring at south is cast the year, 1917. This was the first (and classic) Farenholt US Naval Hospital sundial.

Fig. 3. Parris Island Dial - 1917, Relocated to U.S. Naval Hospital Beaufort, SC. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1014

The second Farenholt dial was commissioned at U.S. Naval Hospital Mare Island, CA, in 1919 shortly after influenza swept through the San Francisco and Vallejo countryside while CAPT Farenholt was commanding officer.[1]

Fig. 4. CAPT Ammen Farenholt at his desk as commanding officer of U.S. Naval Hospital Mare Island (undated). He was CO at Mare Island 1918-1921 and 1928-1930.

[1] CAPT Ammen Farenholt served as CO of US Naval Hospital Mare Island twice: 1918-1921 and again 1928-1930. (http://www.uniforms-4u.com/p-medical-corps-captain-hard-shoulder-boards-3403.aspx accessed 3 Dec. 2022.)

On Sept. 23, 1918, CAPT Farenholt received notice that the influenza epidemic was spreading and would shortly be on the Pacific Coast. The letter warned that nearly 20 percent of the staff would become infected and over 10 percent would get secondary infections of pneumonia. Arrangements were immediately made to accommodate over 1,600 people for the expected wave of infected. The hospital itself only housed up to 200 people and was used for the most seriously ill patients. Makeshift tent-like structures were built around the hospital grounds and even the St. Vincent's Catholic Church school building was used to shelter patients. Although the influenza subsided in late 1918, it resurged again in early 1919.[2]

Added to this, RADM Oscar Farenholt passed away in 1920 in the Naval Hospital Mare Island while his son was commanding officer. Ammen was at his father's bedside when he died. Nine months later, in 1921, CAPT Farenholt attended the commissioning of the first of two ships to be named after his father.

Four Farenholt sundials are known to have Spanish mottos: Dials at Mare Island, CA; Sunnyvale, CA; San Diego, CA; and Hawthorne, NV. The Mare Island motto is: "Como La Sombra Hoyen La Hora", "The shadow tells the hour." Speculation is that the Spanish mottos are in recognition of the dominant role and strong cultural influence that Spain and Mexico had on California's history.

The Mare Island sundial is significantly different from other Farenholt sundials: (1) there is no true chapter ring for the hour marks. They are at the end of long hour lines that start at 4am and continue to 8pm. All other dials are from 6 a.m. to 6 p.m. (2) The hours are delineated in quarter hours. All other dials are delineated in half hours. (3) The gnomon is more 'art deco' than the gracious curves of other Farenholt gnomons. (4) The naval command is not spelled out.

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[2] Source: https://www.calexplornia.com/a-historical-look-at-the-mare-island-naval-hospital/, accessed 3 Dec 2022.

Rather, it is just the initials “U.S.N.H.M.I”. All other Farenholt dials spell the naval command in full (with perhaps an unfinished dial for US Naval Medical Center, Bethesda, MD, intended for the command’s opening in 1942. (5) The date is placed above the command initials, not in the most southern position as on other dials. All other dials have the date in the southern portion of the chapter ring. (6) There are no Farenholt initials on the dial’s southern edge. All of this may indicate the haste with which the dial was made, perhaps to memorialize those that died in Vallejo due to the 1918-1919 influenza epidemic.

Fig. 5. (left) 1919 photo of the Farenholt dial at Mare Island and 2022 photos of the sundial (courtesy of museum staff at Mare Island). Historians found the dial in their artifact storage room. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/. 1076.

1924 was a productive year for Farenholt sundials, commissioning dials at NH Newport, NH Annapolis, NH Brooklyn, NH Pearl Harbor, NH Puget Sound, and NH San Diego. The classic Farenholt style is used for all six dials, as seen in the table below.

Original location: NH Newport Rhode Island.

Current location: In front of Naval Health Clinic New England. 41° 30.233′ N, 71° 19.333′ W.

Details: Standard Farenholt Dial; Gnomon Quatrefoil cutout; Chapter Ring 6 a.m. – 6 p.m. with half-hour intervals; Initial ‘F’.

Motto / Dial Face: Dum Spectas Fugio (Watching as time flies)

UNITED STATES NAVAL HOSPITAL NEWPORT RHODE ISLAND 1924

Original location: NH Annapolis Maryland.

Current location: In front of Naval Health Clinic Annapolis. 38° 59.583′ N, 76° 28.017′ W.

Details: Standard Farenholt Dial; Gnomon Trefoil cutout; Chapter Ring 6 a.m. – 6 p.m. with half-hour intervals; Initials ‘AF’.

Motto / Dial Face: Lex Dei Vitae Viam Monstrat Sed Umbra Horam Atque Fidem Docet (God’s law shows the way, but the shadow teaches the hour and gives us faith)

UNITED STATES NAVAL HOSPITAL ANNAPOLIS MARYLAND 1924

Original location: NH Brooklyn New York. Estimated at 40° 41′ N, 73° 57′ W.

Current location: Outside south entrance to Walter Reed National Military Medical Center, Bethesda, MD. 38° 59.983′ N, 77° 05.600′ W.

Details: Standard Farenholt Dial; Gnomon Trefoil cutout; Chapter Ring 6 a.m. - 6 p.m. with half-hour intervals; No initials.

Motto / Dial Face: Non Numero Horas Nisi Serenas (I count only the sunny hours)

UNITED STATES NAVAL HOSPITAL BROOKLYN NEW YORK 1924

Original location: NH Pearl Harbor, Hawaiian Islands. Estimated at 21° 21′ N, 157° 58′ W.

Current location: Outside south entrance to Walter Reed National Military Medical Center, Bethesda, MD. 38° 59.983′ N, 77° 05.617′ W

Details: Standard Farenholt Dial; Gnomon Quatrefoil cutout; Chapter Ring 6 a.m. – 6 p.m. with half-hour intervals; Initial 'F'.

Motto / Dial Face: My time is in the hands of God.

UNITED STATES NAVAL HOSPITAL PEARL HARBOR HAWAIIAN ISLANDS 1924

Original location: NH Puget Sound, Washington.

Current location: In front of Naval Hospital Bremerton. 47° 35.667′ N, 122° 41.433′ W

Details: Standard Farenholt Dial; Gnomon Trefoil cutout; Chapter Ring 6 a.m. – 6 p.m. with half-hour intervals; No initials.

Motto / Dial Face: Que Dieu Eclairi Les Heures Que Je Perds (The only French language motto: May God light up the hours I fail to light.)

UNITED STATES NAVAL HOSPITAL PUGET SOUND WASHINGTON 1924

Original location: NH San Diego, California. 32° 43.505′ N, 117° 8.933′ W.

Current location: At main entrance to Balboa Naval Medical Center. 32° 43.653'N, 117° 8.731' W

Details: Standard Farenholt Dial; Restored gnomon with irregular cutout; Chapter Ring 6 a.m. – 6 p.m. with half hour intervals; No initials

Motto / Dial Face: Horas Pasadas No Trabajan Nada (Past hours do no work.)

UNITED STATES NAVAL HOSPITAL SAN DIEGO CALIFORNIA 1924

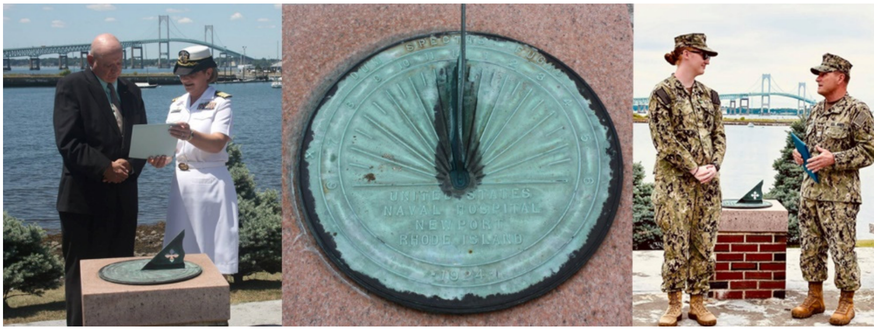

Fig. 6. Farenholt Dial originally placed at US Naval Hospital Newport, RI in 1924. Now at Naval Health Clinic New England. https://sundials.org/index.php/sundial-registry/onedial/1077.

Fig. 7. Farenholt Dial originally placed at US Naval Hospital Annapolis, Maryland. Now at Naval Health Clinic Annapolis, MD. https://sundials.org/index.php/sundial-registry/onedial/181.

Fig. 8 Farenholt Dial originally placed at US Naval Hospital Brooklyn, New York in 1924. Now at Walter Reed National Medical Center, Bethesda, MD. https://sundials.org/index.php/sundial-registry/onedial/461.

Fig. 9. Farenholt Dial originally placed at US Naval Hospital Pearl Harbor, Hawaiian Islands in 1924. Now at Walter Reed National Medical Center, Bethesda, MD. https://sundials.org/index.php/sundial-registry/onedial/462.

Ammen fell in love with and eventually married Henrietta (called Eta by her family) Petronella Afong Whiting on 12 Aug. 1926. She was a native of Pearl Harbor and the daughter of a very well-to-do merchant, Chun Afong.

In 1893, at age 23, Eta had married Naval Officer William Henry Whiting (who was 27 years her senior). Ammen was assigned to the USS Charleston in 1897 and served under Commanding Officer Whiting. Newspaper articles make it clear that he and the Whitings were often stationed together, attended ships commissioning ceremonies together, hosted social events together, etc. Ammen never married during these decades. RADM (retired) Whiting passed away on 26 July 1925.

A year later Ammen married Eta, having known her for over 25 years. She passed away in 1940, and he in 1956. They are buried side by side in the national cemetery at the Presidio of San Francisco, overlooking the bay. Ammen's father and Admiral Whiting are both buried nearby in the same cemetery. The sundial placed at NH Pearl Harbor in 1924 may have been to honor RADM Whiting.

Fig. 10. Farenholt Dial originally placed at US Naval Hospital Puget Sound, WA, in 1924. Now at US Naval Hospital Bremerton. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1078.

Fig. 11. Farenholt Dial originally placed at US Naval Hospital San Diego, CA in 1924. Now it is at Balboa Naval Medical Center. Dial originally was located at the convergence of two sidewalks that met at the main gate to the facility. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1079 .

Commander Ammen Farenholt was the first Senior Medical Officer of the War Dispensary in Balboa Park, San Diego, in 1917. The facility was redesignated as Naval Hospital San Diego in 1919. The facility remained a hospital through WWII and the Korean and Vietnam Wars. The sundial was likely moved in 1988 to its current location and restored with an electroplate of bronze and a new gnomon when a new hospital in Balboa Park was opened and named Balboa Naval Medical Center.

GenealogyBank Mon, May 23, 1932 | San Francisco Chronicle (San Francisco, CA) | Page 5

ON INSPECTION TRIP

Special to The Chronicle

MARE ISLAND, May 22 — Rear Admiral Ammen Farenholt, U. S. N., has left for Hawthorne, Nevada, where he will inspect the naval hospital. He will go thence to Seattle, and on his return in June he will inspect the air base at Sunnyvale.

Farenholt commissioned the next two sundials in the 1930s after he was promoted to RADM on 26 Mar. 1930 during his second command at Naval Hospital Mare Island. As Rear Admiral, he was briefly assigned as Inspector of Naval Medical Corps activities on the East Coast, followed by orders to inspect West Coast activities. The San Francisco Chronicle notes RADM Farenholt's travel to both sites in 1932. However, the dial dates themselves are 1930 for Hawthorne and 1933 for Sunnyvale. Farenholt also commissioned a dial for US Naval Hospital Portsmouth, NH, in 1933. The 1930s sundials, as those from the 1940s, had a star cut-out in the gnomon rather than a trefoil or quatrefoil.

US Naval Ammunition Depot Hawthorne was established in September of 1930 after a major disaster occurred at the Lake Denmark Naval Ammunition Depot in New Jersey in 1926. When the US entered World War II, the Depot became a key national staging area for bombs, rockets, and ammunition in transit to war. The sundial was dated for Hawthorne's commissioning.

Fig. 12. Farenholt Dial at US Naval Ammunition Depot Hawthorne, Nevada. The command is now Hawthorne Army Depot, a 147,000 acre ordinance storage facility. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1080 .

The dial at US Naval Air Station Sunnyvale is interesting. Notice that the San Francisco news article referred to the "air base" at Sunnyvale. The history of this dirigible air base goes back to Mrs. Laura Thane Whipple who helped raise $476,000 to purchase one thousand acres in Sunnyvale, diverting it from a proposed site in San Diego. On April 12, 1933, the Navy commissioned US Naval Air Station Sunnyvale. This is the command name and date on the Farenholt sundial.

However, on Apr. 4, 1933 another US dirigible, the USS Akron, crashed off Barnegat Light, NJ, with a loss of 74 lives, including William A. Moffett, Chief of the Navy's Bureau of Aeronautics. On 13 May 1933, effective 1 June, Secretary of the Navy, C.A. Swanson issued General Order No. 50, renaming NAS Sunnyvale as Moffett Field. This certainly indicates that the Farenholt sundial was cast specifically for the original commissioning of the Air Station on Apr.12, 1933.

One final word: At the base of the pedestal holding the sundial is a small plaque. It reads "PRESENTED BY R.ADM. A. FARENHOLT (M.C.) U.S.N. NOV 21, 1933" Thus it may be that the dial was intended for the station's commissioning but arrived after the name changed to Moffett Field.

Fig. 13. Farenholt Dial for US Naval Air Station Sunnyvale, California. Still west of Hanger One, but now part of NASA-Ames Research and Conference Center. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1081.

The Farenholt sundial commissioned for Portsmouth remains on the site of the old hospital (SE side facing the ballfield). The cornerstone of Building Number One at the Portsmouth Naval Hospital was laid on April 2, 1827, and the hospital began treating patients three years later in April of 1830. It is the oldest US Naval Hospital, and is located in Portsmouth Naval Shipyard on Seavey Island, Kittery, ME.

Although the sundial has not moved, the pedestal it rests on is not original and the capital now has a large crack. Nonetheless, the dial itself is in good condition. The gnomon's shadow clearly shows the star cut-out.

Fig. 14. Farenholt Dial at US Naval Hospital Portsmouth, New Hampshire. Dial remains near the SE corner of the old naval hospital.https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1082.

Fig. 15. Farenholt Dial for US Naval Hospital Corpus Christi, TX. Now at US Naval Air Station Corpus Christi, TX, in the green space north of Naval Health Clinic Corpus Christi. https://sundials.org/index.php/sundial-registry/view-all-sundials/onedial/1083.

In 1864, the same year that Congress appropriated funds for Arlington Cemetery, Abraham Lincoln commissioned Washington, DC's first Naval hospital, located several blocks from the Capitol. In 1906 the Naval Hospital moved to a newly constructed facility at 23rd and E. Street N.W., a location occupied by the US Naval Observatory that vacated in 1893 for the present location in Georgetown on Massachusetts Avenue NW.

