

# The British Sundial Society

## BULLETIN

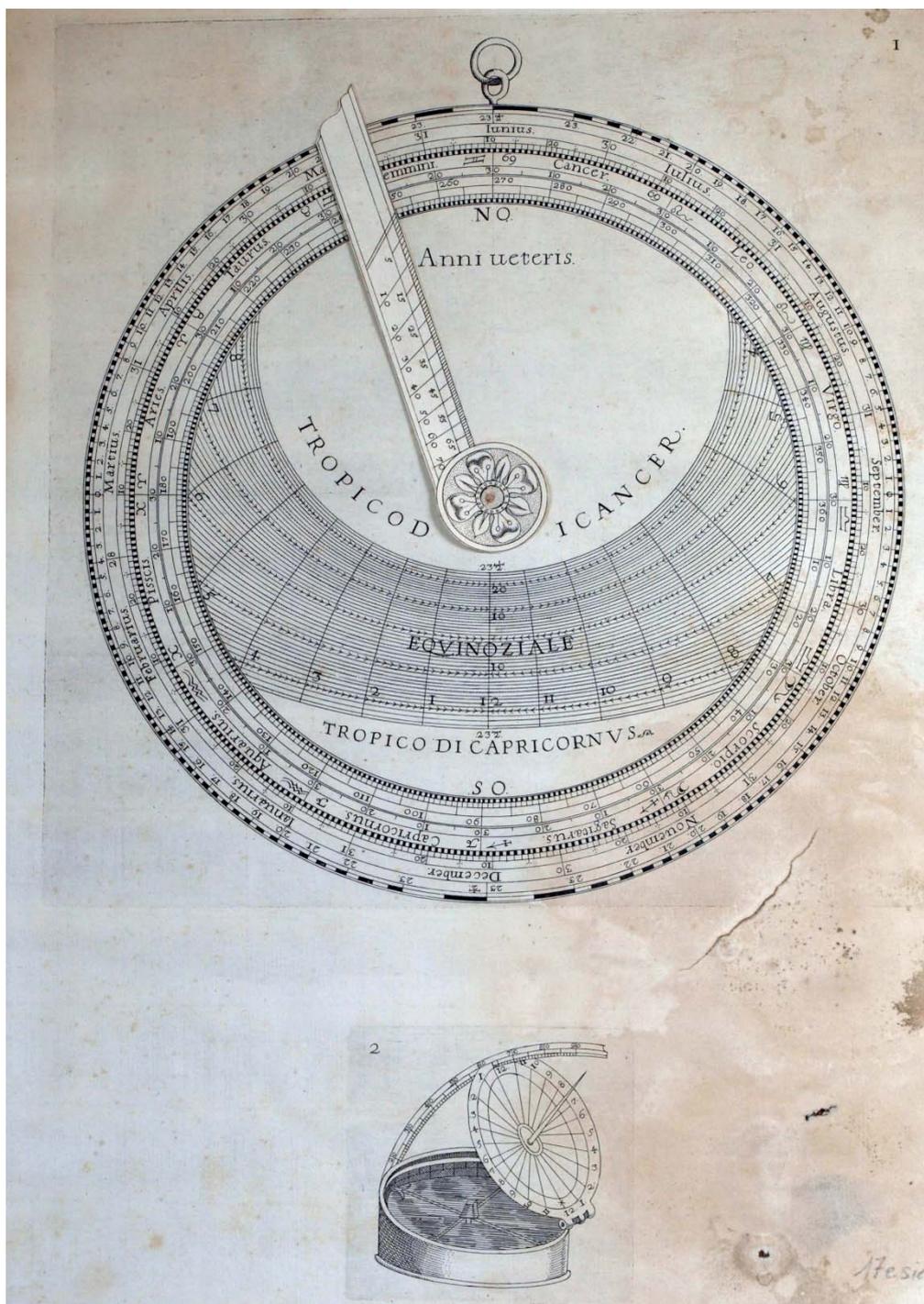
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A page from Sir Robert Dudley's (1573–1649) *Dell' Arcano del Mare* (Vol. 3, Bk V, p.4). Although published in Florence in 1647, the material was actually written at the end of the 17th century, before Dudley had emigrated from England. The main figure shows an "Azumoth dyall" and an actual example, attributed to Charles Whitwell, is in the British Museum. In most respects it uses the same principles as his contemporary William Oughtred's horizontal instrument, though they may be independent inventions. Despite the Italian labels, the drawing is for a latitude of about  $51^\circ$ , probably intended for London. Note the rotating paper altitude scale.

The second figure, from a separate copper plate, is a standard universal equinoctial compass dial.

**Front cover:** A small early-20th-century horizontal dial by Francis Barker & Son of Clerkenwell, London. Note the 'dolphin' gnomon, later copied by makers of mass-produced dials, and the 'art-deco' Arabic numerals. Photo: John Davis.

**Back cover:** The dodecahedron dial at Barrington Court (NT), Ilminster, Somerset. It featured in the March 2013 issue and is seen here from the south, though none of the dials faces exactly south. It is surprisingly small with the actual polyhedron at not much more than head height. Recorded early in the Society's history (SRN0040), it is in good condition and a nice example. Photo: John Davis.

# BULLETIN

## OF THE BRITISH SUNDIAL SOCIETY

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### EDITORIAL

#### Christopher Daniel MBE

BSS members who regularly read the Queen's Birthday Honours List will have noticed that our President, and former Chairman for many years, was awarded an MBE this year. (For those overseas members not familiar with the UK honours system, this slightly archaic award denotes a Member of the British Empire.) The official citation was that it was awarded "For services to the history of marine navigation, timekeeping and sundials" but we know that it is the last of these, for dialling, that is the most important.

It seems that the press also thought that the sundialling aspect was significant as the poster in the picture (not faked!) makes clear. It is a shame that the newspaper in question was the Faversham Times, not the London one, but no matter.

We all offer Chris our sincere congratulations on the award, in recognition of all his work over many years to further a field close to all our hearts. We trust he will wear it with pride at all formal BSS occasions.

One of the reasons that the nomination was successful was the numerous letters of support that were sent, not just by UK worthies in the museum and academic worlds but also by sundial societies worldwide. We are grateful to them all!



# THE BUSCOT OBELISK

MARK LENNOX-BOYD

**W**e have all heard of Seven Dials, but as far as I am aware the Buscot Obelisk is the only sundial to have seven dials on six faces, for reasons which will become clearer later in this article.

In the Spring of last year I gave a lecture on sundials at the Chelsea Physic garden. Lord and Lady Faringdon were kind enough to come. At the end of my lecture I explained that I had for some time wanted to make an hexagonal obelisk with six faces, three for 'days longer', three for 'days shorter', with each face being adjusted for the equation of time and longitudinal displacement from Greenwich. After the lecture Lord Faringdon asked me if I would consider making one for him as the centre piece of his new Egyptian Avenue at Buscot, to celebrate the Diamond Jubilee of HM The Queen. My acceptance of this challenge was instantaneous.

Buscot is open to the public. Lord Faringdon's uncle had made the property over to the National Trust under an arrangement whereby the family is responsible for the development of the grounds and garden. The obelisk stands

in a hedged circle of holly at the end of a long avenue stretching from the house. In the ring of the hedge stand several small obelisks and sphinxes, and in the centre the obelisk I have designed – see Fig. 1.

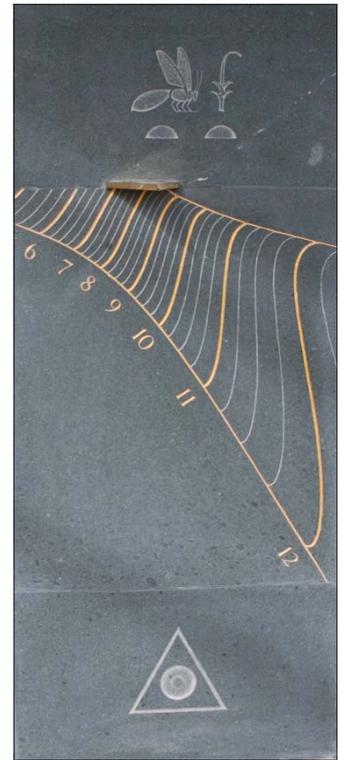
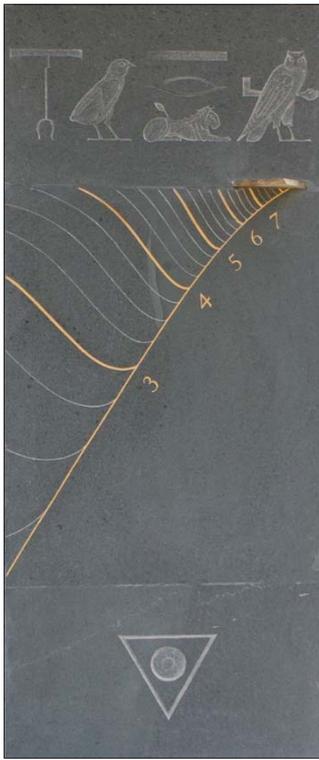
It is five metres tall, of Portland stone, with faces of Broughton Moor green slate, and gold-plated noduses of bronze. The initial design was with steps up to the slate faces, but we concluded that this posed a danger, because someone might clamber up the steps and suffer injury from one of the noduses. So an hexagonal pyramid came into being. The avenue is aligned from the obelisk on a bearing which is almost 300 degrees. One face points down this avenue. At the top on this face is the Egyptian hieroglyph for afternoon. On the face in the direction 120 degrees clockwise from the afternoon face is the hieroglyph for morning and on the southerly face is the Egyptian for mid-day. Above the other three of the six dials are hieroglyphs representing the words Queen, Elizabeth (in a cartouche), and Eternity (see Figs 2–7). The hieroglyphs were researched by Dr Wendy Monkhouse of the National Trust.