In 1937, President Franklin Roosevelt sketched a new Naval Hospital and personally selected the site on Rockville Pike in Bethesda, MD. The site was a run-down farm with a small natural spring-fed pond that reminded the President of the biblical pool of Bethesda, famous as a spiritual place of healing. The pond was renamed Lake Eleanor to honor Mrs. Roosevelt. Funds were appropriated in 1938 and ground broken in 1939. Roosevelt commissioned the hospital on Aug. 31, 1942, as the National Naval Medical Center (NNMC).

RADM Farenholt retired in 1936, so perhaps the last 'Farenholt Sundial' was that for Corpus Christi. However, after the commissioning of NNMC a familiar looking sundial appeared at the hospital's flagpole. At the top of the dial was the motto: "Temporis ars medicina fere est" (Time is made by the art of medicine) and the gnomon had the familiar trefoil cutout. But south of the gnomon there is no command name, year, nor the 'AF' initials of RADM Farenholt. Nonetheless, it is certainly in the Farenholt style.

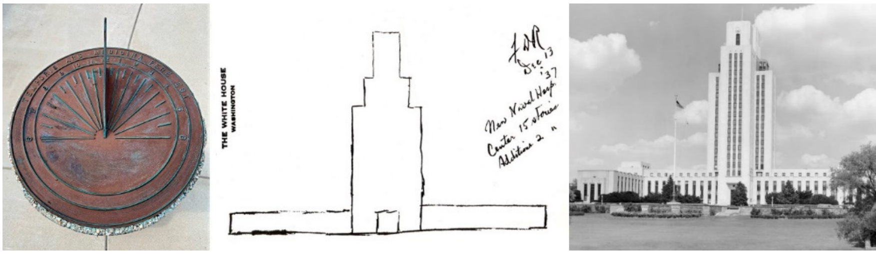

Fig. 16. Farenholt Style Sundial for National Naval Medical Center Bethesda, Maryland, now named Walter Reed National Medical Center. The dial remains west of the main entrance by the flag pole. https://sundials.org/index.php/sundial-registry/onedial/258.

Two other dials deserve mention. There is a photo of a sundial near building 321 at US Naval Supply Depot Oakland, CA, that Navy Archives identifies as a Farenholt sundial. It was installed in 1941 or later, but the undated photo shows an uncharacteristic gnomon shape. The dial itself appears to be circular and the right size, but a query to the Port of Oakland leadership regarding the fate of this dial has not received a response (as of July 2022).

The second dial is only known through the internet:

> *Sundial Bronze Naval Farenholt: $4750.00*
>
> *Admiral Farenholt commissioned Sun Dials for Naval Hospitals from the 1920's thru the 1940's. The Admiral retired to San Diego in 1936 where he continued to commission dials thru the war years. This dial dated 1945 was made for the Naval Hospital in Houston, Texas [29.45 degrees latitude]. The hospital in Houston was scheduled to open in 1945 but did not open until late in 1946. Several years before the completion Roosevelt expressed intentions to transfer the hospital to the Veterans Administration at the end of the war, and the transfer was made by executive order [of] President Truman in 1949. The dial was never installed.*
>
> *Of the nine known Farenholt dials still in existence, this is the only one privately owned. The best examples viewed via*

internet are two dials located at Walter Reed National Military Medical Center, Bethesda Md: the Brooklyn NY and Pearl Harbor dials, both of these dials are installed slightly tilted for latitude correction. The Admiral commissioned his dials for precise locations, and each have a unique motto either in Latin or English. The picture will show this dial's motto to be, "THIS HOUR ALONE IS THINE". These dials are among the most recognized and photographed in the USA.

Dial condition: The dial's inscription [tho still decipherable] has been roughly chiseled off, easiest restoration would be to smooth out entirely. The inscription read, "Naval Hospital, Houston Texas". The gnomon is missing but dimensions and various designs are known. This is most likely the last commission of a remarkable man, and early dial enthusiast.

No information has been found about the seller nor date of the advertisement.

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NH Mare Island California

The staff at the Mare Island, CA museum.

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NAS Sunnyvale California

Nicholas A. Veronico, author of *Moffett Field* in Paolo E. Coletta, ed. "United States Navy and Marine Corps Bases, Domestic" http://www.militarymuseum.org/MoffettFldHist.pdf.

NH Portsmouth New Hampshire

HM2(FMF) Christopher Merrell, Medical Homeport LPO, NMRTU Portsmouth.

NH Corpus Christi Texas

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About the Authors

Ron Marcell is a retired Navy Chief working as the Emergency Manager and Command Historian for NH Beaufort. It was the simple question, “What’s the story behind that sundial by the flagpole?” that led him to research and co-write this article. He is humbled and honored to offer you this glimpse into the Farenholt story and the sundials, and the many ways their tale is woven into the fabric of our nation’s history.

Robert Kellogg, PhD, is a prolific writer, researcher, presenter, and webmaster for the North American Sundial Society, where he shares his deep knowledge of sundials with beginners and experts alike. He lives in Potomac, Maryland.

THE SHADOW ON THE SUNDIAL

John Malcolm[1]

Upon yon dial-stone
    Behold the shade of Time
For ever circling on and on,
    In silence more sublime
Than if the thunders of the spheres
Pealed forth its march to mortal ears.

Day is the time for toil;
    Night balms the weary breast;
Stars have their vigils, seas awhile
    Will sink to peaceful rest;
But round and round the shadow creeps
Of that which slumbers not nor sleeps.

Before the ceaseless shade,
    That round the world doth sail,
The towers and temples bow the head,
    The Pyramids look pale,
The festal halls grow hushed and cold,
The everlasting hills wax old!

Coeval with the sun
    Its silent course began,
And still its phantom race shall run
    Till worlds with age grow wan,
Till darkness spread her funeral pall,
And one vast shadow circle all.

[1] Although this piece is not included in his book of poetry, the composer is likely Major-General Sir John Malcolm GCB, KLS (1769 – 1833).

Double Horizontal Sundial With Elliptical Craticular Layout

César Busto (Logroño, Spain)

This article describes the steps that led to the design and construction of a double horizontal sundial using the work developed by Samuel Foster on elliptical craticular sundials.

Introduction

Sundials are called *self-orienting* if their design allows them to be aligned with the meridian. I have always been attracted by this feature which makes them easy to use and adds the possibility of using them to find the North.

In order to be self-orienting, some designs incorporate two horizontal sundials, each using a different parameter of the sun's movement, e.g., azimuth and hour angle.

Two examples of this type of horizontal, self-orienting double sundials are:

- The double horizontal sundial with stereographic projection invented by William Oughtred.
- the double horizontal analemmatic sundial invented by Jean-Louis de Vaulezard.

In the latter, the need to move the analemmatic index or gnomon each day and keeping it fixed while moving the plane of the quadrant to find the north, seemed to me cumbersome and subject to the errors of correctly positioning the index.

Earlier this year, for the development of a new app, I was investigating the calculation of different types of azimuth sundials with a fixed gnomon. The first one was the one using stereographic projection and then I started to investigate analemmatic ones.

While looking for information, I found the article *Analemmatic Sundial With Fixed Gnomon* by J.A. Sassenburg [1] and going deeper I came across the article *Elliptical Sundials: General & Craticular* by Fred Sawyer [2] which offers a complete development of Samuel Foster's studies and writings on elliptical sundials and establishes the formulas to be able to calculate any type of analemmatic sundial with a fixed index.

I now had the tools to design an analemmatic sundial in which the index did not need to be moved.

Design

After careful study of Fred's document, I created an Excel workbook with the general formulae so that I could experiment by modifying the various parameters and see the result. In this step, Helmut Sonderegger's *Alemma* [3] program was very helpful to check the consistency of the results obtained.

The equations used are those found on pages 29 and 30 of Fred's article [4].

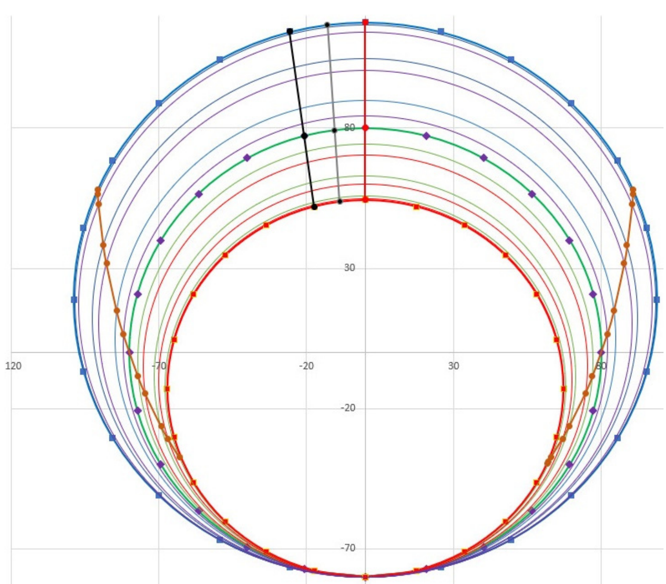

Fig. 1. Graph obtained in Excel for a reticular elliptical sundial.

By giving the index or style an inclination of *(90 + φ) / 2* with respect to the horizon [or following the nomenclature of the Alemma program, *(90 − φ)/2*] the ellipses of a classical analemmatic dial become circles. If instead of moving the index we keep it fixed and draw a circle for each value of the Sun's declination and make all the hour lines converge at the midnight point of the equinox circle, the design of Fig.1 is obtained.

Seeing the large circle in the center, I came up with the idea of inserting a classic horizontal sundial and designing a gnomon with two styles, one for each type. In this way, a double horizontal sundial would be obtained, which would be self-directing.

The first step was to create Excel and VBA macros to convert the data obtained into *x*- and *y*-coordinates for a CAD program, such as the free version of Nano CAD v.:5.0 [5], and to plot it.

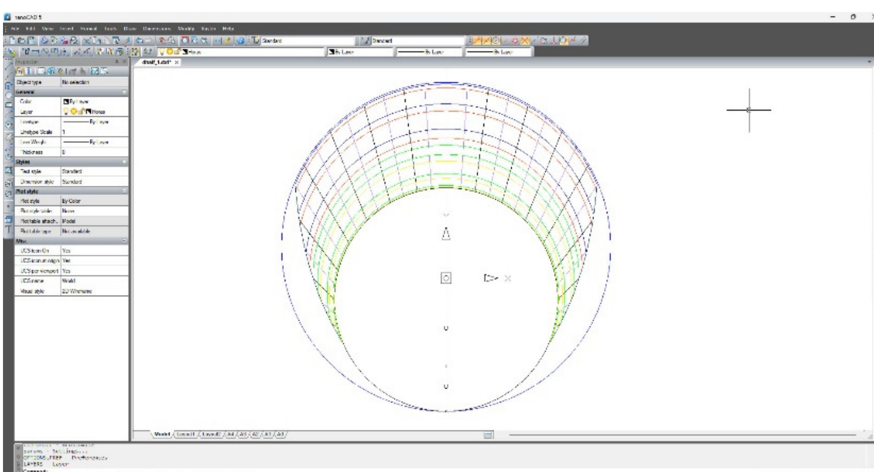

Fig. 2. The CAD drawing.

I calculated the horizontal hour-angle sundial with the help of the *Shadows Pro* [6] program and inserted it into the CAD drawing by converging the hour lines of the CAD drawing at the point where the hour lines of the elliptical sundial converge.

Working with a CAD program makes it easier to insert, trim and add lines. In this way it was easy to divide the horizontal sundial for the space needed for the gnomon.

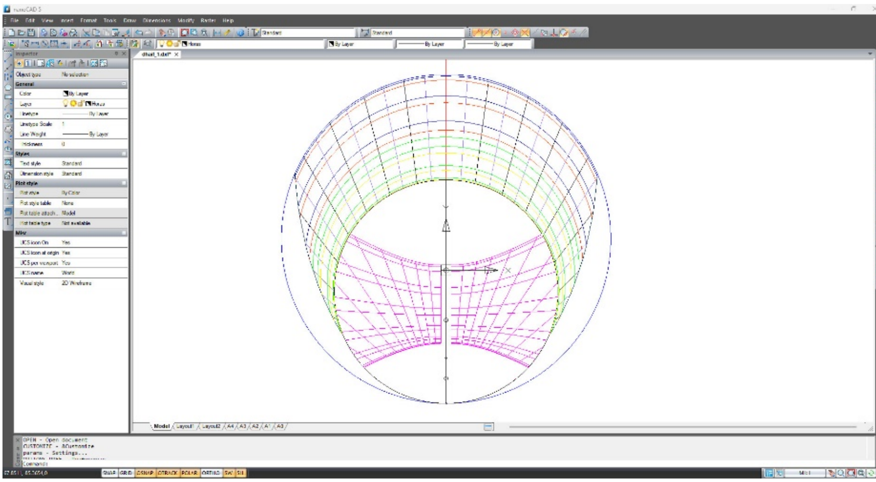

Fig. 3. Elliptical and horizontal dials tapered in the CAD program.

For applying different styles and colors to the lines, adding text and other elements and generating a vector graphics file to facilitate engraving, I used Corel Draw.

At this step I also added a pie chart of the Equation of Time, the coordinates of my location (Logroño, Spain) and the longitude correction. With this information, and the formula also included, the official time can be calculated. With all these data, the final design of the sundial plan was obtained, which can be seen in Fig. 4.

On each sundial the declination lines corresponding to the first day of each month and those of the equinoxes and solstices have been plotted. The elliptical sundial includes the sunrise and sunset lines that delimit the shaded areas on each side. This makes it possible to determine the approximate length of the day for a given date.

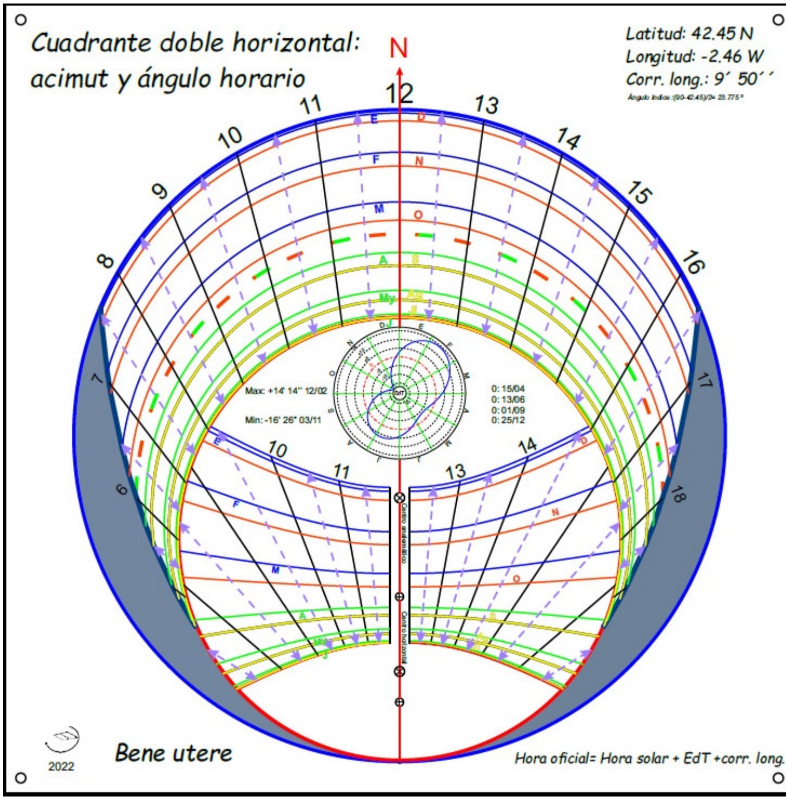

Fig.4. Final design of the sundial plan.

Now it was necessary to design a gnomon, or shadow-casting element, that would make it possible to read the true solar time on both sundials. For this, the gnomon should have:

- ✓ A polar style with an inclination to the plane equal to the latitude of the site. The origin would be at the point where all the time lines converge and its longitude should cast a year-round shadow on the horizontal sundial. It should incorporate a node to allow the date to be read from the declination lines.
- ✓ A style with an inclination equal to *(90 + φ) / 2* with respect to the plane, where *φ* is the latitude. The origin would be at the center of the circumference of the equinoxes and would have the necessary length to cast a shadow within the line corresponding to the summer solstice during the summer solstice.

With these parameters and the technical requirements of thicknesses and drillings needed for anchoring to the sundial plane, I designed the following profile in a CAD program.

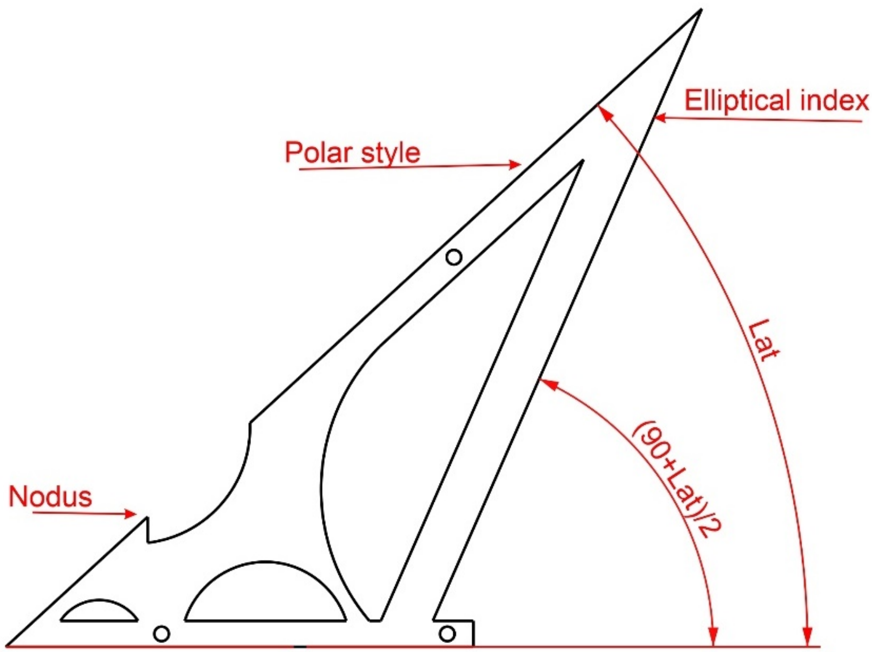

Fig. 5. CAD design of the gnomon.

The DXF file was used to generate the 3D figure using the FreeCAD [7] program.

The piece has a thickness of 6 mm in order to allow the holes for anchoring the plane. This thickness is that of the polar style which has already been taken into account in the layout of the horizontal dial.

However, the elliptical dial's index has to have a sharp edge. As I was planning to build the part with a 3D printer, I decided to design the part in two wedge-shaped halves and join them together to get the edge.

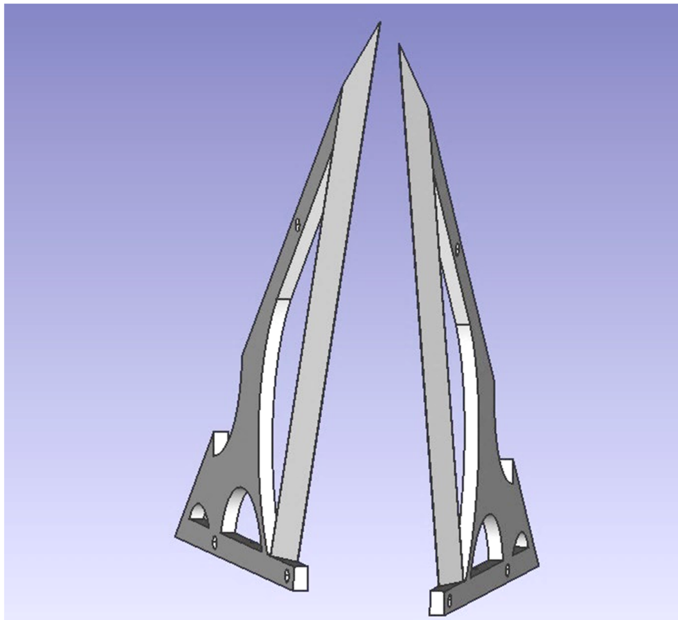

Fig. 6 Design of the two halves of the gnomon.

<u>Manufacturing</u>

The face of the sundial was engraved on a 1.5 mm white lacquered aluminum sheet by UV printing – a precision, color and resistant printing technique – by a specialized company in Vitoria (Spain).

The two pieces that form the gnomon were built with a 3D printer at home.

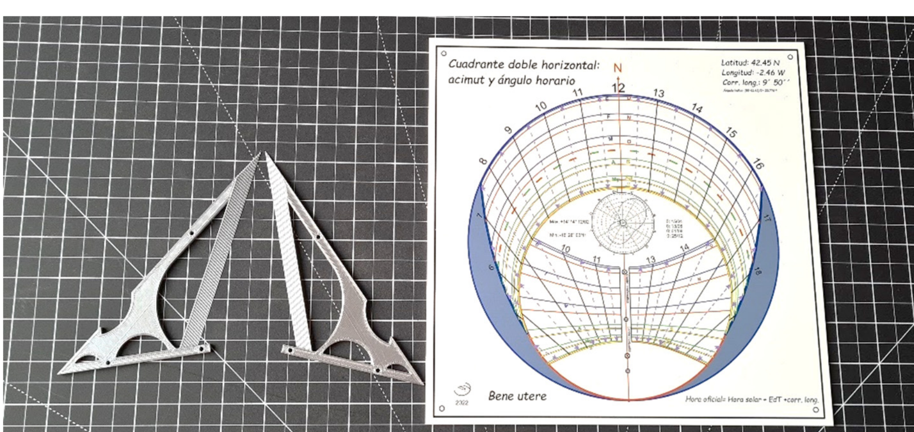

Fig. 7. Elements of the sundial before assembly

After assembling the two halves of the gnomon and mounting it on the plane, the complete assembly was obtained.

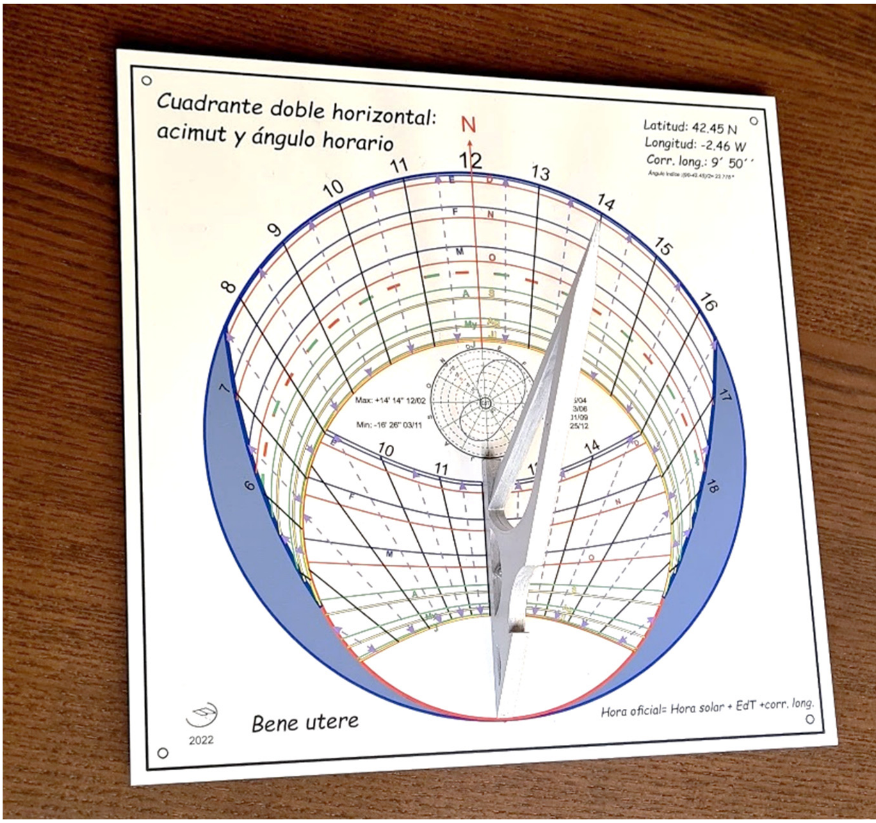

Fig. 8. Complete sundial seen from above.

Tests

With everything finished, the time had come to test the dial's operation. On 2nd October 2022 I placed it in the sun. As the date was easy to identify on both sundials because of the proximity to the beginning of the month, it was very easy to match the times and get a perfect alignment.

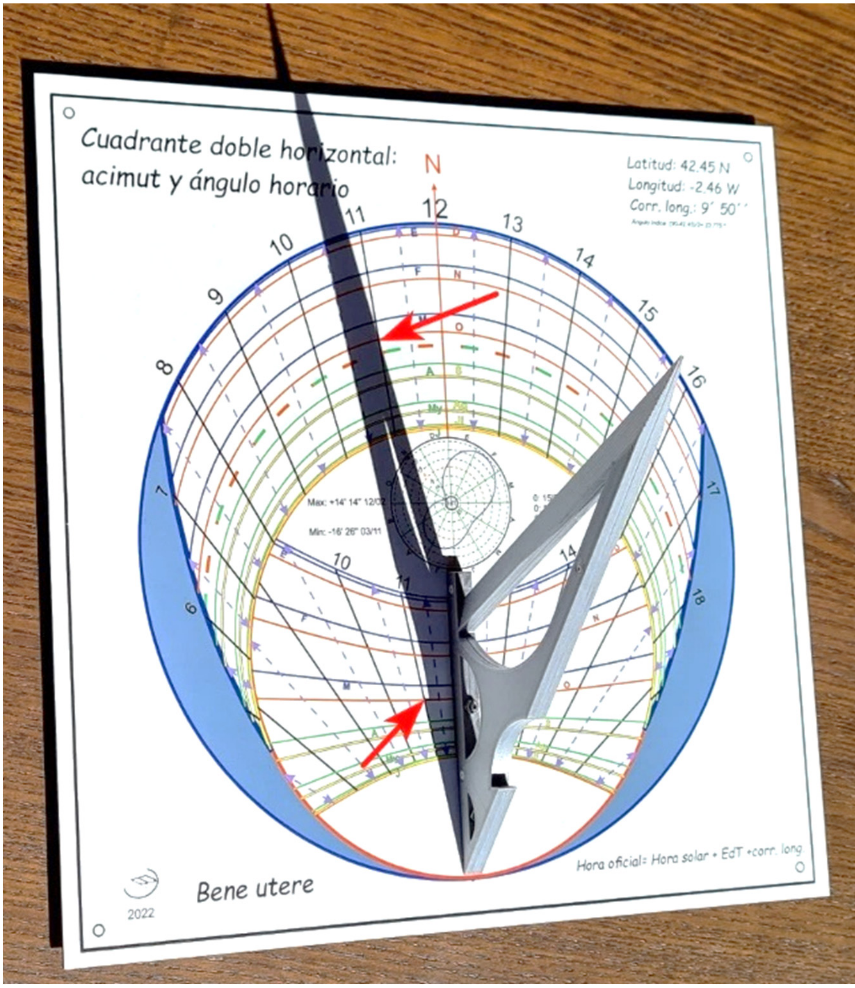

Fig. 9. Testing the sundial.

It worked perfectly from a gnomonic point of view, but as the minutes ticked by and noon approached, a common problem with this type of clock arose.

As mentioned above, the index of the elliptical sundial is the edge of a wedge and as the sun's azimuth approaches the meridian line, the edge enters the shadow of the back face, thus giving the wrong azimuth. In this case the angle at which the reading is wrong is between ±16.7°. In Fig. 10 you can see the effect and the reason for it.

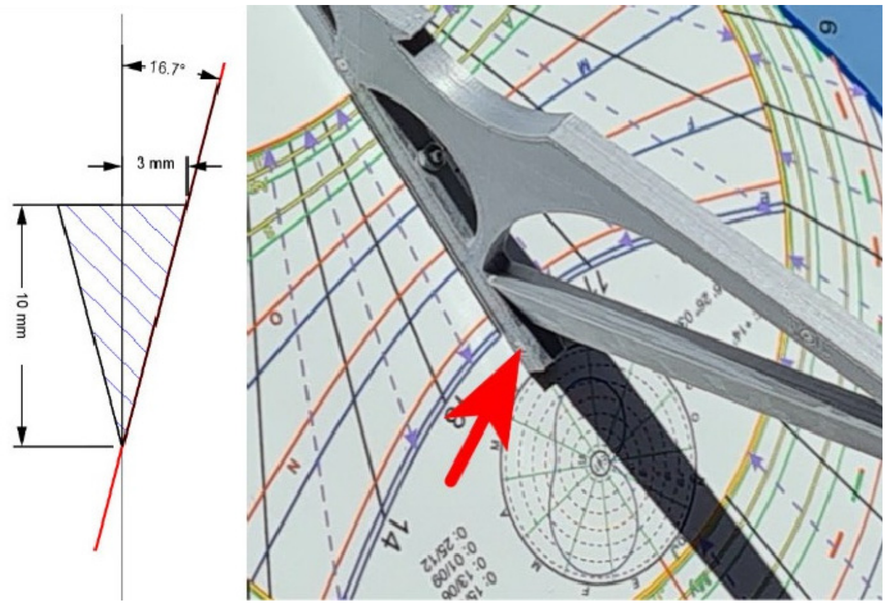

Fig. 10. Shadow of the wedge.

Looking for alternatives

3D printing at home gives you the freedom to build prototypes easily, quickly and cheaply. You just have to have an idea, draw it and in a few hours, you can touch and test it.

A first solution was to convert the wedge into a 2 mm sheet ending in an edge. As shown in Fig. 11, this allows the error to be reduced to one third of that of the wedge at the angle where it is in the shadow of the wedge.