The dials read GMT. Below each of the dial faces is a carved circle with a central button, set in a triangle which is pointing up on three faces and down on the other three. This circle is the Egyptian for the sun, and the triangle indicates the face that should be read for days longer or shorter. Readers familiar with astronomical ephemerides will recognize this as the sign for the sun, an ideogram which originated 5000 years ago.

The six faces of the dial were designed in Shadowspro 3.0.1 by means of Parallels Desktop because it operates in Windows and my computer is a MacBook Pro. It will be noticed that the noduses are not symmetrically placed in the centre of each face with the exception of the southerly one. This I consider not to be very important aesthetically, and was necessary in order to ensure that the sun is always reading on one of the dials for both days longer and days shorter. Look at Figs 2–7 and this point will be clearer. One dial (the northerly one) has two noduses and two dials which are there for the earliest period of the day from dawn at or near midsummer, and for the last period till sunset at the same time of the year – hence seven dials.



Fig. 1. The completed obelisk at the centre of the Egyptian Avenue.



*Left to right, top to bottom:*

*Fig. 2. Readings for days shorter under the hieroglyph for afternoon.*

*Fig. 3. Readings for days longer under the cartouche for Elizabeth.*

*Fig. 4. Readings for days shorter under the hieroglyph for midday.*

*Fig. 5. Readings for days longer under the hieroglyph for Queen.*

*Fig. 6. Readings for days shorter under the hieroglyph for morning.*

*Fig. 7. Readings for days longer under the hieroglyph for Eternity.*

The stonework was designed in Vectorworks 2012. Some of the slabs repeat themselves, and dimensioned drawings at a scale of 1:20 allowing for a few millimetres of mortar between the joints were drawn for each of the various slabs. There were 11 different designs in all for the Portland stone, and three for the slate faces. I will not mention the name of the Portland stone company responsible because the stonework was cut inaccurately and much finishing was required when the construction was built. The dial faces were designed at a scale of 1:4 and later blown up life-size for the stonemason who engraved them.

Both the faces and the stonework were designed in the shade of the terrace at my wife's family house in Italy where I spent 10 days last summer. When designing something as prone to error as in these calculations I find it essential to have a clear brain, something I can enjoy only when I am relaxed. I am always concerned about making a mistake, for we all know one mistake with computers can be fatal for a whole project. After design, and waiting for a suitable period of time to allow my brain to forget the original work (this happens very quickly with me), the designs were checked, and after a further delay rechecked. I had no time to make a complete working mock-up to check my calculations with the sun, and lived in some fear of error until the object was constructed and the dials had been fixed in place and adjusted so that one dial read the correct time. On a rare sunny day last February the 'morning' dial (days longer) read 11:45am correctly and when the sun moved round the 'afternoon' dial (days longer) on the other side read 12:15pm correctly. So I knew they were right for days longer. I live in hope that after the summer solstice the dials will read correctly for days shorter!

The first task before designing the dials was to measure the bearing down a centre-line of the avenue. Two stakes were put in a direction from the centre of the holly circle which by eye appeared to be down the centre line of the avenue. A firm of surveyors Derek Skeats Associates Ltd of Oxford was engaged to measure this bearing. I was concerned that it is so easy to supply readings of grid or compass north, rather than true north, that I requested all three so that I could make comparisons to ensure that the information based on true north was correct. I am pleased to say that the firm was most helpful and that the figure of  $298.022^\circ$  given to me for the bearing down the avenue from true north was clearly right. Armed with this information, I designed the six dial faces.

Meanwhile, a consulting engineer had been asked to advise on the foundations and to comment on the overall strength and feasibility of my proposed design. He gave his approval to the latter and specified reinforced concrete foundations two metres deep. He certainly cannot be accused of under specifying on this, and even a hurricane should not topple the obelisk. So the foundations were put in, each course of the pyramid laid and filled with concrete, reinforced with rods between each layer. In all 50 tons of concrete were used. The base course of stone was built with one hexagon edge perpendicular to the line of the two stakes. The surveyors returned to do this measurement accurately and determine the six points for the corners of the base course. This established the alignment of the three sloping courses. The weather was atrocious and caused immense frustrations to the builders. We could not have had more rain, and were prevented from completing the construction during the Jubilee year itself, but this will seem of little importance in the passage of time. So once the pyramid was built we had an immensely strong object with reinforcing rods protruding out of the top layer of concrete, which was level with the top layer of stone.

The construction was carried out by Terry Cook, an employee of the Buscot estate, and by Fergus Wessel with some help from his assistant. Fergus is a stone carving artist who operates from a workshop at Milton-under-Wychwood in Oxfordshire. He also engraved and gilded the six faces and the twelve smaller ones, which are each 40mm thick. A problem was how to fix and align the dials accurately, for I knew that with all the care in the world the hexagon would be slightly out of its designed position, perhaps by no more than half a degree. Subsequent measurement has shown that the orientation of the pyramid was indeed out by about half a degree, so my judgment was accurate. The solution was to build the faces on a cage of hexagonal dimensions mounted on a simple turntable, for adjustment against readings by the sun. So John Huddleston, my neighbour in Lancashire and a brilliant blacksmith, made a cage of stainless steel 6mm thick of the right dimensions, to which the six faces were bolted from behind. He also made the seven bronze noduses. A half-size model in cardboard of the cage demonstrates the prin-



*Fig. 8. Cardboard model of the cage, half size. The hexagonal base rests on the circular ring and can be turned slightly. The levelling bolts of the ring can be seen. On the left can be seen a representation in balsa wood and cardboard of the upper and lower faces and the lower cornice which was inserted after the faces had been bolted to the cage, and the cage had been orientated accurately.*

ciple – see Fig. 8. The cage with slates and the lower cornice during construction can be seen in Fig. 9. You can also see a gold-plated nodus and observe that it is fixed directly onto the slate and is not in contact with the stainless steel. What you cannot see is that the cage extends below the lower faces for a distance of about 150mm to its base which then sits on a stainless steel ring of 12mm thickness, which has six levelling bolts. When this ring had been accurately levelled and the bolts lightly cemented onto the pyramid, the cage and engraved faces with noduses were placed on it and the team then waited in some frustration for a sunny day. When it finally came the assembly was turned about half a degree until the correct time was read on one face. My delight was complete when the dial read the right time on the companion face 120 degrees anti-clockwise, as I have already explained.

The reason the cage extended below the lower faces was to make room for the lower cornice to be built under the lower faces. This was now done, as you can see in Fig. 9, and when the cement had dried the cage was filled with concrete, the faces and lower cornice acting as shuttering – they had been taped behind on the joints to prevent seepage. The concrete was poured in stages in order not to put too much pressure on the slates, and it had several reinforcing rods. It had to be as strong as possible to take



*Fig. 9. The faces and lower cornice during construction. The slate faces have been bolted to the cage. One nodus has been fixed. The lower cornice has been inserted in line with the slates, but is not yet pointed.*

the weight of the solid obelisk sections and I was concerned that the base of the lowest obelisk section was of greater diameter than the concrete core, on account of the thickness of the slates, which could not be allowed to take any of the weight.

So now we had a sundial but without the top slate faces and top cornice. Another simpler cage was made by John Huddlestone which sits above the noduses and has bolted to it the six top hieroglyph faces and cornice pieces. A little more concrete with reinforcing rods followed, and the four sections of the obelisk lowered by crane and cemented in turn. The three main sections of the obelisk have a central stainless threaded bar and six surrounding bars all 12mm

diameter and 200mm long. Each was carefully epoxied into 15mm holes 100mm inside from the corners. The holes had been drilled most inaccurately by the supplier and had to be redrilled. I am told there is no danger of the obelisk being blown over. It is in fact of a reasonably aerodynamic section and to my eye more pleasing for being hexagonal, rather than square as in an orthodox design.