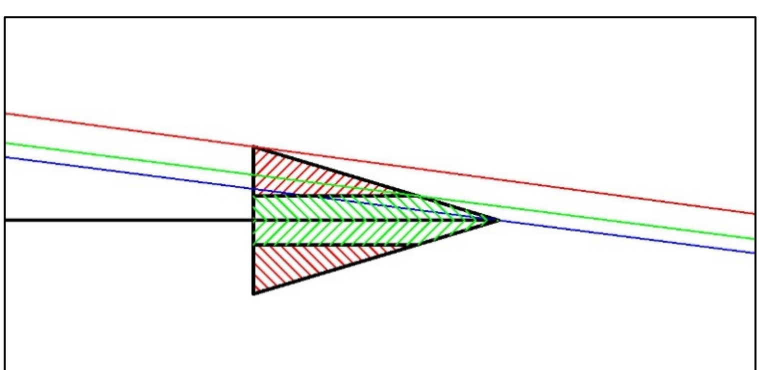

Fig. 11. Error of the wedge and the blade.

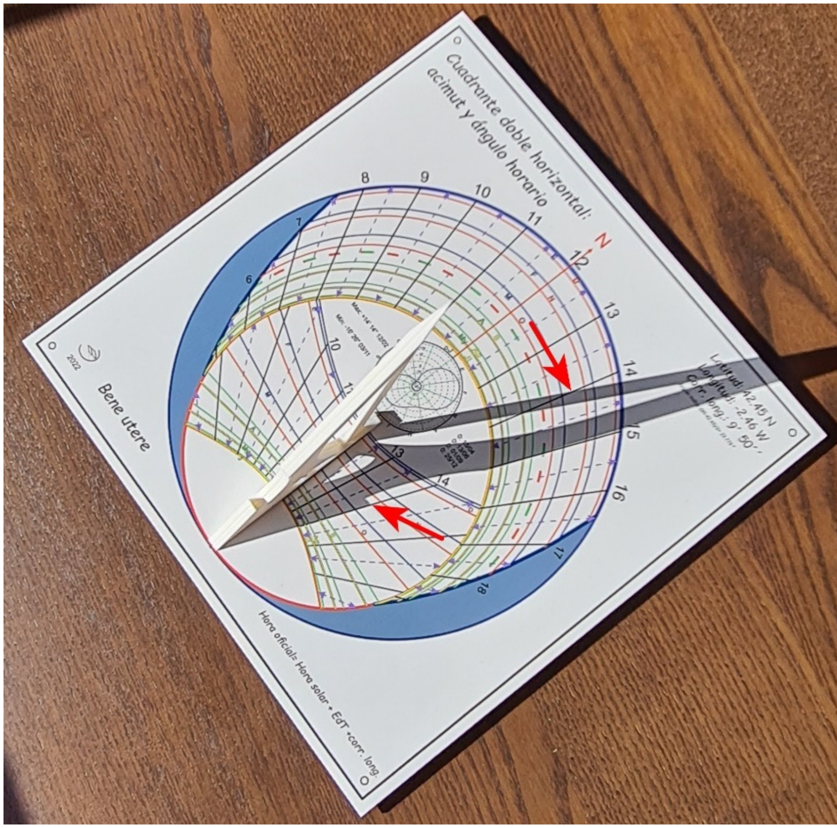

Fig. 12. Sundial with the index in the form of a foil.

Another solution was to modify the gnomon to replace the wedge with a 3 mm diameter rod, which I had at home from another piece of work, and which would act as the index of the elliptical dial.

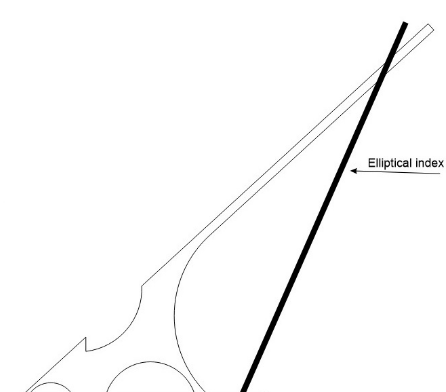

Fig. 13. Gnomon with rod.

Now the index of the elliptical sundial is only affected by the shadow of the horizontal sundial style which in the worst case is at a distance of 30 mm so that the angle from which it is no longer useful is 2.8° on either side of the meridian. This is also the case for the wedge or blade index.

Fig. 14. Section of the gnomon.

Once the rod has been printed and assembled, the completed gnomon looks as shown in Fig. 15.

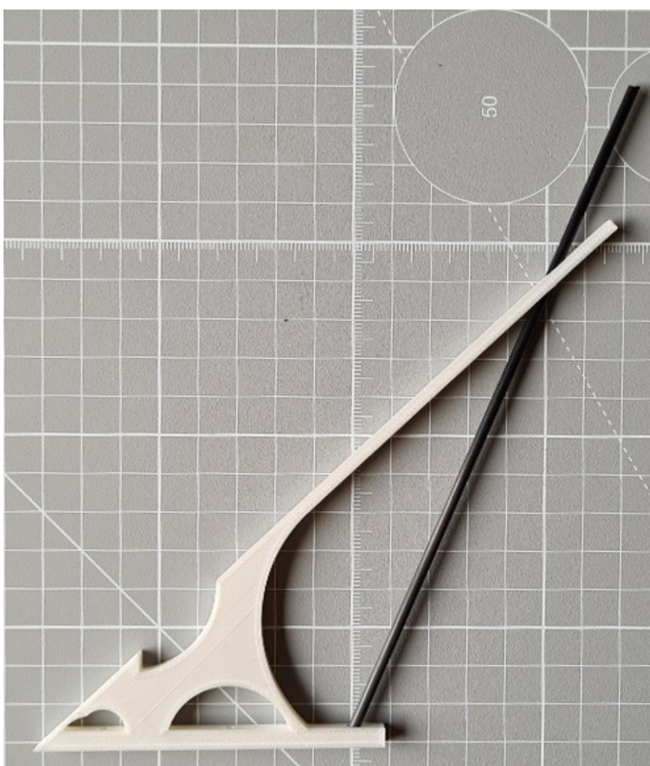

Fig.15. Gnomon with finished rod.

Replacing the wedge gnomon with the rod gnomon, the sundial is shown in Fig. 16 and already illuminated by the Sun in Fig. 17.

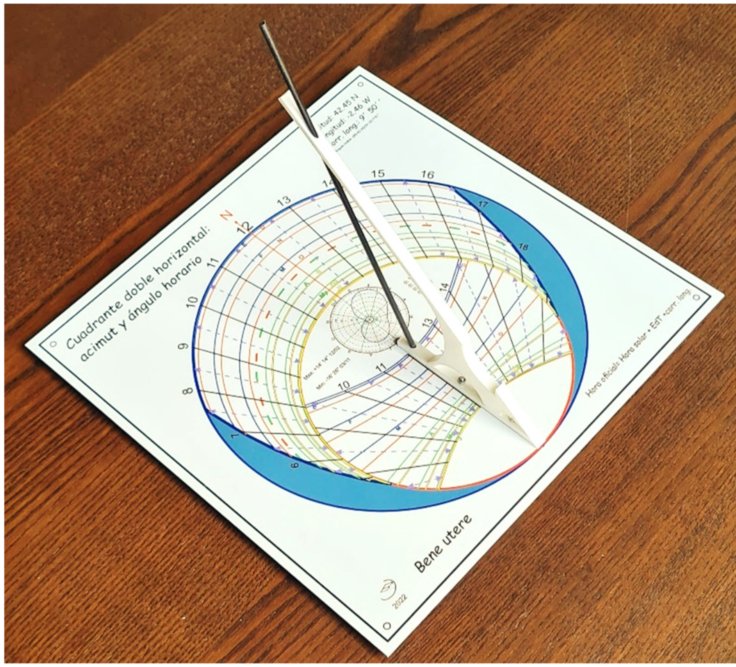

Fig.16. Set with the new gnomon.

While it is true that with this arrangement the elliptical sundial can be used closer to noon, the reading of the time on it is now less accurate as it has to be done at the center of the shadow of the rod and not at the sharp edge of the shadow of the edge.

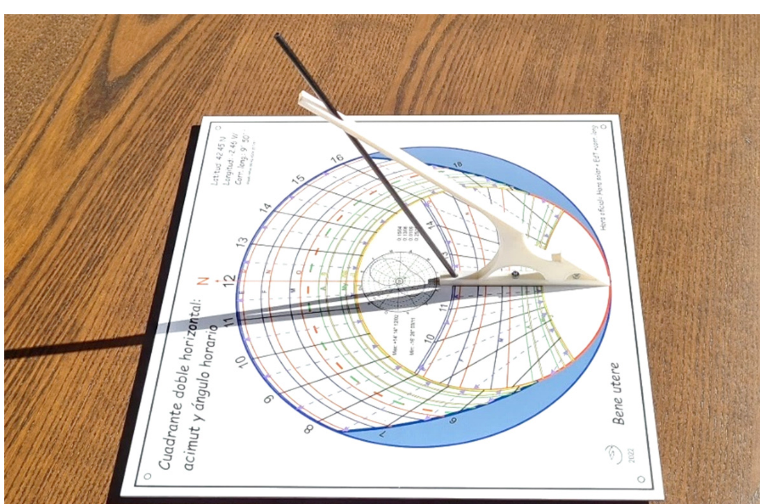

Fig.17. Double horizontal sundial with rod gnomon.

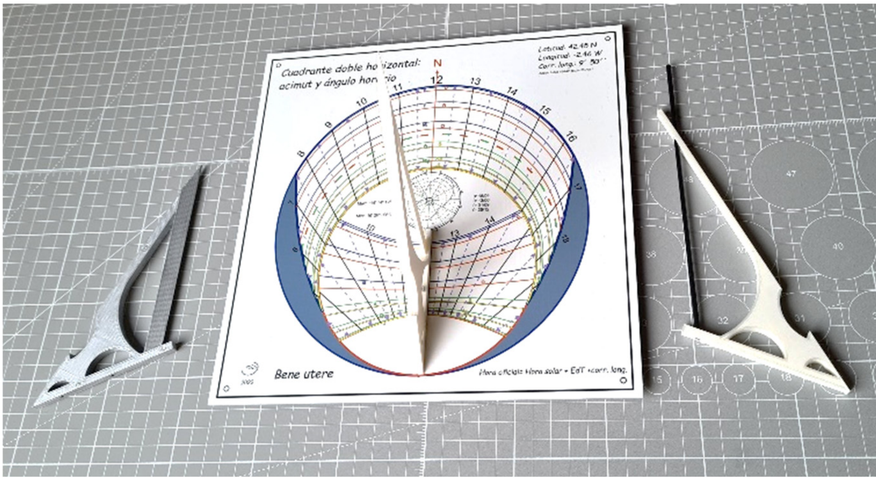

Fig. 18. The three versions of the gnomon.

Conclusion

After so many months of work, the result far exceeded my initial expectations. My sundial is original, complete and accurate.

This work has allowed me to marvel at the research and theoretical developments carried out over centuries by geniuses such as Samuel Foster, Vaulezard, William Oughtred and many others, which, updated and modernized by contemporary experts such as Fred Sawyer, Denis Savoie, etc., allow amateurs, with hard work, patience and the use of modern calculation and design tools, to realize new sundial concepts.

On the other hand, the use of tools such as 3D printing facilitates experimentation and the manufacture of more efficient designs economically and quickly, although they can never become the works of art created by craftsmen.

Acknowledgement

The English translation was done by Lara Busto.

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César Busto *cbusto1@gmail.com*

From The Registry

#1088

A noon mark at Emerson School, Ann Arbor, MI, designed and constructed by Mike Kapetan.

Notice how the apertures for indicating noon on the solstices and equinoxes are shaped so that on each occasion the light projected onto the meridian line forms a circle.

Rainbow Quiz – Solution

Steve Lelievre (Victoria, BC)

Photograph by Wikimedia user Subho 21 (colors enhanced). Creative Commons Licence.

Question

From The Compendium 30(1), Jan. 2023.

The above photograph of a rainbow was taken at Daytona Beach, Florida, on December 26, 2016, in the afternoon. What time was it taken?

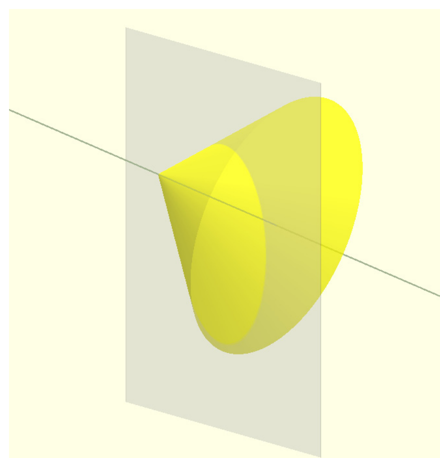
Please note: as with some of my previous quizzes, finding a solution involves guesswork so there is no single correct answer.

To see a larger version of the photograph or to obtain it in digital form, visit https://tinyurl.com/htm93cw4 and click the option for the largest preview size. *You may want to avoid looking at the lower part of the webpage, as it discloses the timestamp of the photograph!*

Solution

Rainbows occur when rays of sunlight enter water droplets in the air and are redirected towards the observer by a combination of internal reflection, refraction, and dispersion. Often, as in the photograph, the bow is seen as an arc, but full circles may be observed if the observer is above the space occupied by the water droplets.

A myriad of individual droplets is instantaneously at the critical angle needed for the sunrays striking them to be bent back towards the observer. In that instant they all lie somewhere on the surface of a cone with apex at the observer's eye (actually, a series of cones are involved because different wavelengths of light undergo different amounts of refraction). As the raindrops fall through the cone's surface, they are replaced by new ones from above for as long as the shower lasts. The center of the rainbow, i.e., the axis of the cone, is always opposite the sun. The cone angle for the red outer edge of the visible band of the bow can be taken as 42° [Source: Wikipedia.]



The figure, right, represents the cone inclined so that its axis is aligned to the sun (off to the left). A sunray travelling parallel to the axis encounters a water droplet and is diverted back along the cone towards the observer's eye.

If we direct our gaze along the cone's axis, we perceive a circle or circular arc. When we look or point a camera horizontally, we have the intersection of the cone with a vertical plane (gray: the camera's field of view) resulting in a slightly elliptical shape.

Usually, a rainbow is limited to an arc because the droplets are never below the horizon, but from a high viewpoint, such as a clifftop or overlooking the spray from a waterfall, the full circle is sometimes seen.

Discussion

I received several solutions to the quiz with slightly different approaches used. The solutions, including my own, relied on the scene being a rainbow over the sea, conveniently providing the horizon. The ratio of the width (or half-width) of the bow to its maximum height is used to estimate the altitude of the sun and hence Hour Angle. Most respondents assumed the photograph was taken with the camera pointing horizontally (making the film/sensor a vertical plane) and centered on the bow.

Erwin Wechsler's solution was:

$\vec{\imath}, \vec{\jmath}, \vec{k}$	unit vectors of the reference system.
$\vec{v}$	unit vector of the sunray's direction.
$\vec{a}$	unit vector pointing to the top of the rainbow.
$\vec{b}$	unit vector pointing to the end of the rainbow, so $\vec{b}$ has a component along $\vec{\jmath}$ as well as $\vec{\imath}$.
h	height of the sun (altitude).

$\vec{v} = \vec{\imath} \cdot \cos h - \vec{k} \cdot \sin h$

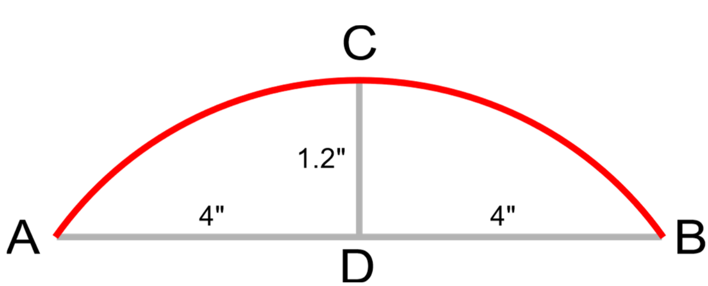
$\vec{a} = \vec{\imath} \cdot \cos(42 - h) + \vec{k} \cdot sin(42 - h)$

$\vec{b} = \vec{\imath} \cdot cos\ \alpha + \vec{\jmath} \cdot sin\ \alpha$ where 2α subtends the width of the rainbow.

We verify $\vec{v} \cdot \vec{a} = cos\ h \cdot cos(42 - h) - sin\ h \cdot sin(42 - h) = cos\ 42$

$\vec{v} \cdot \vec{b} = cos\ h \cdot cos\ \alpha = cos\ 42$

$$cos\ h = \frac{cos\ 42}{cos\ \alpha}$$



Now considering the rainbow as recorded by the camera, we have

$$\overrightarrow{CD} = \overrightarrow{AC} - \overrightarrow{BC} = 6.9\text{" (measured)} - 5.7\text{" (measured)} = 1.2\text{"}$$

$$\overrightarrow{AB} = 8\text{" (measured)}$$

We define *m* as the aspect ratio:

$$m = \frac{2\ \tan\alpha}{\tan(42-h)} = \frac{2\ \tan\left[\cos^{-1}\left(\frac{\cos 42}{\cos h}\right)\right]}{\tan(42-h)} \qquad h\ \in (0;42)$$

The tangents are used because they correspond to projections onto a vertical camera film.

From the measurements, we have $m = \frac{8\text{"}}{1.2\text{"}} = 6.\dot{6}$. Using iteration, it can be determined that the equation produces this value when *h* is 33.1°.

Solar altitude, *h*, is related to Hour Angle, *t*, by

$$sin\, h = \ sin\, \varphi\, sin\, \delta + \ cos\, \varphi\, cos\, \delta\, cos\, t.$$

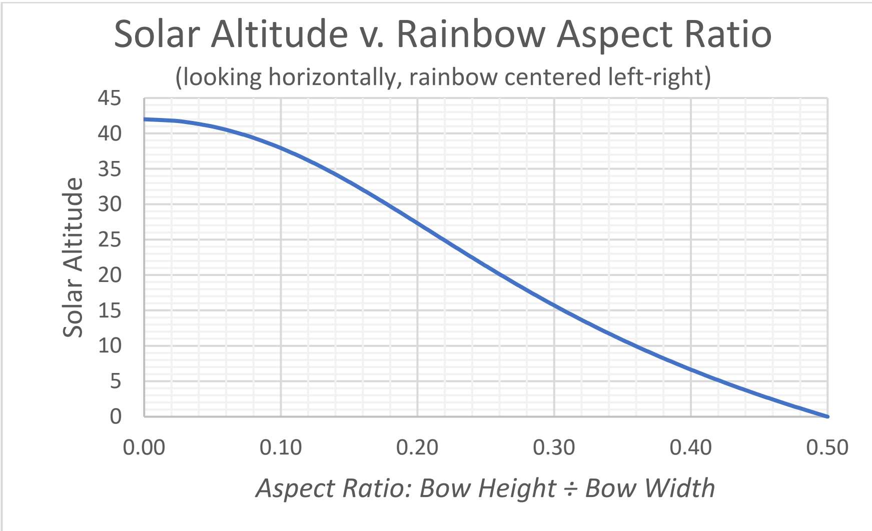
Having found *t* but wanting Civil Time, it is necessary to adjust for Equation of Time and offset from the time zone meridian.

With these adjustments incorporated, Erwin's solution to the quiz was 1:55 p.m.

Although not as concise as Erwin's solution, my approach was also based on vectors. Some slight differences in measurements meant that my answer came in at 1:42 p.m.

I obtained the same formula for *m* as Erwin did, except that in my solution the aspect ratio was swapped around, height for width.

The graph below is a plot of *m* as I defined it (i.e., the reciprocal of Erwin's *m*.)



<u>Other solutions</u>

Other respondents used side-on views to produce geometrical constructions, all slightly differently stated but based on the same principle. There is not room to reproduce them all here, but a couple of the variations deserve a mention:

Bill Gottesman chose to use one of inner color bands of the rainbow because it seemed to provide a more complete arc at the left side of the bow. However, his choice meant that Bill had to find a value other than 42° for the cone angle. By searching the internet, he found a (rather complicated) formula that uses the refractive index in water of the color chosen. A bit of further searching led him to a suitable refractive index value, and finally he was able to calculate a cone angle of 41.57° for the green-blue band of the rainbow that he was interested in. After making his measurements of the image and doing the math, Bill's solution to the quiz was 2:01 p.m.

David Bubenik explored the EXIF meta encoded within the digital version of the rainbow image. From this, he found that image had been cropped at 30.8982% and 86.5868% from the top (with no cropping of the sides). With this information, he was able to determine that the optical axis, the center of the uncropped photograph, is a couple of degrees below the highest part of the rainbow arch, i.e., just inside the innermost visible color band. In other words, he showed that the camera was tilted up from horizontal. The resulting calculation led David to a solution of 2:00 p.m.

A timestamp mystery

Solutions ranged from 1:08 p.m. to 2:01 p.m. with the majority falling after 1:30 p.m. (Most of the variation in the range of results can be attributed to slight differences in estimates of the height and width of the rainbow). However, examining the photograph's timestamp, we find that it was taken at 1:04 a.m. I missed this point as I was setting the quiz, misreading it as 1:04 p.m.

Was the camera clock set incorrectly? Or could it be that the photographer was a visitor from another time zone?

I favor the latter choice. To change from say 1:30 p.m. to 1 a.m. involves a shift of either +11½ hours or −12½ hours. On the date in question, Daytona Beach was using UTC – 5, so it might be that the person is from a zone that uses either UTC + 6½ or UTC – 17½, which is again UTC + 6½. This zone is applicable to Myanmar. Similarly, a change from 2:00 p.m. to 1 a.m. corresponds to a home time zone of UTC + 6. This covers a several countries including Bangladesh, Bhutan, parts of Russia, Kazakhstan, and Kyrgyzstan.

Long story short, I speculate that the photograph was taken by a visitor from one of the places mentioned. The timestamp was 1:04 a.m. on December 26 but the local Civil Time was likely running 11 hours behind that, making the local time 2:04 p.m. on December 25.

Rolf Wieland's added question

As part of Rolf Wieland's calculation, he derived a value for the 'Viewing Angle', β, which he defined as half the horizontal angle subtended by the ends of the rainbow at the observer's eye.

Rolf calculated β to be 22°. He used this value in posing and answering the following question:

Why can't we see any part of the coast on the left side of the picture?

The coast at Daytona Beach runs 24° northwest. The visual range of distance is about 5 km for an eye-level of 1.8 m. The azimuth of the sun is az = 11° southwest [for Rolf's time estimate], the sun is at the back of the photographer. So, the sunrays have the direction 11° east of north. The viewing angle of the rainbow is $\beta = 22°$ *to both sides of the sunrays, so we see at the left end of the rainbow only* $\beta - az = 22° - 11° = 11°$ *west of north, 13° less than the coast. Thus, the coast is outside the picture.*

But it is sure that the picture was not taken in the morning (az = −11°) because at this time some coastline would appear in the picture: $\beta - az = 22° + 11° = 33°$ *west of north, 9° more than the coast.*

<u>Last words</u>

For a design for a rainbow-based portable dial, see: Moir, John. 2001. "The Rainbow Sundial – Nature's Own Water Clock!". *The Compendium 8*(1), March 2001, pp.13-14.

Moir's design involves aligning the sights of the device with the top of the bow. A date-calibrated scale on the side shows the time thanks to a plumb line.

See also: Mills, Allan. 2011. "The Rainbow as a Solar Timekeeper". *BSS Bulletin 23*(ii), June 2011, pp.2-.

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SUNSHINE OVER THE CLOUDS – GNOMONIC ACTIVITIES FOR AIRLINE PASSENGERS[1]

Heinz Sigmund (Heidelberg, Germany)

Preliminary remarks

Einstein`s theory of relativity of time has shown us the immediate relation between space and time. When we are traveling, which means moving within space, time also passes in the ordinary sense of our daily experience. And for hundreds of years, we have determined time due to the movements of the stars, caused mainly by the rotation of our planet Earth around its own axis and the sun. Basic astronomical phenomena like day and night and the seasons depend on it. So, as we travel upon the surface of our home planet, we have to deal with a 'double motion' in space, which causes time shift: first, the duration of the flight and second, the time passing by Earth`s rotation.

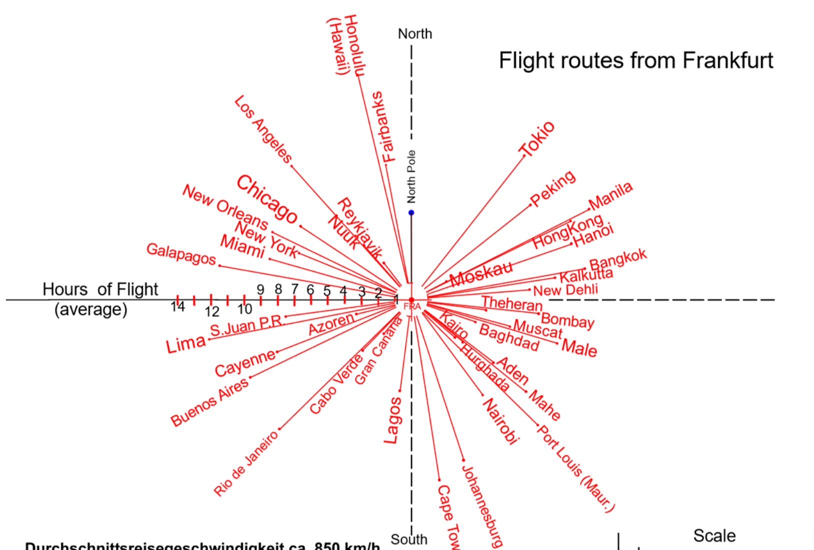


Fig. 1. Flight paths from Frankfurt

[1] This article is a translation, originally published as "Sonnenschein über den Wolken-Unterhaltsame Gnomonik für Flugreisende" *in* Helios Sonnenuhren-Blog / Hellers, 2017, https://www.helios-sonnenuhren.de.

On an 8-hour flight, from Frankfurt to New York for example, our watch shows when we arrive in America, about 8 hours later than the departure in Germany. But as we travel in a westerly direction, we arrive there about 6 hours earlier according to New York`s Time Zone. In this case, we have the impression that the sun almost does not move for hours. However, on flights traveling in an eastern direction, the night hours pass very fast.

Sometimes flights can be very boring. In this situation it would be interesting to determine this constant shift in space and time by observation, and by measuring with simple instruments such as a sundial.

The same situation may occur during a cruise trip, but the time zone shift will happen much more slowly, which means that instead of hours, we need days before we notice any changes.

Arriving at the holiday resort, this kind of activity may be continued, for example, by observing the sun`s position with special sundials, sun compasses or homemade star maps for the night sky. In order to really enjoy the flight, and vacation time, we should prepare these activities before at home.

First let's look at our flights. And then at the activities at our destination.

TRAVEL PREPARATIONS

Flight maps

First, we should compile all important information about the flight path, schedule times and such, to be entered into an appropriate world map.

The best would be a so-called azimuthal equidistant map projection, centered exactly on the geographical position of our departure or arrival airport.

This kind of map allows us to easily draw the flight routes as straight lines, and also permits us to make equal distances for the flight duration by simple geometrical division (Fig. 2.)

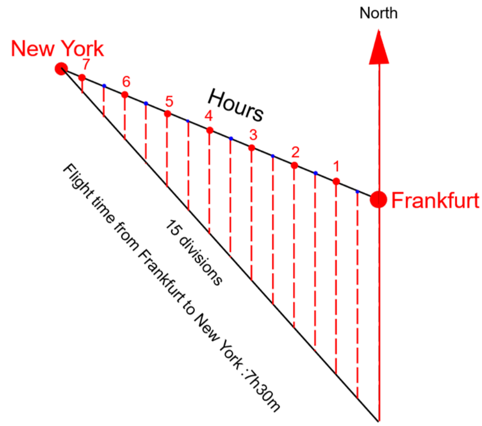


Fig.2. Time division of the flight's duration

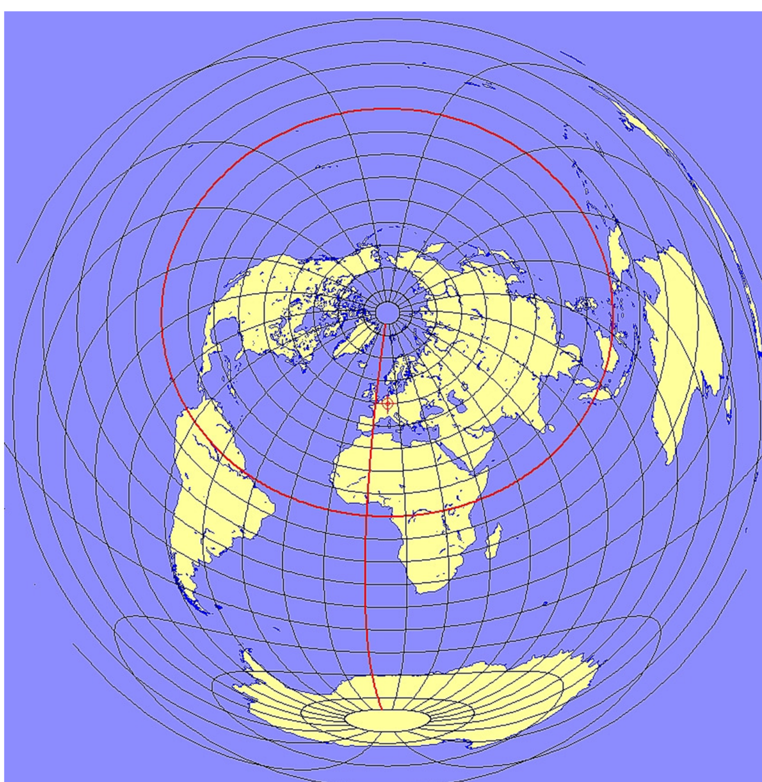


Fig. 3. World map in an equidistant azimuthal projection for Frankfurt.