In 1822 Jean Francois Champollion made a break-through discovery in the decipherment of hieroglyphs. He was a brilliant linguist who by the age of 16 knew 12 languages. He learnt Coptic and knew that the sun in that language was Ra. He also knew of a cartouche which had the sun symbol as the first carving and two carvings at the end which he knew read 'ss'. So he reasoned correctly that the cartouche meant the name 'Ramses', and thereby later managed to fulfil his life's ambition of completing the decipherment of the language. I like to think that should an Egyptian from that age be transported in a time machine to Buscot, he would be fascinated by this monument. He would recognize it as an obelisk but would be initially horrified at the sacrilege in making it hexagonal, rather than square, yet on closer examination would realise that the dials had something to do with the divisions of a day indicated by curves and very unfamiliar ideograms, and the passage of his God across the sky. Looking at the object even more closely he might reason that the triangles round the sun symbols referred to whether the days were getting longer or shorter.

#### NOTES

Buscot Park is near Faringdon in Oxfordshire. Opening times will be found on the Buscot website:

[www.buscot-park.com](http://www.buscot-park.com).

Fergus Wessel's website is [www.stoneletters.com](http://www.stoneletters.com).

For a portrait and mini-biography of the author, see *BSS Bull.*, 24(i), March 2012. He can be contacted on [marklennoxboyd@mac.com](mailto:marklennoxboyd@mac.com)

## Most Enjoyed Article Award 2012

Peter Kunath, who won this award for his article 'Lost and found—the long journey of an unusual sundial' about the Henry Moore sundial, was unable to attend a BSS event to have his prize presented to him so instead we sent him his certificate and prize—a reproduction astrolabe. He is pictured here with them. The caption that Peter supplied for the photo is:



*German Ambassador at the BSS Bulletin Court  
- Award ceremony at May 6th = Taurus 17, 2013, 3 p.m.  
local time with Peter Kunath.*

*The astrolabe shows celestial sphere at this date and time.  
On the right a model of the Moore-Sundial (scale 1:38)*

The choice of the astrolabe for a prize was a lucky one as Peter tells us that a few months ago he was asked to explain to an audience at Cologne City Museum how their astrolabe, dated to circa 1400, worked. As a result he produced a small booklet on the subject for them.

# THE GLOBE DIAL OF PROSYMNA

KARLHEINZ SCHALDACH and ORTWIN FEUSTEL<sup>1</sup>

The globe and the sundial were symbols of erudition in Roman antiquity. Cicero praised Archimedes as a man close to God because he could construct spheres, and to him horologia were examples by which one could see the work of God in man. Also, on the mosaic of the Roman villa on the Isle of Wight and at the meeting of the philosophers on the mosaic in Naples, the globe and the sundial are the instruments of the scholar. How great must have been the symbolism when both instruments were combined in one! This explains why our object at issue here (Fig. 1) was not damaged and stayed safe from its inception around 100 BC until its consecration to the Argive Heraion in the 2<sup>nd</sup> century AD.

The Heraion is located just to the west of the main road from Mycenae to Argos, approximately equidistant to both places. The traveller Pausanias, visiting the site in the 2<sup>nd</sup> century AD, referred to the area as Prosymna (*Description of Greece* 2.17.1-7). This temple of Hera, daughter of Kronos and wife of Zeus, was the ritual centre of the Argolid and one of the oldest and most famous of Greece, which is also expressed in Homer when he let Hera say (*Iliad* 4, 50–52): “The three towns I love best are Argos, Sparta and Mycenae of the broad streets”. The sanctuary flourished from the 8<sup>th</sup>–5<sup>th</sup> century BC, but continued in importance throughout the Roman period, when baths and a palaestra were added near the site.

But it is not only the symbolic content and its particular location to where it was donated, but also the subtlety with which the globe sundial was manufactured that allows us to say that it is one of the most amazing scientific objects that has survived from antiquity. It does not work with a pointer as most dials do but with a terminator, the boundary of light and shadow, in a way that we can speak of a three-dimensional nomographical procedure. Ptolemaios also used nomograms in his *Analemma* but the idea cannot have come from him – as the globe is older – or from the French engineer Philbert Maurice d’Ocagne (1862-1938) who is commonly said to have invented nomography in 1884.<sup>2</sup>

Though the globe is extraordinary, it has until now been described only briefly, from the excavator Carl Blegen in 1939<sup>3</sup> to Sharon Gibbs in her work from 1976 on *Greek and Roman Sundials*.<sup>4</sup> Blegen himself admitted that he had not understood the system of arcs and lines and that he did not know enough about sundials to perform on it “an intelligent discussion”, as he said. Also, Gibbs gave only measure-



Fig. 1. The Prosymna dial. Top view of the globe with line system I, some holes and parts of line system II.

Photograph by K. Schaldach.

ments and a brief interpretation. So this article represents the first detailed description with analysis results of the data of the dial.

## Description

The globe was not found in the Heraion, which lies on a hill, but at the end of a slope a small distance from it, where the stone probably rolled down to. The dedication to Hera is another strong argument that it was originally placed in the Heraion.

It lies now in the *apothiki* (i.e. depot) of the ephorate of Nafplion, which is not open to the public, but a visitor to the ephorate will be shown a resin copy. It is a solid ball of white marble with a radius of about 268 mm. It carries a dedicatory inscription (inscription A), a labelled point system (inscription B) and three line systems I, II and III, of which only line system II is labelled (inscription C). The surface of the sphere is flattened in the region of the line systems and shows in the other parts traces of a toothed stone chisel.

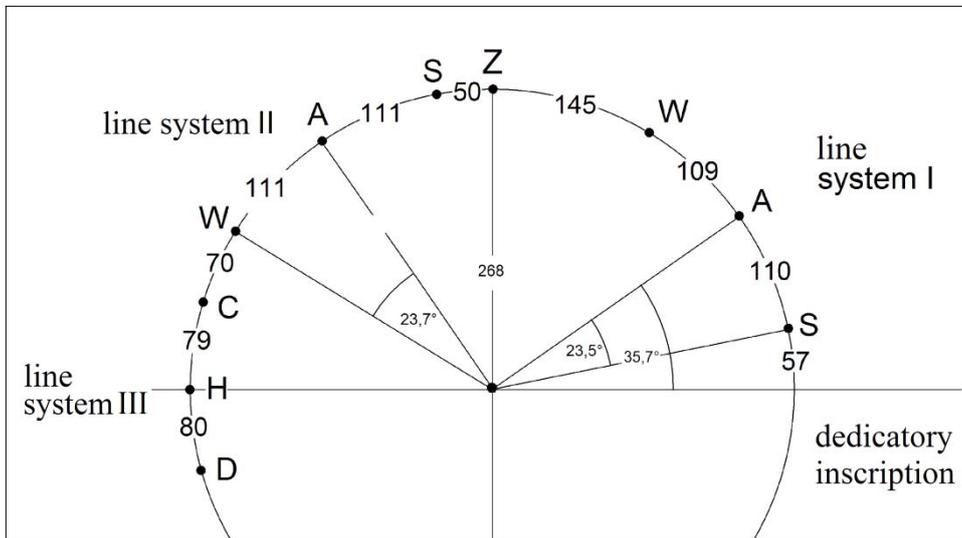


Fig. 2. S stands for the summer line, A for the equinoctial line, W for the winter line, Z for the zenith and C, H and D for the lines of system III. Drawing by K. Schaldach.

The sphere is bisected by two great circles. One great circle passes through the zenith, the highest point, and the nadir, the lowest point, where a 10 cm wide by 10 cm deep hole with the remains of a lead filling hints that the sphere was attached to a base of some kind. That circle can be interpreted as a meridian line. Fig. 2 shows a cross-section along the line with some measurements (large numbers) that gives the impression that the important values of the sphere (which were calculated, therefore the small numbers) as  $\epsilon$ , the obliquity of the ecliptic, with  $23.6^\circ$  and the latitude  $\varphi$  with  $35.7^\circ$  fit rather well, compared with Ptolemaios, who in his *Syntaxis* gave the climatic zone of Rhodos as  $36^\circ$ , which stood also for the whole of the Peloponnese.

A second great circle bisects the ball horizontally. On the N-half of the sphere, below the horizontal line, there is the votive inscription which says (inscription A; where | represents the meridian line, which separates the following text):

Ἡρης ἱροπόλος με | θεῆς ἀνέθηκε Θάλεια  
ἠλιακῶν ὥρῶν | ἄγγελον ἡμερίους.

(The priestess of the goddess Hera, Thalia has ordained me, the herald of the sunny hours for the mortals.)

This inscription was cautiously dated by Blegen to the second century AD. The space under the inscription is empty. Only the meridian line leads down to the lowest point of the sphere.

Above the inscription and the horizontal line is the line system I (B after Blegen) that incorporates the zenith and has a shape like that of a hollowed sphere with a hole in the zenith, but the connecting lines between the hour points are made by straight lines. Also, there are small holes marking the intersection of the meridian line with the equatorial line in order to emphasise that spot.