In Figure 3, the just-described world map is centered on Frankfurt (Germany). Its lines of geographic latitude are spaced equally for 10° and those of longitude for 15°, corresponding to the global time zones. Just to give an overview, we have assembled important flight routes worldwide from Frankfurt showing the directions, the distances in kilometers to their destinations, and the average flight time duration in hours (Fig. 1.)

If you need another flight path with maps centered on other international airports, you can refer nowadays to a lot of already-existing map software on the internet. I can recommend examples of freeware for easy handling (Ref. 11 c, d, e.)

Another possibility is to mark flight routes as straight lines on any kind of gnomonic (or central) projection, as is commonly used for horizontal sundials whose shadow of the gnomon tip touches the datelines. But it is important to know that in this projection, the flight distances are not equally spaced (see Fig. 11.)

The aforementioned world map gives us information about space and time during our flight. To get further data for the sun`s exact position, we need a second diagram, for use as a transparent overlay on the map. The latter must be centered on the sun`s actual declination, corresponding to the actual date. Then the new lines of geographical latitude represent the altitude of the sun, which allows us (among other things) to find times of sunrise, sunset and the dawn.

Centuries ago, this information could be obtained by one of the oldest astronomical instruments: the Astrolabe. The similarity to our modern world map projections is really evident. Indeed, the classical designs of stereographic, central or orthographic projection were developed for the astrolabe and have been adapted later to geographical maps.

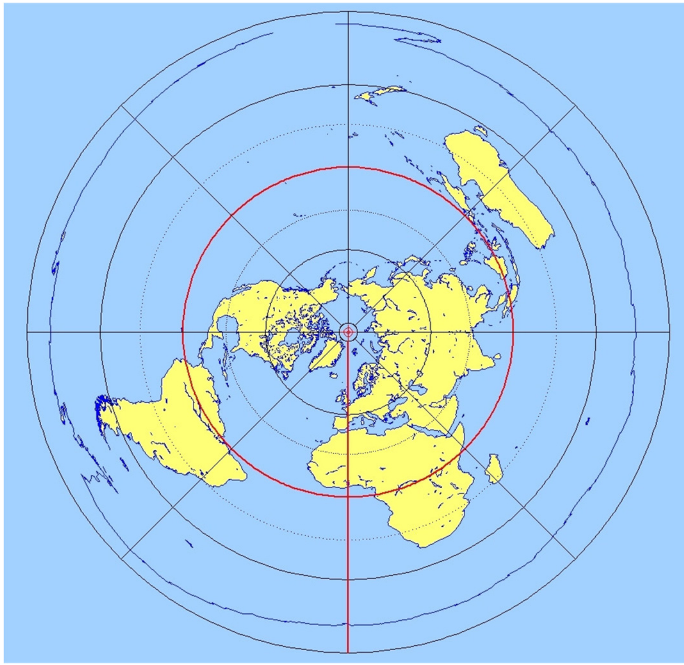


Fig. 4. Equidistant polar map.

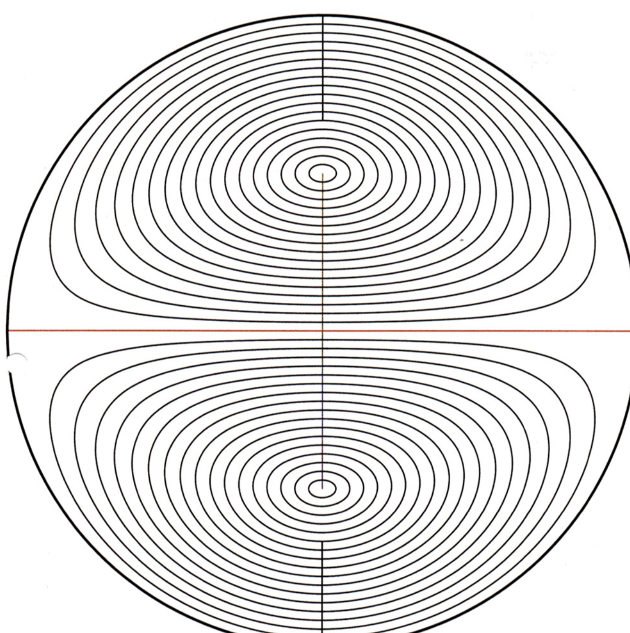
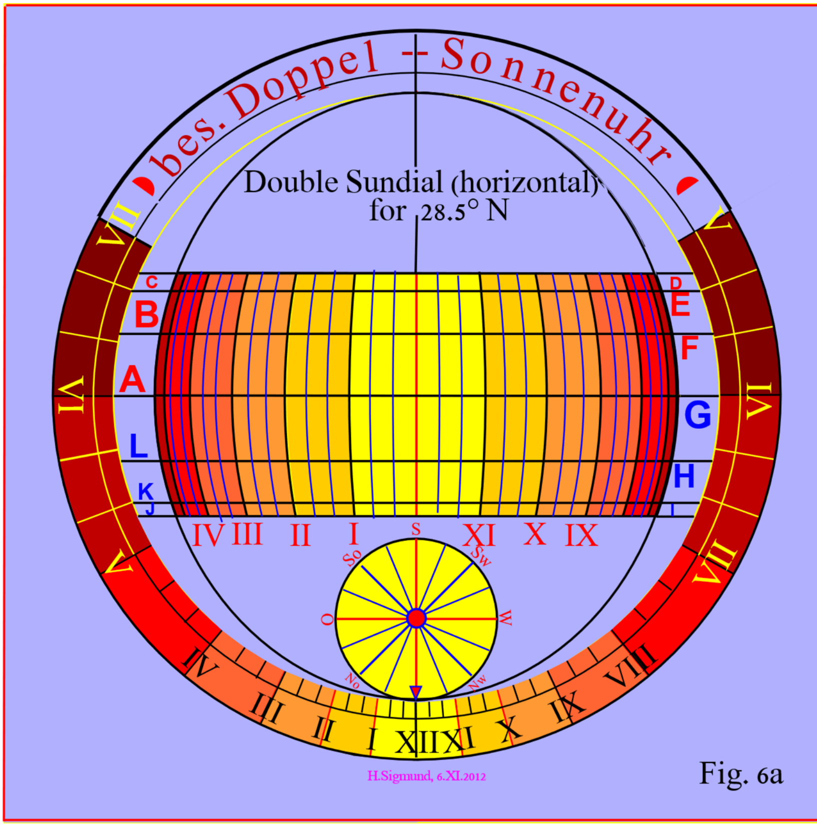
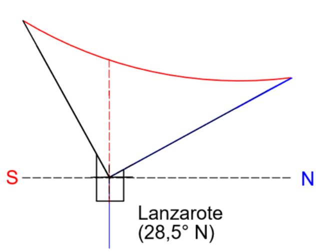


Fig. 5. Map network (solar altitude at the equinoxes) relating to Fig. 4.





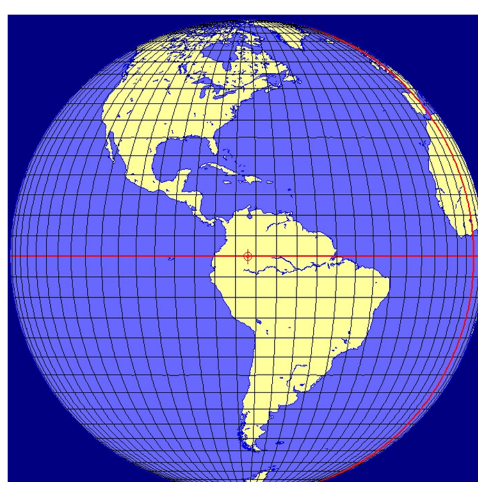


Fig. 6 (a) Double horizontal Sundial (b) Double hand for [a] (c) Transversal orthographic map for meridian of Glastonbury CT, 72.5° W.

Fig. 7. Equatorial Sundial (upper face)

Figure 4 contains a world map centered on the North Pole in a so-called azimuthal equidistant projection. To determine the sun's apparent global movement, we fix the overlay (Fig. 5) in the center of the map (North Pole) and make it rotatable.

The sun's altitude is shown by 5° steps at the time of the equinoxes, where, at noon, the sun reaches its zenithal culmination over the equator (one of the centers of the concentric lines of altitude). The red (horizontal line) represents the terminator (day/night line) running through the North pole.

Now there are two options: either we rotate the map, which corresponds to the movement of the earth, or we do the same with the overlay representing the apparent course of the sun. To show the passing of time we could add a 24 hours circular scale (Fig. 9).

Other examples of the rotatable plates are shown in Figures 8, 10, and 11. Although they use other azimuthal projections, they are still centered on one of the Earth`s Poles. The following maps will be described in detail as real examples of trips the author has taken.

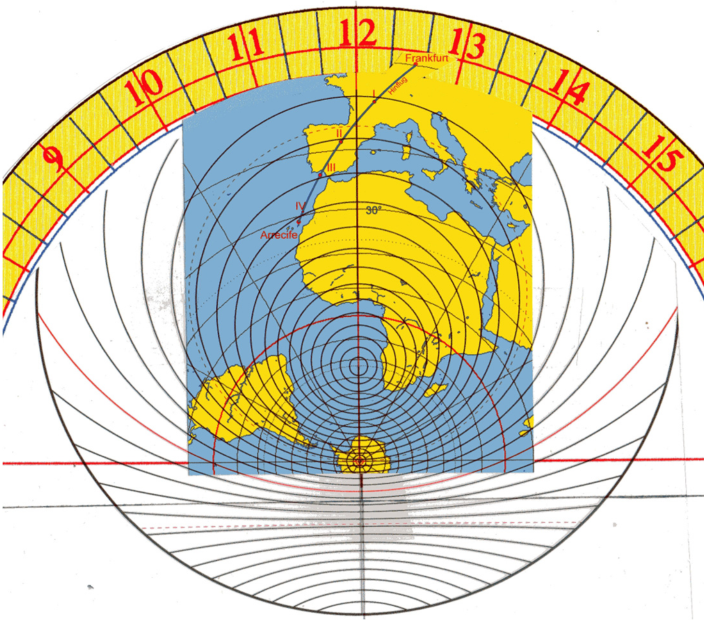


Fig.8. Portion of a stereographic polar map for a flight route from Frankfurt to Arrecife.

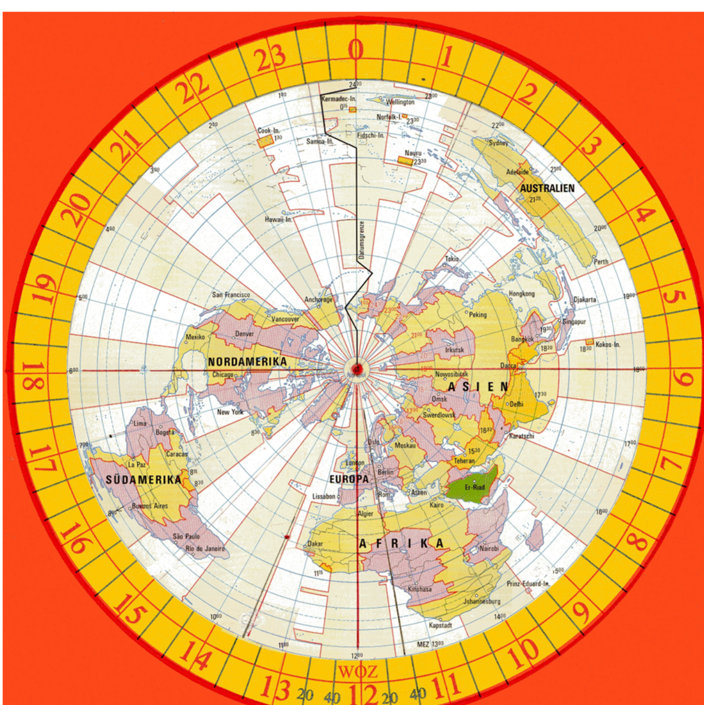


Fig. 9. Equivalent polar world map with time zones as a copy template.

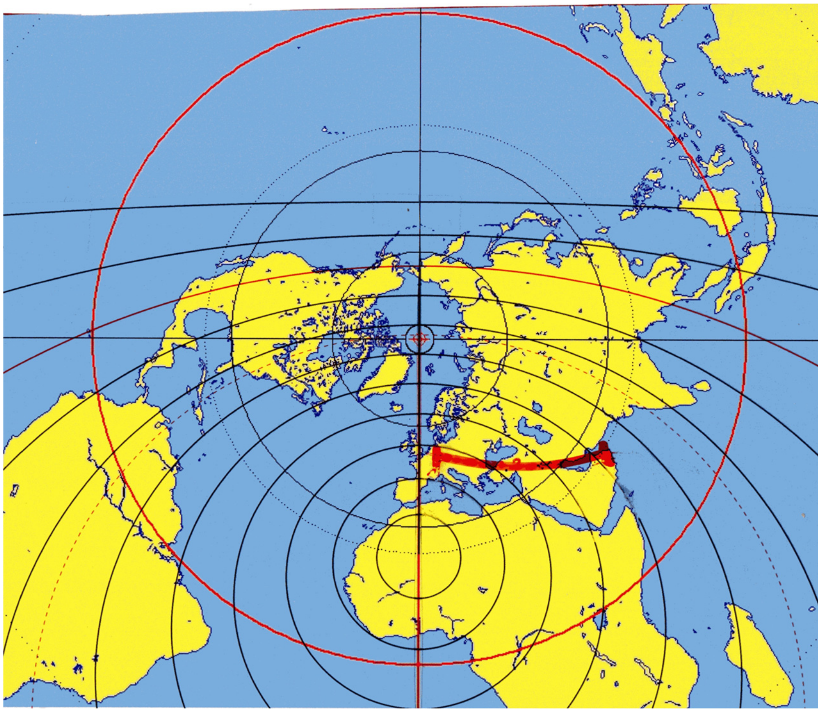


Fig. 10. Stereographic polar map with flight route from Frankfurt to Abu Dhabi with solar altitude circles for the summer solstice.

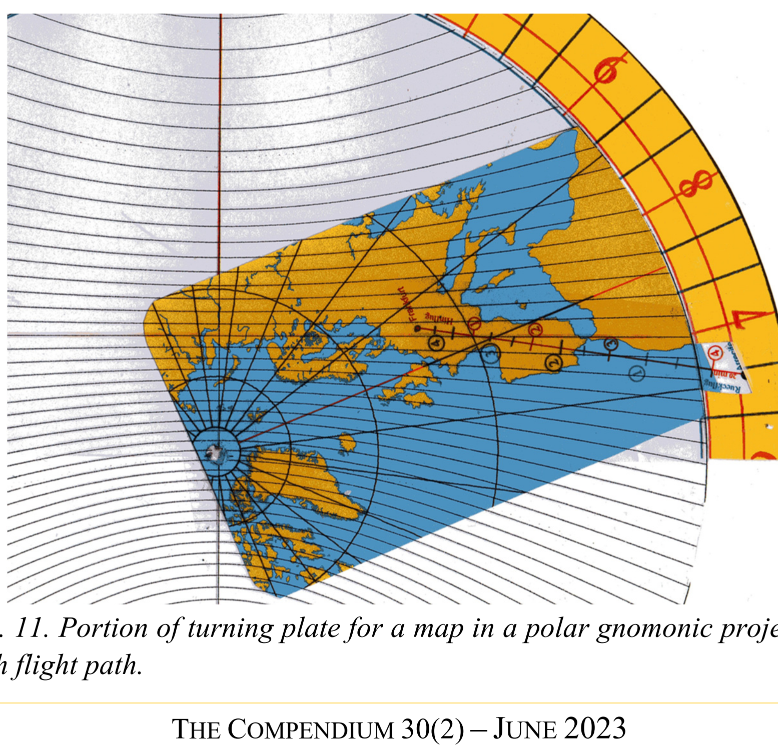


Fig. 11. Portion of turning plate for a map in a polar gnomonic projection with flight path.

Figure 8 gives an elaborate example of a flight from Frankfurt to Arrecife (Canary Islands). The map shows a portion of the world, centered on the South Pole, using the stereographic projection. Its overlay is drawn for a sun`s position at northern winter's solstice:

The subsolar point on Earth (i.e., the zenith of the sun) touches, at local noon, the tropic of Capricorn which is the center of the altitude lines (in 5° intervals). Going north, the altitude of the sun decreases and reaches for example, approximately 30° over Gibraltar! The limitation circle of the overlay represents the horizon as a circle line of sunrise/sunset. The flight route appears as a slightly curved line with roman numerals for the hours elapsed since departure from Frankfurt. Turning the plate, we can now determine (for each hour point on the flight path) local time and the sun`s altitude. We can also recognize whether the sun will already have set during the flight.

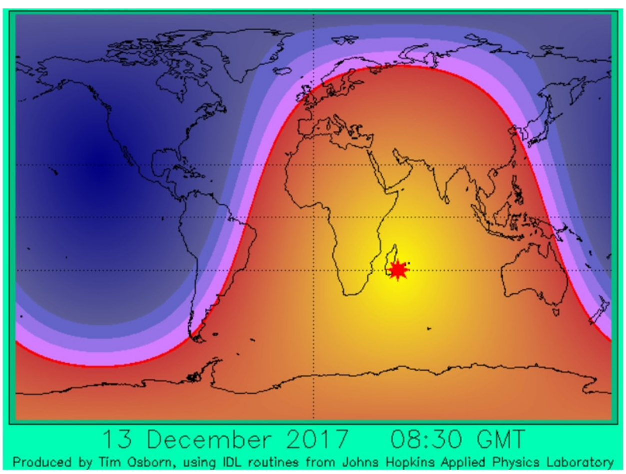
Since a stereographic projection show Great Circles as circular arcs, we can easily design the flight path by using a drawing compass (pair of compasses). To find their center, we only need a second point on the route.

Fig.10 contains the same map projection but centered on the North Pole at summer solstice with altitude lines for each 10°. It has been designed for a plane trip from Frankfurt to Muscat (see red curve as flight path.)

Our next example uses a polar gnomonic projection for a flight from Frankfurt to the Canary Islands. As mentioned above, the flight route appears as a straight line, but the lines of the sun`s altitude are normally hyperbolas; only the horizon (red line) is represented by a straight line perpendicular to the meridian.

Meanwhile many airplanes now provide displays showing the exact current position and the traveled flight path taken from a software program (Ref. 15), as seen in Fig. 14b. In our example, we see our position at the moment of sunrise over Romania during a flight from Abu Dhabi to Frankfurt at the end of July.

But the world maps shown on the displays are mostly cylindrical equirectangular (Fig.13a) which means that the lines of longitude and latitude are all parallel and equally spaced. The equator is a red horizontal line, dividing the map in two parts of northern and southern hemispheres. The Meridian of Greenwich appears as a central vertical line. The two poles are stretched from points to latitude lines of 90°. In this kind of cylindrical map projection, the altitude lines of the sun (Fig.13b) generally appear as open or closed geometrical curves; in our case, for the time of winter solstice. The curved red one also marks the horizon. The subsolar position at noon lies on the tropic of Capricorn.



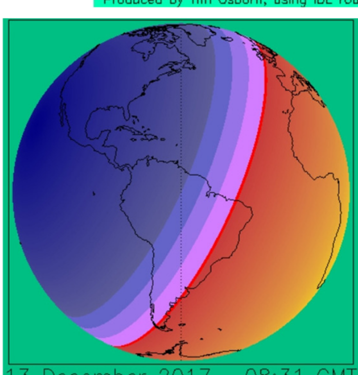


Fig. 12 (a) Tim Osborn`s Sun clock as Plate carrée (b) as polar orthographic projection.

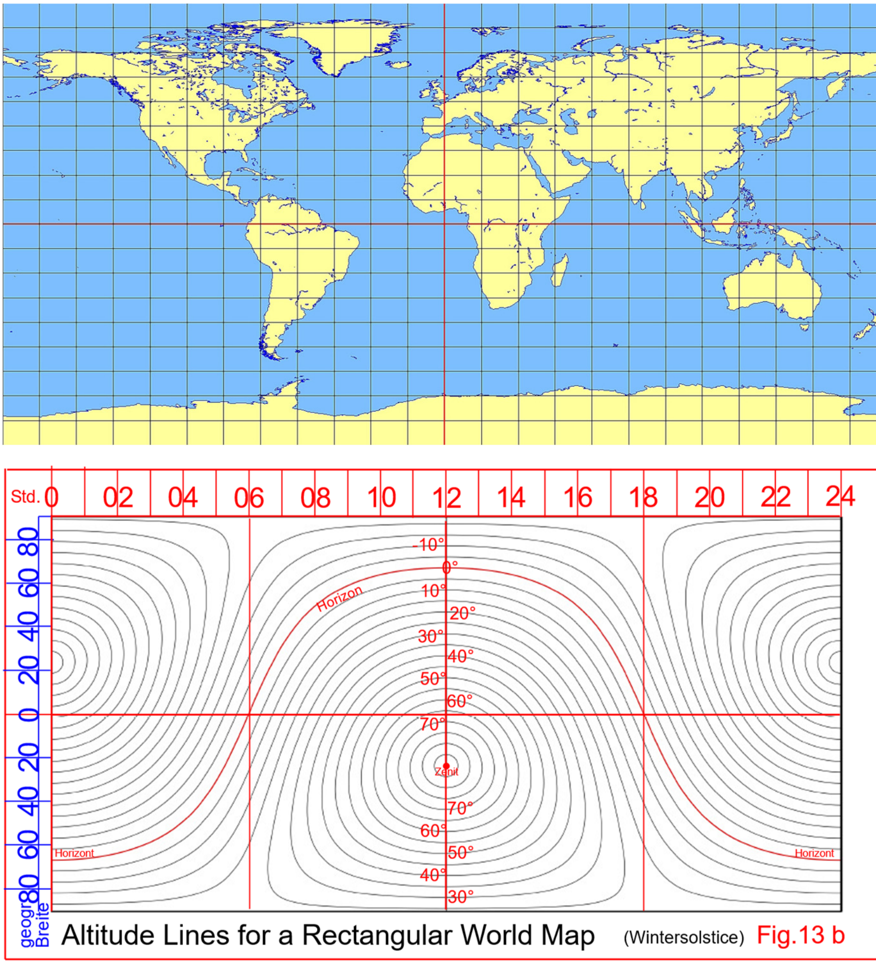


Fig. 13 (a) Equirectangular world map (b) Altitude network for winter solstice.

The little passenger information displays mentioned above normally show only day and night limits which correspond to the sun`s altitude of 0° degrees. With modern software programs (Ref. 11), we can easily add the supplementary lines in intervals of 5 or 10 degrees, as seen in Fig.13b, by the following procedure: The needed input for the map software is ‘oblique’ and the maps center for the overlay network is defined as 90° minus the declination of the sun. If we want to simulate the Earth`s motion, we must, instead of rotating the plate around its center, move the map from the left (west) to the right (East) but not the hour scale and the overlay. For practical reasons, we could create a kind of ‘endless’ map by making an exact copy of the world map and fixing the left and the right ends together.

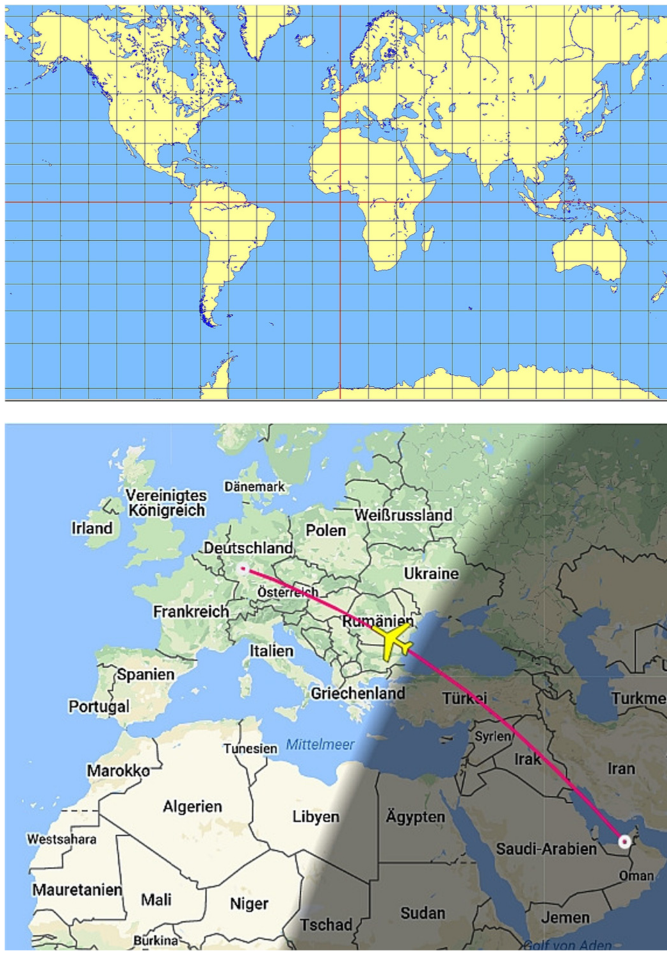


Fig. 14 (a) Mercator's projection (b) Map detail with flight path.

In his software program, *SunClock* (Ref. 14 / Fig. 12), Tim Osborn’s world map gives, after the input of date and time, the daylight area (in yellow and red) the subsolar point (as a red asterisk) and the different dawn zones (civil, nautical, and astronomical). First, he uses an equirectangular map projection (Fig.12a.) Second, he offers a circular map in an orthographic projection (Fig. 12b) with a more realistic view of the globe.

To go back to the beginning of our article (descriptions of different kinds of map projections) where we preferred those that are mostly used for the astrolabe, we have to mention that it is also possible to use other projections such as the famous world map by Mercator (16th c.) which is still used today, e.g., by Google Earth or in software programs based on it. Mercator's Projection is a classical navigation map, where the direction from any point on the globe to another is a straight line. With it, it was possible to find the way over the oceans by using a magnetic compass; the bearing does not need to be changed during a trip. However, this did not mean that a ship took the shortest way to its destination! For that, travel has to follow the so-called Great Circle routes (which only appear as straight lines, for example, in the gnomonic projection.)

Often used today, is another typical geographic projection called *'equivalent projection'* (or equal-area projection) meaning that all areas on the globe are of a comparable size on the map (Fig. 9.) It also shows the modern international time zones. Its circular polar design allows us to use it as a turning disc with overlay and integrate a flight route as described above. Another application involves distorting it to an elliptical shape as a special horizontal or vertical sundial. For the procedure, see Reference 6.

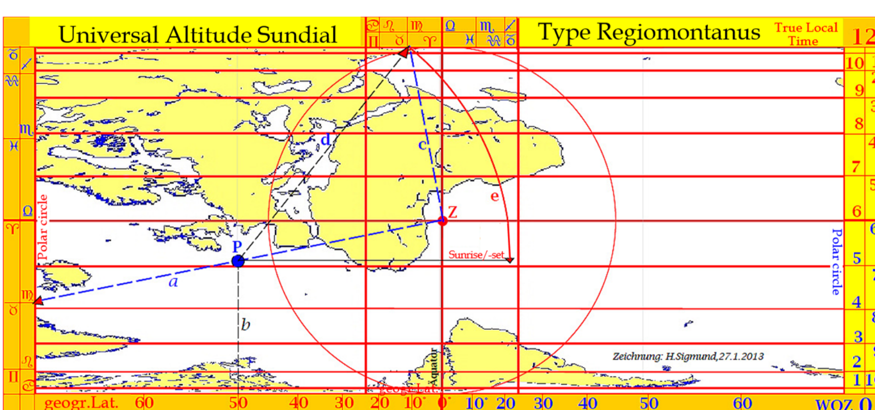


Fig. 15. Universal Altitude Sundial according to Regiomontanus in a special map projection [An enlarged image appears at the end of the article.]

Sundials

Since we now have at our disposal the exact data for our airplane`s position and the sun`s apparent movement during our flight, we are also able to design suitable sundials.

But when moving in space on a flight, the geographical position and the true local time are continuously changing, so for determination of time, only universal or altitude independent sundials are applicable.

The equatorial dial as shown in Figure 7 may be used for this purpose because it can be declined according to the geographic latitude. Its design also contains the circles of solar declination, and being centered on the pole, where the gnomon has to be fixed in a right angle to the dial face, it can be regarded as an azimuthal gnomonic projection. The large red stripe cutting the circle, marks the beginning of the dawn zone in relation to the geographical latitude (90° minus declination of the sun) and the time of sunrise (on the right) and sunset (on the left). The dateline circles (for some zodiacal signs) allow us to orient this sundial without a magnetic compass. For this purpose, we only have to turn the whole instrument until the top of the gnomon`s shadow touches the actual dateline. During a cruise between the Atlantic Ocean and the Mediterranean Sea in July 2010, I really enjoyed the use of this sundial: first, I could determine True Local Time and second, the direction of our ship`s movement at every moment (after having added a wind rose under my sundial). Because the plane of the equatorial sundial is parallel to the equator, the sun reaches the upper side of the dial face only from end of March until end of September (for the northern hemisphere); in winter time the shadow falls on the reverse side.

As another possibility, I propose one of the most famous universal altitude sundials, first described by Regiomontanus in the 15th century. It permits us to find the hour everywhere on Earth by observing the sun`s height above the horizon when only the geographic latitude is known. In its original version, the instrument has to be held vertically with its sights inclined to the sun. The plumbline, having already been set to geographic latitude and to the actual sun`s declination, then shows True Local Time. This kind of handling may be very inconvenient on moving ships or airplanes; therefore I propose the following modification (Fig. 15):

We put the instrument on a horizontal surface, then we mark the sun`s declination on the zodiacal scale (on the left). In our example, we chose the beginning of Taurus/Virgo (Line *a* from *Z*.) Now we draw a vertical line, *b*, from the latitude scale and find the intersection point *P*. From there we aim for the zodiacal scale on the top (arrow from point *P*). Now we have reached the sun`s culmination altitude for this day. The arc centered on *P* marks the sun`s path for a half day. The intersection with a horizontal line drawn from *P* gives the time of sunrise or sunset on the parallel drawn from the hour scale (on the right side.) By placing a ruler at *P,* we can immediately measure the sun`s height on the circular arc by its intersection with the parallel hour lines.