From the zenith, and symmetrical to each other to the opposite side of the globe, there is a radiating point system consisting of two rows of six flat holes with a diameter of 8 mm each, not – as Blegen noted – to hold chopsticks in order that their shadows indicate the hour, but for fastening

bronze rod studs. Each of the holes is accompanied by a number with a height of about 8–10 mm (inscription B):

ς' ε' δ' γ' β' α' [ιβ] ι' θ' η' ζ' ς'  
(6 5 4 3 2 1 12 11 10 9 8 7 6)

The holes pass line system II with its seven day lines and 13 hour-lines. The reason that we have more hour-lines than, for instance, a hollow spherical dial is because we need one hour-line for the sunrise and another for the sunset, as in this case we have no stone edge to define the surface for the shadow. The series of holes begin with the holes on the horizontal line, which are marked by a Greek 6, and then climb up to the hole at the zenith which is marked by 12. Fig. 1 shows the sphere with parts of systems I and II and the point system from a bird's-eye view, while Fig. 3 was photographed from the East.

Line system II looks more elaborated than I, because the lines fit well with the rounding of the stone.

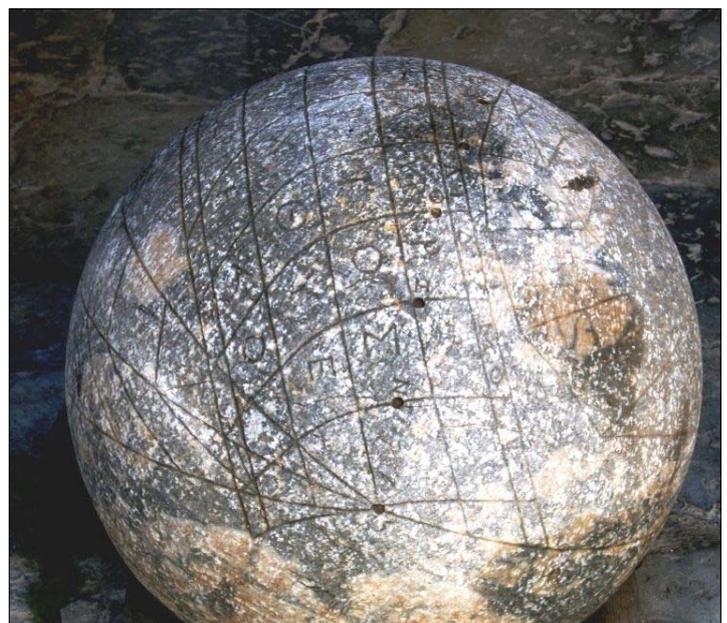


Fig. 3. View from the east of the globe with parts of line systems II and III as well as holes for the hours six to eleven. Photograph by K. Schaldach.

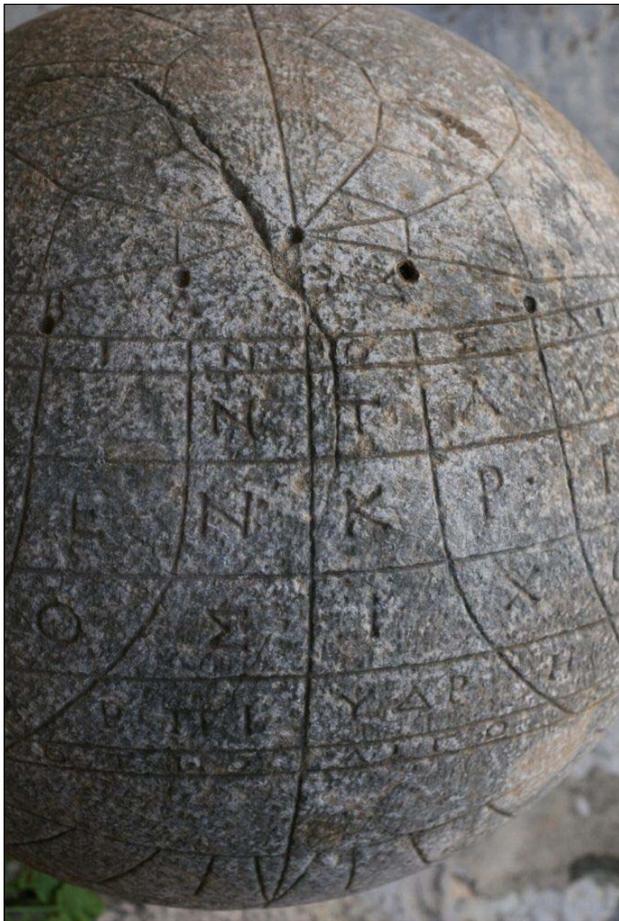


Fig. 4. View from the south of the globe with parts of line systems I, II and III as well as holes for the zeroeth/twelfth, first/eleventh and second/tenth hours. Photograph by K. Schaldach.

In the squares formed by the lines are letters which give the following names of the zodiac (inscription C):

καρκίν   ος	δίδυμοι
λέων	ταῦρ(ος)
παρθέν(ος)	κριός
ζυγός	ιχθυε(ς)
σκορπι(ός)	ὕδρηχό(ος)
τοξότης	αιγόκε(ρως)
Cancer	Gemini
Leo	Taurus
Virgo	Aries
Libra	Pisces
Scorpio	Aquarius
Sagittarius	Capricorn

Special features are the notation for καρκίν | ος which crosses the meridian line into the field for Gemini, and the rare variant ὕδρηχός for ὕδροχός. While the first seems to be an error of the stonemason, the variant ὕδρηχός is not unknown and it therefore indicates neither a particular time nor a special background. A close view of line system II is shown in Fig. 4.

The zodiac is given in the common order, that is, counter-clockwise. The solstices and equinoxes are not mentioned in the inscription, but they can easily be added: the summer



Fig. 5. View from the south of the globe with the meridian and the middle part of line system III. Photograph by K. Schaldach.

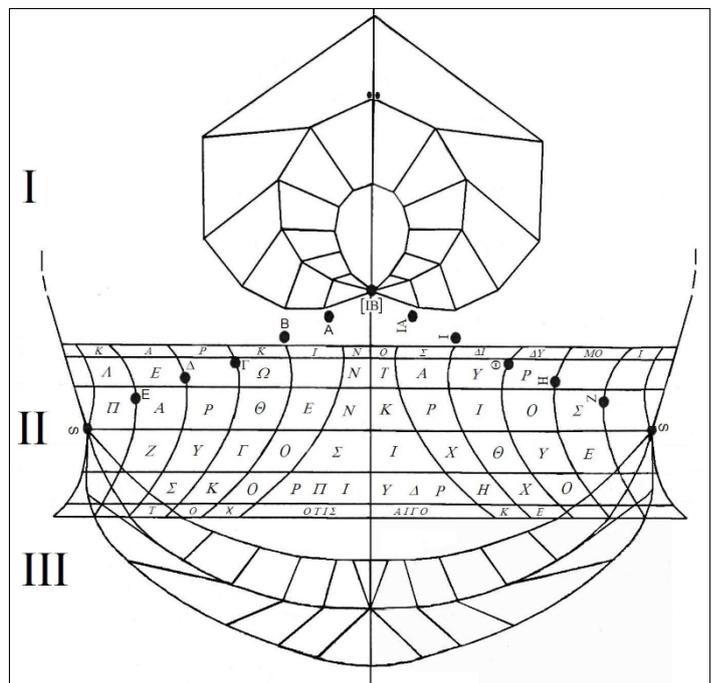


Fig. 6. Drawing of the line systems I, II and III, with the inscriptions B and D. Drawing by K. Schaldach.

solstice near the top, the winter solstice at the bottom line of that system.

Line system III, for which there was previously no interpretation, crosses over system II. The horizontal line is part of the system, which is also bisected symmetrically by the meridian line (Fig. 5).

The drawing Fig. 6 provides a flattened surface of the globe with an overview of all the systems and inscriptions. It is not to scale. The top stands for the N, the bottom for the S, the right side for the E and the left for the W side of the sphere.

Blegen said that the labelling of the holes and lines of system II “seem to belong to the end of the second century BC”, while Gibbs does not mention any age. Actually, inscription A is very different from the inscriptions B and C, and Blegen’s dating proposal possible, but we would like to expand it into the first century BC as well.

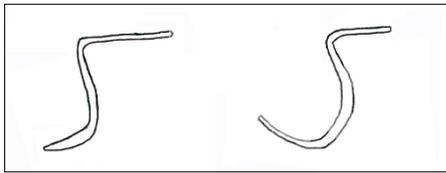


Fig. 7. The stigma. Drawing by K Schaldach.

A problem is that the stigma ζ form of the 6s tends to be more Roman than Hellenistic (Fig. 7). Probably they are later additions as they are slightly larger than the other hour-number letters and their orientations do not seem to be consistent with them. Nevertheless, it is the very first sundial on which the hours were marked by Greek numerals.<sup>5</sup>

Then about 200 years after its production, around the middle of the 2<sup>nd</sup> century AD, the piece was given to the Hera sanctuary as an offering of the priestess Thalia. The poetic expression ἄγγελος ἡλιακῶν ὥρῶν in the dedicatory inscription has, we believe, no close relationship with the original scientific nature of the device. Also, the word ὥρῶν together with ἄγγελος are only found in Galen, the prominent physician, surgeon and philosopher of the 2<sup>nd</sup> century AD (ὅταν δὲ τὴν δευτέραν ὥραν ἀγγείλῃ τὸ ἡλιακῶν ὥρολόγιον = If the sundial announces the second hour), another reason for the rather late dating of inscription A.

### Review of the Analysis

Both the pattern of the spherical line nets and the kind of indicator (namely using the terminator) mean that, in contrast to the calculation of dials with a gnomon, a totally new way of thinking is required: not using the tip of the sun vector to indicate the time and date but instead the edge of the terminator plane, perpendicular to the sun-vector. Thus it was necessary to find possible solutions not previously used. The mathematical tools and methods required were analytical analysis (column vectors), trigonometry, 4<sup>th</sup> order curves, and transformation of coordinates by rotation and by orthogonal projection. Using these methods it was possible to derive formulae for calculating the intersection point coordinates between spherical lines as well as the hole positions and the terminator.<sup>6</sup>

### Function of the Series of Holes

The 13 holes are arranged on the globe's south face: one hole is positioned at the globe's zenith, twelve holes are distributed symmetrically on both sides of the meridian down to the sphere's east and west points. The two curves branch with the hole positions from the zeroeth to the sixth hour, and from the sixth to the twelfth hour, deviate only slightly from the first vertical – see Fig. 8. The terminator cuts exactly the individual hole positions for every full hour only at the equinoxes. We will see later that in this respect the holes and the line system III are causally related. Of course it is possible to read the temporal hours at the hole positions too, because the scatter range for the terminators for non-zero declination values is negligible in comparison to the circumference of the globe. Fig. 10 shows as an

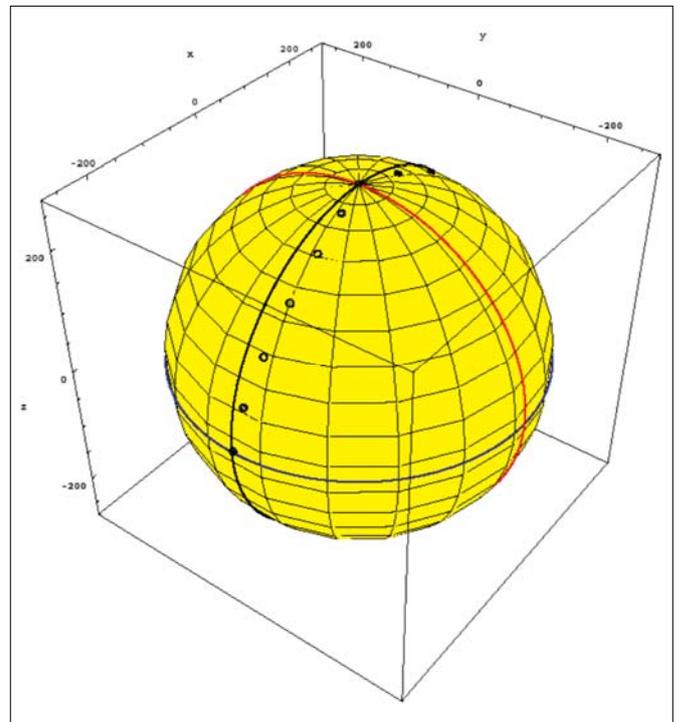


Fig. 8. 3-D representation of the holes for the hours 0 to 6 and 10 to 12. The great circles for the horizon, meridian and first vertical are also shown. The 3-D direction of sight has the angle coordinates  $\theta = 51^\circ$ ,  $\eta = 217^\circ$ .<sup>8</sup>

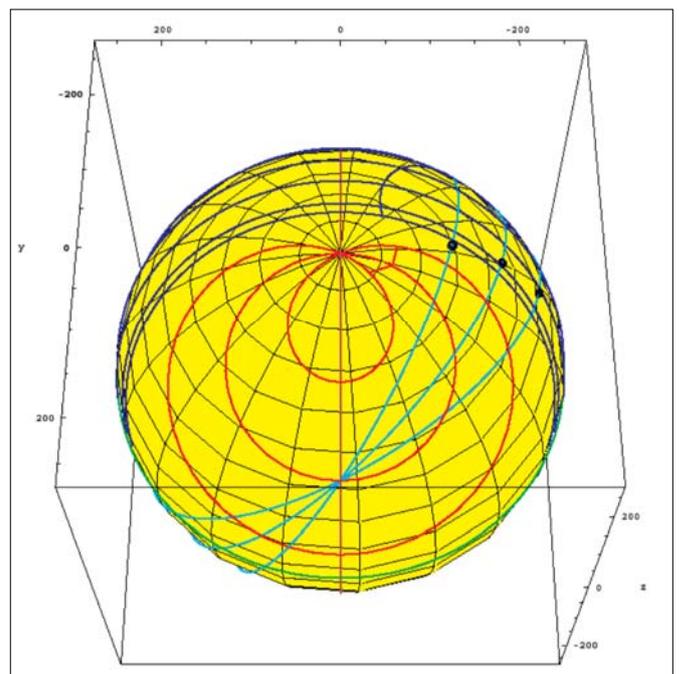


Fig. 9. 3-D representation of line system I with the outer branch of the conchoid of a circle (= summer solstice line), the inner branch of the conchoid (= winter solstice line), the equinoctial line and the two great circle arcs between the three seasonal lines for the first temporal hour. In addition, the hole positions and terminator lines (cyan) for equinoctial hours 2 to 4, the meridian (red) and horizon line (green) as well as parts of line system II (blue) are inserted. The 3-D direction of sight has the angle coordinates  $\theta = 28^\circ$ ,  $\eta = 90^\circ$  (northern view).

example three terminator lines that run through hole position 1.

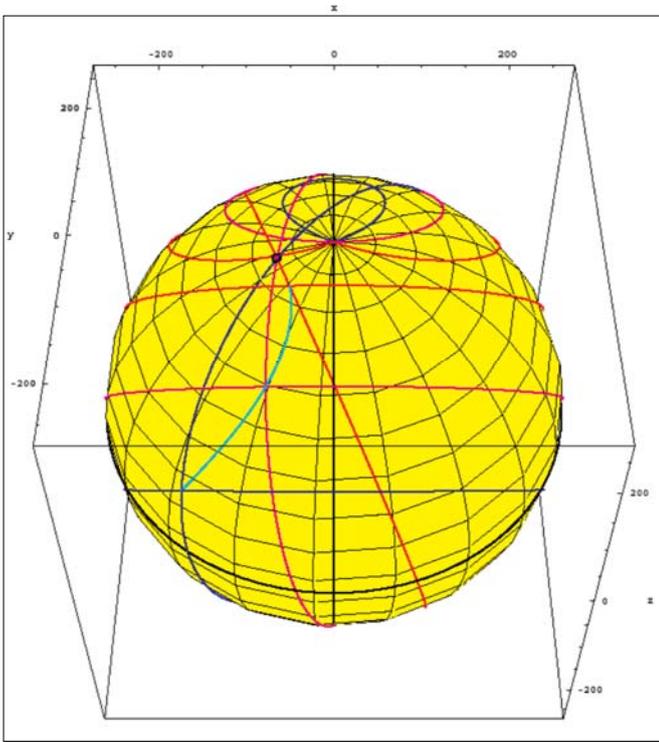


Fig. 10. 3-D representation of line systems I and II with the declination lines for the winter solstice (blue), summer solstice (red) and equinoxes (magenta). In addition, the hour line (green), three appropriate coloured terminator lines and the hole position for the first temporal hour are shown. The 3-D direction of sight has the angle coordinates  $\theta = 39^\circ$ ,  $\eta = 270^\circ$  (southern view).

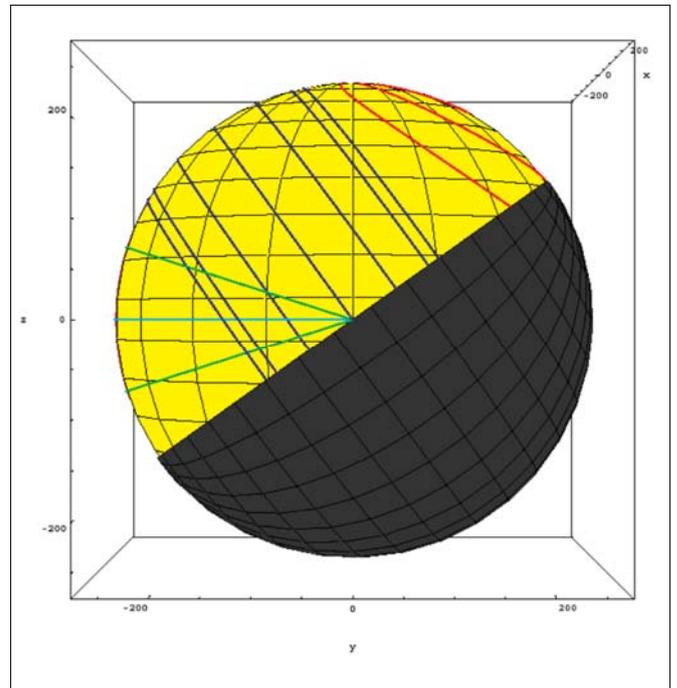


Fig. 12. View from the east of the globe with the terminator position for the sixth hour at the equinoxes. It can be seen that the terminator runs through both the east point (intersection point between horizon circle and first vertical) and the equinoctial circle of line system I.