To get a special relation to our travel, I have developed a new map projection by combining and modifying classical designs using a very creative map software (Ref. 11b.)

Fig. 15 shows this kind of map centered on the geographical longitude of Greenwich, which allows us to find geographical coordinates and to recognize immediately the time difference to UT (Greenwich Time.)

It would also be easy to incorporate the flight route, because its path appears (as with a stereographic projection) as part of a circle!

A quite different kind of universal instrument which does not need the geographical position is a so-called latitude independent sundial (Refs. 12,13.)

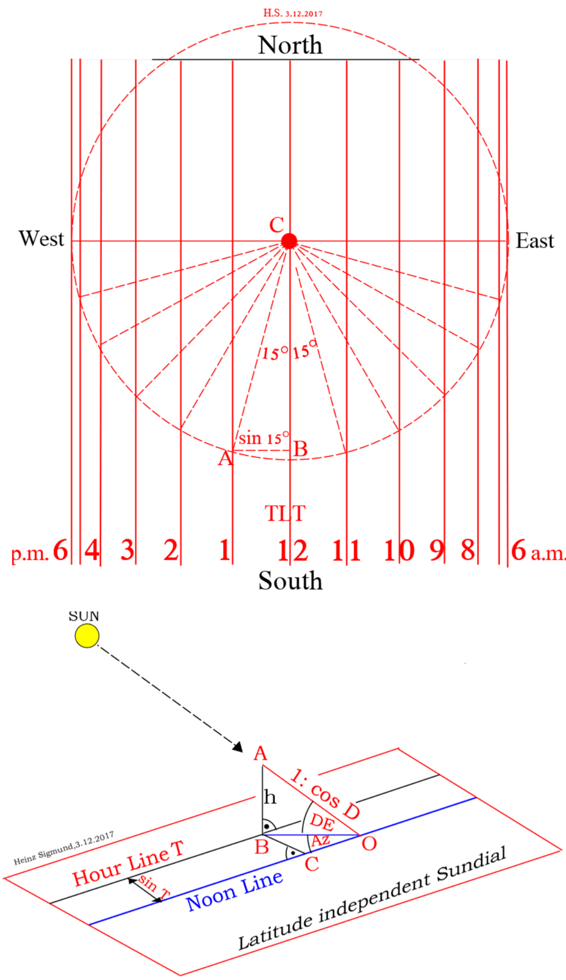


Fig. 16 (a) Latitude independent sundial - drawing instructions (b) design of the instrument.

Fig.16a explains the geometrical drawing of the dial face: a vertical and a horizontal line cross at a right angle in point *C*, marking the 4 cardinal directions. From the center, the hour angles (each 15°) are marked on the circumference of a circle with any radius. Through the intersection points, for example *A,* we draw vertical parallel hour lines of any length. Now we place on the noon line at *O* (Fig.16 b), a movable gnomon whose length corresponds to 1:cos *D* (declination of the sun) and is therefore variable. From its top, *A*, we hang a plumb line which should exactly touch the horizontal plane of the dial. Then we have to turn the instrument to the North-South direction and by aligning the gnomon exactly to the sun, we can read True Local time by the point of the plummet on the hour lines.

As a last example, especially for use at our holiday resort, I want to introduce a new variation of a double sundial (Ref. 4.) It could be regarded as a modification of William Oughtred`s proposition from 1636. This author had combined a normal sundial for one latitude with an oblique stereographic projection for the sun`s orbit within the zodiac, probably derived from the astrolabe.

In my version, I chose an orthographic transversal projection where the circular lines of the zodiac have become straight lines. As this kind of ‘astrolabic’ sundial can only be used on the equatorial plane, I had to adapt it to a certain latitude, in my case the Canary Islands (28° N). Therefor the zodiacal area of a circular map (Fig. 6c) was distorted to an elliptical shape (Fig. 6a) by parallel projection (similar to the analemmatic sundial). The shadow-casting double hand is shown in Figure 6b. The northern part forms an angle of 28° with the horizon and is aimed at the Polar Star; the southern part is perpendicular to the northern part. In this configuration, we recognize the principle of the double sundial; the instrument should be turned until both scales show the same time. (On the inner part of the dial face the time has to be read at an intersection point of the zodiacal parallel and the elliptical hour arc.)

With this kind of astrolabic sundial, we come back to our map projections. It would be possible to add (as an overlay) part of a world map, distorted to an ellipse.

In Figure 6c, we give another example of this transversal orthographic projection for the longitude of 72.5° (Glastonbury, CT.)

Distortion of circular maps is also very helpful for creating very informative geographical sundials. Figure 9 with its complete hour scale, can be used as a template (Ref. 6.)

Concluding remarks

The different kinds of flight route maps and sundial types described in this article are only suggestions for individual choice. I wanted to show the palette of possible activities, beginning with the simplest geometrical drawing of a sundial or using the most common map available, up to computer-aided calculations of complicated map projections and date lines on sundials.

It is remarkable that, for example, the very old, but nevertheless ingenious designs, which were developed centuries ago for the astrolabe, may serve us in our hobby activities as a playful challenge to get a fundamental knowledge of what our modern technology is really based on. For example, the above-mentioned small displays in modern airplanes show, on equirectangular maps, a simulation of the airplane in real time motion, and, if the technology is not failing, it gives immediate information. By distorting the globe in an unusual way, it produces a strange curve of the Earth`s day and night limits, not obvious as great circles on the globe. Also, the rotation of our home planet is not really recognizable when we only see a linear movement of the world map. It is quite different if we use a polar azimuthal projection as a rotatable overlay or look at an orthographic map with its realistic design.

Knowing that computer-generated world maps are the result of mathematical calculation, we may recognize that we, as modern users, risk no longer comprehending the full context; the relationship to the original is important and precious. I do not want to condemn our new technical aids – I regard them as an enormous enrichment of our opportunities – but they should not hinder us from doing projects by experimentation, with a spiritual pleasure in benefitting from the long historical tradition of science.

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    b. Geocart / Version 3.1.0
    c. G.Projector / Version 1.4.6. b y Robert B. Schmunk/NASA GISS https://www.giss.nasa.gov/tools/gprojector/
    d. J.L.Tonne (call sign W4ENE) "Pizza" http://www.tonnesoftware.com/pizza.html
    e. Great Circle Maps by SM 3GSJ (2.8.9) [*Not found as at June 2023, perhaps try http://gc.kls2.com/ instead. Ed.*]
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15. SunFlight.net - Chase the sun and map the path of your flight (Flight Simulation software [*As at June 2023, SunFlight.net appears to be non-functional; perhaps try https://sunflight.org/ instead. Ed.*]

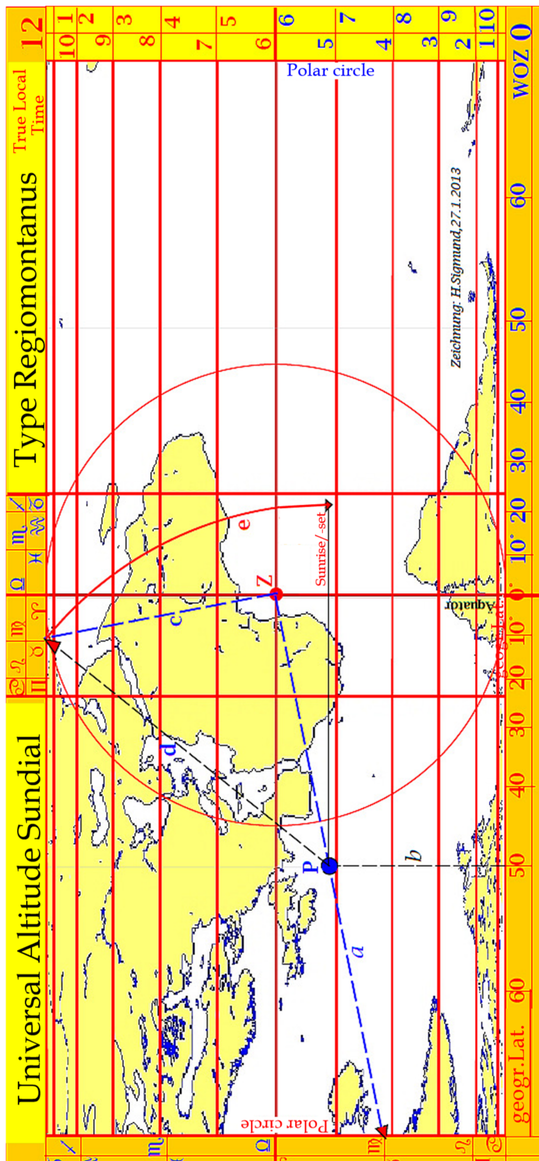


Fig. 15 bis.

Heinz Sigmund *heinzsigmund@arcor.de*

Quiz: Where Is It?

Set by Siegfried Rasper and Len Berggren

This photograph of a sundial in a famous city was taken by a vacationer who had travelled overseas. Immediately after being taken, the photograph was emailed to a friend back home. It was delivered a few moments later at 05:19 CET in the morning of February 7, 2023.

The traveller did not mention the place or even the country being visited. Can you help the recipient determine which city is home to the sundial? (Or at least make a shortlist of cities.)

Send your answer and a brief explanation to *steve.lelievre.canada@gmail.com*.

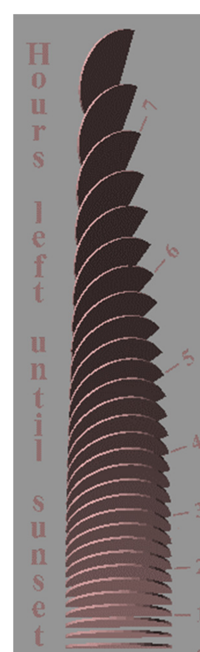
A Shadow Plane Hours to Sunset Dial

Steve Lelievre (Victoria, BC)

Suppose you have a small disk positioned horizontally. At sunset, when the sun is on the horizon, the disk is illuminated edgewise so no shadow occurs. At other times of day, sunrays hit the disk obliquely and are blocked – a shadow occurs behind the disk.

Now recall that as the day progresses the Sun appears to travel around the Earth, advancing at 15° per hour around the polar axis. If you rotate your horizontal disk by 15°, also around the polar axis but in the opposite direction to the sun's movement, you put the disk back into the orientation (relative to your local frame of reference) that it had one hour earlier.

Hence in this new orientation, seeing no shadow from the disk indicates one hour before sunset. (By "no shadow", I mean no shadow above or below the plane of the disk; a thin line of shadow is inevitable in the plane of the disk due to the thickness of the material.)



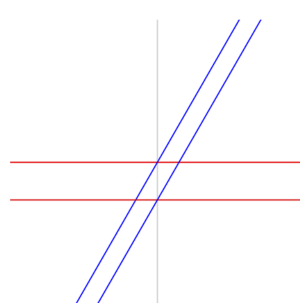
Repeat for other times of day and you have the makings of a so-called Shadow Plane dial, but one that is slightly unusual in that it will show hours remaining until sunset.

For my implementation, I positioned the disks one above the other so that their centers lie on a vertical line. I have disks for quarter hour intervals. As well, I chose to make it a due West dial so the disks are reduced to semicircular fins protruding from the dial face and it does not operate before noon.

At my latitude, the longest day of the year is just a few minutes over 16 hours so the dial, being west facing, is laid out to indicate a maximum of 8 hours to sunset. The design does not consider the effect of atmospheric refraction or solar diameter on sunset, but I find that readings match published times of sunset well enough.

In this photograph, the fin corresponding to 6¾ hours to sunset was producing the thinnest shadow, so that would be the reading. In practice, it is easy to interpolate to get a reading even when the plane of the sun does not line up exactly with a fin.

The only minor difficulty I had with the design relates to the spacing of the disks in the vertical column. As seen in the graphic (below right) a pair of lines that are equally spaced on a vertical axis, approach each other as they are rotated away from horizontal; this tightening also occurs for the disks that make up the dial. Fortunately, it turned out to be easy to deal with. I treated successive pairs of disks as parallel –not true but close enough – so the perpendicular distance needed between successive disks is proportional to the cosine of the rotation of either one away from vertical. All I had to do to achieve adequate perpendicular spacing was to adjust the vertical position of the disks according to the inverse of the cosine of the rotation.



I made my dial using a 3D printer. As a result, the finish and overall appearance is rather plain. Perhaps another person could make a more interesting and pleasing design. For instance, I imagine a woodworker producing an ornately decorated wooden block with semicircular recesses instead of my fins; the user could try a coin in successive positions until the thinnest shadow is obtained.

Steve Lelievre *steve.lelievre.canada@gmail.com*

Have you got a 'show and tell' story like the one above that you're willing to share? Or perhaps a short report about a public sundial in your area? Send it in! (In-depth articles also accepted …)

sundial.society+editor@gmail.com

From the Registry

Located at Weeks Field Community Park, a former airfield in Fairbanks, Alaska, sundial #998 is the northernmost sundial in the NASS Registry. The shaft hole of an old airplane propeller acts as a nodus; the arms are cut from an unused section of oil pipeline.

Photo courtesy of Martin Gutoski, the designer and builder.

DIGITAL BONUS

This issue's Digital Bonus has two slideshows from our 2022 conference:

- David Robinson's *In the Heat of the Moment: Forging Sundials.*
- Pam Morris' *Time…. Light… and… Shadow… as seen and felt…. By an artist.*

As well, there is an OpenSCAD source file for Steve Lelievre's Hours to Sunset Shadow Plane dial, from his article on page 75.

THE TOVE'S NEST

From the Editor – Here are some recent publications I've learned of that may be of interest to other dialists:

- Gysembergh, V., Jones, A., Zingg, E. et al. Ptolemy's treatise on the meteoroscope recovered. *Arch. Hist. Exact Sci.* **77**, 221–240 (2023). https://doi.org/10.1007/s00407-022-00302-w. [*UV fluorescence and multispectral reflectance imaging have revealed the text of 12 pages of previously illegible writings from the Abbey of St. Columbanus at Bobbio (Italy). It appears to be a copy of Ptolemy's otherwise-lost description of the meteoroscope, a form of armillary sphere.]*
- Maslikov, Sergei J. The Greek portable sundial from Memphis rediscovered. Journal for the History of Astronomy, v.52, iss.3, Aug. 2021, pp.311-324. DOI: 10.1177/00218286211033068 (pay-walled). [*An Ancient Greek portable sundial thought lost was recently located in the archives of the State Hermitage Museum in St. Petersburg, Russia.]*
- Alain Brieux, Francis Maddison, et. al. Répertoire des facteurs d'astrolabes et de leurs œuvres en terre d'Islam [Directory of Astrolabe makers and their works in the Islamic world]. 2022. ISBN: 978-2-503-58637-3.

I blamed my own imprudence for parting with so substantial a blessing as my quiet, to run after a shadow.

- Isaac Newton to G.W. Leibniz