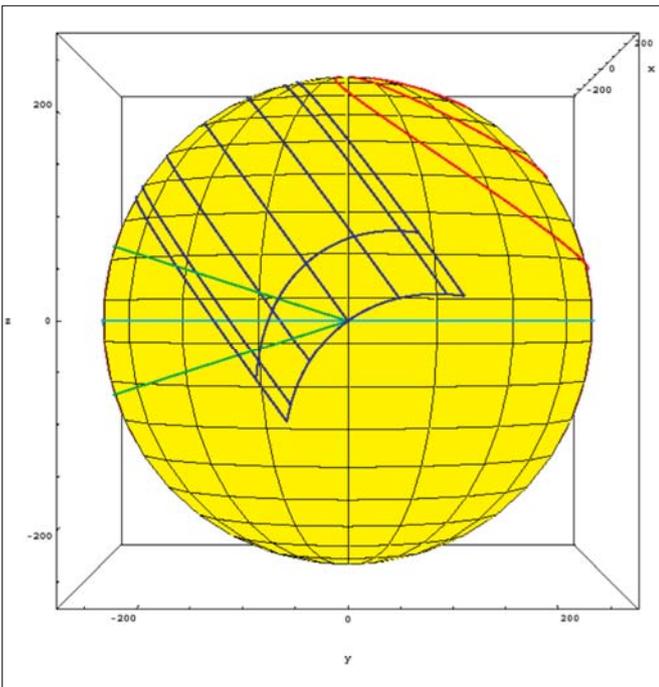


Fig. 11. 3-D representation of line system I (red for solstitial and equinoctial lines), line system II (blue coloured zodiacal lines) and line system III (cyan coloured upper and lower lines, green coloured horizon line). The 3-D direction of sight has the angle coordinates  $\theta = 90^\circ$ ,  $\eta = 0^\circ$  (view from the east). In addition, the hour lines (blue) for temporal hours 5 and 6 are shown.

The typical deviation<sup>7</sup> of measured and calculated values concerning the arcs between the holes is about  $\pm 2\%$  for the holes from 1 to 5 and 7 to 11; only the deviations for the remaining hole distances amount to 8.5% and  $-12.5\%$ .

### Functions of Line System I

Line system I consists of two branches of the conchoid of a circle for the solstice lines and a circle for the equinoctial line. Both curves are orthogonal projections from the equinoctial plane onto the northern surface of the sphere. The cuspidal point of the conchoid is at the globe's zenith; the vertices are positioned at the meridian line. The centre of the equinoctial circle lies on the meridian line and the circle itself runs through the globe's zenith – Fig. 9. Ten pairs of great circle arcs are arranged between these algebraic curves; their intersection points are related both to the temporal hours and the seasons. The arc pair for the first temporal hour is also shown in Fig. 9. In Fig. 6, two dots are drawn at the intersection of the meridian and equinoctial lines: all equinoctial terminators pass through this point (Fig. 9).

The typical deviation range along the inner branch of the conchoid is from  $-1.6\%$  to  $1.3\%$ . The deviations along the equinoctial circle are divided in two; there are deviations in the range of only a few percent but also more than 10%. The deviation range for the outer branch of the conchoid is very non-uniform, namely from a few percent up to some 10% as freak values. The deviations for the arc lengths between the declination curves vary in a similar manner.

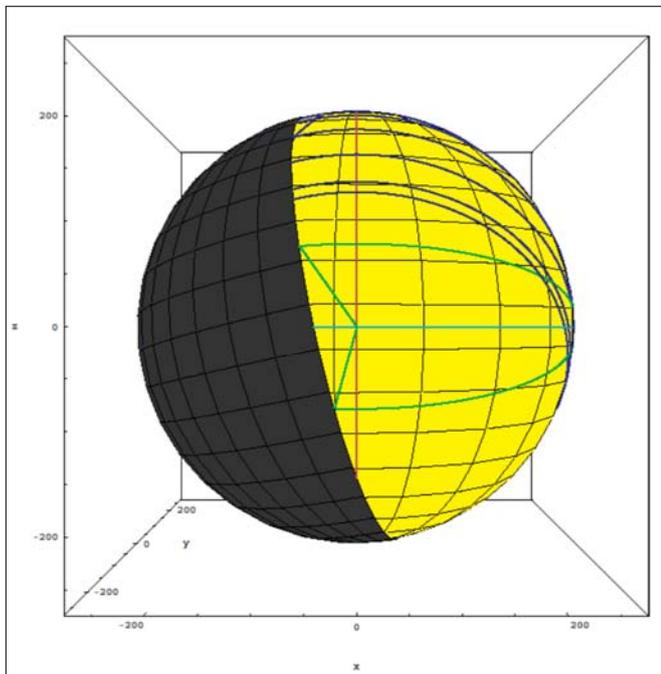


Fig. 13. View from the south of line system I with five declination lines and part of the hour line for hour 1 as well as line system III with three great circles and two great circle arcs. The terminator at the equinoxes cuts the accompanying intersection points between arcs and great circles of system III and first hour and equinoctial lines of system II. The two arcs intersect with the cross point of meridian and horizon circles.

### Functions of Line System II

Line system II is formed by one great circle arc for the equinoxes, six parallel circle arcs according to the zodiacal belt, and twelve temporal hour lines. The hour lines contain a low bend between the summer solstice line and the equinoctial line as well as a considerable bend between the equinoxes and the winter solstice. Figs 10 and 11 show as examples the curves for the temporal hours 1, 6 and 7.

The deviations for the 48 circle arc lengths along the declination lines and the meridian line show the following results: about one third of the measured lengths deviate less than  $\pm 5\%$ , about one fifth is within the range  $\pm 5\%$  to  $\pm 10\%$ , and about two fifths are within the range  $\pm 10\%$  to  $\pm 20\%$ .

The systems I and II can each indicate, in principle, the seasonal dependence of the temporal hours. For each system, there is more than one intersection of the terminator and the current season but the second system allows this ambiguity to be resolved. Additionally, the daily moment of the sun's culmination (sixth hour) is best read if the terminator touches the relevant intersection point of system I as well as the east and west point at the system II, see Fig. 12.

### Function of Line System III

Two great circles arcs – one above and one below the horizon circle – and the horizon circle itself belong to system III; the two great circle arcs intersect at the east and west points, and the angle between them is about equal to the latitude. Ten pairs and two single arcs are inserted

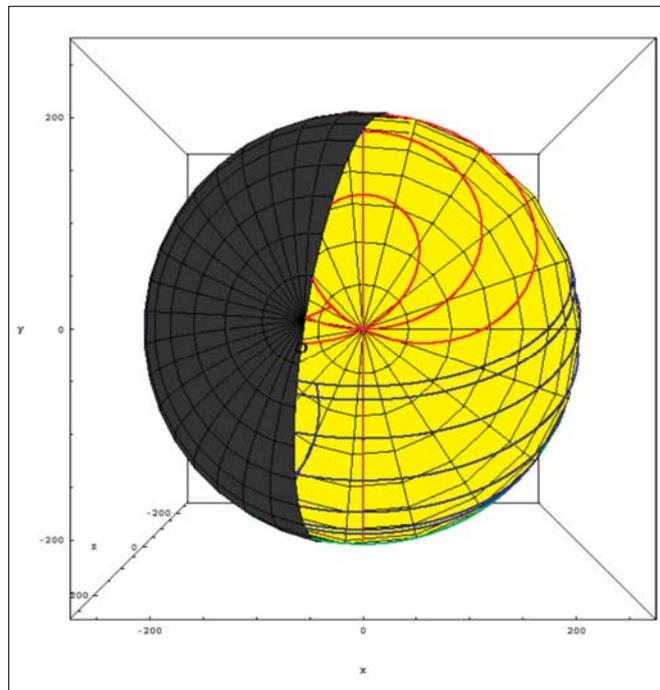


Fig. 14. Top view of the globe with the terminator for the first hour at the equinoxes. The terminator runs through hole position I, the intersection points between the hour line and the equinoctial line of system II as well as the great circle arc and the equinoctial line of system I.

between the three great circles. This net does not serve for the continuous indication of an astronomical quantity. Rather, the purpose was clearly to indicate two very important annual events, namely the equinoxes: the terminator cuts simultaneously only at the equinoxes each three intersection points. In Fig. 13 only two visible intersection points are seen because the third one is covered by the terminator on the horizon line. The individual points of these triplets are located along the three great circles; the distance from point to point amounts to one temporal hour at the equinoxes, *i.e.* one equinoctial hour.

The deviations vary as follows: along the horizon line they are mostly of a few percent, along the lower half circle they are partially in the  $\pm 10\%$  range, along the upper half circle they are unusually high, *i.e.* up to  $\pm 30\%$  near the meridian line. But this deficiency is not as significant as the fact that the stonemason has probably chiselled by mistake the upper and lower arcs mirror-imaged with respect to the horizon line; comparing Figs 5 and 13 makes this clear. In spite of this handicap it has been still possible to use at least the cross points along the horizon circle, but of course that was not really the intended use of system III.

### Final Remarks

One may suggest that this unusual sundial seems to be overcomplicated with three nets of lines and a row of marking studs for indicating the time and season. But there are definitely plausible explanations for this 'redundancy'. On one hand, systems I and II, as well as system III and the arrangement of marking studs, complement one another in an appropriate manner as described (see Figs 13 and 14).

And on the other hand, the terminator does not offer a sharp boundary line rich in contrast (especially with a hazy sky) and so two readings on different faces improve the evaluation of the relevant values sought.

On the whole, the ingenious concept of the Prosymna globe sundial, and the generally impressively small differences between calculated and measured values, demonstrate the high knowledge and skill of the designer as well as the stonemason who have together created this admirable rare specimen about two thousand years ago.

## ACKNOWLEDGEMENTS

We have to thank Christos Piteros and the 4<sup>th</sup> Ephorate of Prehistoric and Classical Antiquities in Nafplion for allowing us to measure and photograph the globe dial and to publish our results; Klaus Hall (Berlin) for his help with the inscription; and Alexander Jones (New York) for his suggestions on the stigmata.

## REFERENCES and NOTES

1. Introduction and description by Karlheinz Schaldach, review of the analysis results by Ortwin Feustel.
2. Nomography continued to be an important procedure in the art of gnomonics as we know from astrolabes, quadrants and the *quadratum horarium generale* of Regiomontanus, to mention only a few examples.
3. Carl Blegen: *American J. Archaeology*, 42, 443-4 (1939).
4. S.L. Gibbs: *Greek and Roman sundials*. Yale University Press, New Haven and London, 27–30, 376–8 (1976). The dial is nr. 7002G.
5. Strictly speaking they are the ends of the hours that are marked.

Sometimes it is claimed that F (digamma) stands for 6 in Greek, which is wrong as there is no example known for that and we have only the form similar to C or like that on the globe which was called stigma in Byzantine times.

6. O. Feustel: 'The mathematical analysis of the globe sundial of Prosymna' is expected to be published in September 2013 *NASS Compendium*.
7. Deviation is defined as the difference between a measured and a calculated value divided by the measured value (in percent).
8.  $\theta$  = angle that the z-axis makes with the direction of sight vector,  $\eta$  = angle that in a right-handed system the x-axis makes with the projection of the direction of sight vector onto the xy plane.

Karlheinz Schaldach's ties with the BSS began in 1994 with a



talk at the summer meeting on medieval sundials (abbreviated version in *Bull.*, 96.3). Latterly, his interests turned to the Graeco-Roman sundials on which he has written articles and books. He began to write his first book on the Greek dials when he was lucky to stay in Greece for some years and to get support in his research work by Hermann Kienast, the former scientific

director of the German Archaeological Institute in Athens, whose monograph on The Tower of the Winds with a contribution by Karlheinz will be published in the near future. His second book will represent sundials of the Greek islands, many not yet published, as well as the history of Greek gnomonics from its very beginnings until 500 AD. He can be contacted at [info@antike-sommenuhren.de](mailto:info@antike-sommenuhren.de)

For a biography and portrait of [Ortwin Feustel](#) see *BSS Bull.*, 24(ii), (June 2012). He can be contacted at [feustel\\_gnomonik@t-online.de](mailto:feustel_gnomonik@t-online.de)

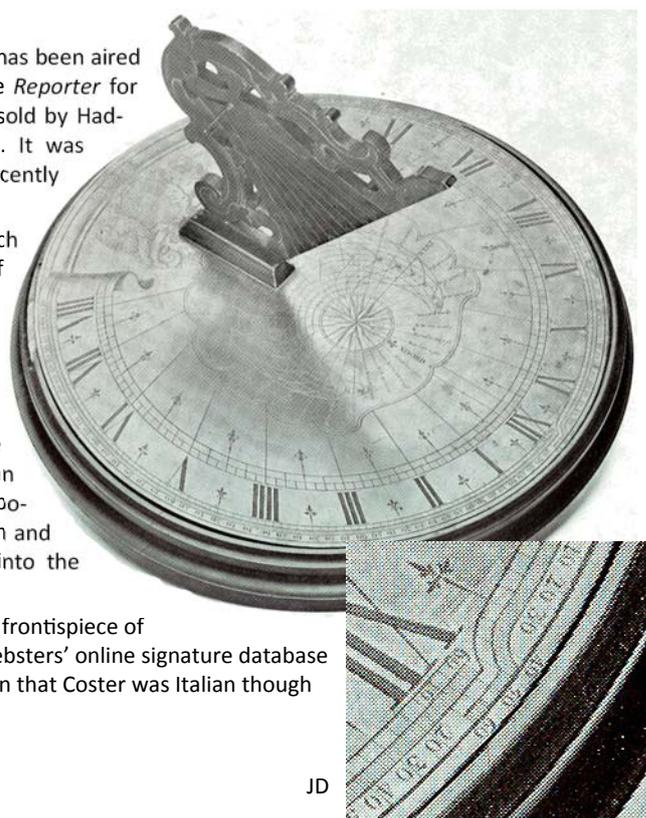
## Noon Overlaps and Underslung Gnomons

The subject of noon (or gnomon) gaps in the hours scales of dials has been aired a few times recently, notably in the June *Newsletter* and in the *Reporter* for 2010 (Cheltenham). In the latter, the common proprietary dial sold by Haddonstone Ltd, which features an overhanging gnomon, was shown. It was thought that this feature was perhaps a modern invention but I have recently found a much earlier example.

In H. Michel's 1966 book *Les Cadres Solaires de Max Elskamp*, which details the collection of this early (1862–1931) European collector of scientific instruments, there is the illustration shown here. The text describes the dial as being by the 18<sup>th</sup> century engraver D Coster and being bronze, 42 cm in diameter and of the style "à la capucine". The unusual overhanging gnomon is noted, including its subsidiary east and west pin gnomons. As a result of the overhanging gnomon, the origins of the hour-lines are swapped over from the east and west tips of the gnomon, with the result that the scales overlap at noon rather than having the usual gap. The inset shows that this has been properly incorporated. It is not so obvious that the origins of the hour-lines before 6am and after 6pm are also correctly swapped, a feature not incorporated into the Haddonstone dial.

Not much is known about D Coster. It seems he was the engraver of the frontispiece of Nicholas Bion's famous *Traité de la construction...* He appears in the Websters' online signature database only through this sundial which is dated there to 1715 with an suggestion that Coster was Italian though the dial was for The Hague.

So, as usual, there is "nothing new under the sun"!



JD

# IN THE FOOTSTEPS OF THOMAS ROSS

## Part 6: The Sundials of Robert Palmer, Schoolmaster

DENNIS COWAN

Robert Palmer (Fig. 1) was the schoolmaster in Currie, a village just outside Edinburgh, for forty years from 1828 until his death in 1868 at the age of seventy-one. By all accounts he was an exceptional man of great character and intellect, full of enthusiasm for eve-



Fig. 1. Robert Palmer, from: 'The History of Curling' by John Kerr, pub. David Douglas, Edinburgh (1890).

rything he did, and he had abilities that would have made him stand out in any profession that he chose. He excelled in English, Latin, Greek and mathematics. He was the local Registrar, responsible for recording births, marriages and deaths. Additionally, he was also an Inspector of the Poor, and in this capacity he would examine requests for poor relief from within the parish. In his spare time he was an excellent and passionate curler.

He was a founder member of both the Currie Curling Club and the Caledonian Curling Club, later to become the Royal Caledonian Curling Club, the governing body of the sport in Scotland. His fame as a skip in that sport is illustrated in Charles Lee's famous painting of the Grand Match<sup>1</sup> at Linlithgow in 1848, where he is seen welcoming the stone as it is making its way to the tee. He invented the tee-ringer, said to be one of the most useful of curling appliances.

He was also a keen astronomer, but it is as a maker of sundials that I first came across him. In the *Book of Sundials*,<sup>2</sup> Mrs Gatty writes "at Riccarton Castle, Midlothian, there is a dial of grey stone inscribed 'Robert Palmer fecit, 1829', most scientifically constructed, and another by the

same maker is in the neighbouring churchyard of Currie. This was presented by Palmer to the parishioners and heritors in 1836".

He is mentioned in *The Castellated and Domestic Architecture of Scotland*<sup>3</sup> where Thomas Ross says "two dials of very scientific construction one at Currie and another at Riccarton were made in 1836 and 1829 respectively by the village schoolmaster, Robert Palmer, who taught the elementary principles of astronomy, and had the walls of his schoolroom painted with astronomical diagrams".

When the old school was renovated around 1989, hemispheres of the world were found painted on the walls underneath layers of wallpaper. One room had the Americas on its walls whilst another room had Asia. Unfortunately no photographs of the maps were taken and the walls were covered again.

Ross does not provide us with any sketches of Palmer's dials, probably because they were not ancient sundials; to him they were fairly modern and not architecturally important. He probably referred to them only to illustrate the teaching of the scientific principles of dialling and other mathematical studies in the Scottish parish schools of the time.

Palmer was known to have been friendly with Sir James Gibson Craig, the owner of the Riccarton estate on the western fringes of Edinburgh, who shared his interest in curling. Palmer was new to the area having left the south west of Scotland to take up his teaching appointment in Currie. He probably wanted to make an impression with the



Fig. 2. Riccarton sundial pedestal, now without its dial.

local landowner, so perhaps it is not surprising that he made a sundial for his new friend, given that his extensive knowledge of astronomy and mathematics would surely have been discussed.

Palmer's sundial for Sir James was placed in the sunken garden at Riccarton, adjacent to the curling pond. The curling pond no longer exists, although its outline can still be clearly seen today.

Riccarton Castle was originally a 16<sup>th</sup>-century tower which was extended in the 17<sup>th</sup> century and altered and added to between the years 1823 and 1827. The estate was requisitioned by the military in 1939, but by the mid-1950s the house had fallen into a state of disrepair and had become structurally unsound and so was demolished in 1956. In that same year it was reported that Mrs Sudlow, then owner of the estate, had removed the sundial from its pedestal and taken it with her to Somerset. Unfortunately, nothing more is known of this sundial after its departure from Riccarton<sup>4</sup> and it is presumed lost.

The estate was sold to Midlothian County Council who subsequently gifted it to Heriot Watt University in 1969. The estate now forms the Edinburgh Campus of the University and the sundial pedestal (Fig. 2) is still in place and is a prominent feature within the sunken garden.



Fig. 3. The Currie sundial.

Fortunately we do know the whereabouts of Palmer's second sundial (Fig. 3) which is still in the churchyard of the parish church of Currie, as it was in Ross's day. It has an extremely detailed circular metal dial plate (Fig. 4) on a moulded stone shaft sitting on a circular plinth. It includes Roman numerals from 4am to 8pm with a one minute scale and has noon markings for around fifty places all over the world including Trafalgar, Waterloo, Quebec, Mecca, Mauritius and London.

Waterloo was an interesting inclusion, but perhaps not surprising given that Palmer was a schoolmaster. There is no doubt that the Battle of Waterloo, which took place eight miles from Brussels in 1815, would have formed part of the curriculum of the school some twenty years later. It was a



Fig. 4. Detail of the Currie dial plate, with missing gnomon tail.

very famous victory for the British where the Duke of Wellington's army, well supported by the Prussians, finally defeated Napoleon's French army.

In a similar vein, in 1805 Trafalgar was the scene of Admiral Lord Nelson's great victory over the combined fleets of the French and Spanish navies. Perhaps too, Quebec was included for a similar historical reason, as the important British victory against the French in the Battle of Quebec in 1759 paved the way for the eventual creation of Canada. Sixteen points of the compass are marked around the outer rim of the dial and part of the gnomon remains in place. It has equation of time details and has many inscriptions including "this dial calculated drawn and engraved by Robert Palmer schoolmaster inscribed 1836".

Unfortunately the dial face is now rather weathered and some parts are difficult to read. Palmer gifted the sundial to the parishioners of Currie.

But these two sundials were not the only ones made by Robert Palmer. He made another one, recorded by neither Ross nor Gatty.

Palmer had made an earlier sundial in 1826 in Kirkcudbrightshire (now Dumfries and Galloway) near to his birthplace, before he took up his new teaching position in Currie. This sundial is situated just outside the churchyard at Kirkbean, a few miles south of Dumfries, and the birthplace of American naval commander John Paul Jones, the so-called father of the American navy. For anyone interested in American history, Kirkbean and its small museum is well worth visiting for this reason alone. Palmer was the schoolmaster in nearby Southwick and his sundial was possibly a wedding gift to Thomas Grierson, who was the minister of the church in Kirkbean at the time. Like Palmer, he too shared an interest in curling and even composed a few songs in honour of the game.

A two hundred and fifty mile round trip to Kirkbean to see the sundial was unfruitful as the sundial was missing at the time of my visit in the summer of 2012, although the fluted red ashlar pedestal was still in place (Fig. 5). Later investigations revealed that the church had been recently sold and the sundial was removed from its pedestal by one of the church elders for safe keeping.



Fig. 5. The Kirkbean pedestal.

This earlier sundial, like the Currie dial, has equation of time details and indicates the time of noon at various locations around the world including Canton, Siam, Calcutta, Madras, Bombay, Isle of France, Ispahan, Bagdad, Jerusalem, St Petersburg, Athens, C. G. Hope, Rome, London, Gibraltar, Cork, St Mary's, C. St Roque, Rio Janeiro, Cayenne, Barbadoes (sic), Quebec, Jamaica, N. Orleans, Acapulco and California.

It includes zodiac symbols and is also inscribed "*anno domini 1826*" with the motto "*Cito labitur Helas*" and "*Robert Palmer fecit*" as well as "*TG*" possibly for Thomas Grierson for whom it was believed to have been made.

The dial also includes the words of Psalm XIX V.4-5 as follows:

*"Their line is gone through all the earth,  
Their words to the world's end.  
In them He set the sun a tent;  
Who, bride-groom like, forth goes,*

*From's chamber, as a strongman doth  
To run his race rejoice."*

It is the reference to bride-groom within the psalm, the date of 1826 and the initials of T.G. which give rise to the possibility that this dial was a wedding gift to Thomas Grierson, who married in 1827.

These are the only three sundials that Palmer is known to have made. He is buried in the churchyard at Currie not twenty yards from his last sundial. He was obviously a highly respected member of the community and Palmer Road and Palmer Place in Currie reflect this, both having been named in his honour.

He appears to have been a remarkable man.

### ACKNOWLEDGEMENTS

Many thanks to Robert Whitton of the Currie and District Local History Society and Graham Dane of the Currie Community Council who very kindly provided background details of Robert Palmer and of the Riccarton estate. Many thanks also to Kaye Gilbert of the Kirkbean Parish Heritage Society who provided details of the Kirkbean sundial.

### REFERENCES & NOTES

1. A Grand Match, or Bonspiel, takes place outdoors and only if the ice is thick enough, normally 7 inches, as there can be several thousand players and spectators on the ice. There have been only three matches since 1935 and none since 1979 although one "nearly" took place in the winter of 2010/2011. See this website article on the subject: <http://royalcaledoniancurlingclub.org/curling-history/grand-match/>. Lees' painting is said to be worth in the region of £500,000 and is owned by the Royal Caledonian Curling Club. A campaign to raise the £45,000 needed for the restoration of the painting is currently underway. Palmer can be seen at the left hand side of the painting with outstretched arms facing the centre. <http://royalcaledoniancurlingclub.org/charles-lees-painting-restoration-appeal/>.
2. Mrs Gatty: *The Book of Sun-Dials*, George Bell and Sons, London (1890).
3. D. MacGibbon and T. Ross: *The Castellated and Domestic Architecture of Scotland*, David Douglas, Edinburgh (1892).
4. 'Lost in Somerset' *BSS Recorder*, Cheltenham Edition (2012).

For a portrait and CV of the author, see *Bulletin* 23(iv). He can be contacted at [dennis.cowan@btinternet.com](mailto:dennis.cowan@btinternet.com).

## READER'S LETTER

### 'Accurate' Time

Martin Hogbin complains that a normal garden sundial is not "accurate" (*BSS Bulletin* 25(ii), p.18). In fact such a dial, if correctly designed and executed, can display Solar Time to an accuracy of one minute or better.

He has devised a very elegant way of making a sundial which he says will "actually tell you the time!" By "THE time" he evidently means the version of time displayed on his radio-controlled watch.

An alternative approach would be simply to trust the watch, and to allow the sundial to tell its own, different, but equally accurate time.

*Fiona Vincent  
St Andrews, Fife*



# THE FAVERSHAM GUILDHALL NOON-MARK

CHRISTOPHER DANIEL

I am not exactly sure how I came to submit a paper to the Faversham Town Council on the possibility of having a sundial on the wall of the Guildhall. However, from time to time, I had received encouragement from the Director of the Faversham Museum, Dr Arthur Percival, and also from a number of local citizens, to provide a public sundial for the town. Whilst I had already completed a sundial commission in Faversham, some months earlier, this had been a private work, not normally visible to the public.<sup>1</sup>

Basically, the paper which I addressed to the Town Council was entirely speculative, pointing out that, historically, sundials would have been placed on those public buildings which had been furnished with a clock, namely the parish church and the Guildhall.<sup>2</sup> Early clocks, which often went wrong, required regulating and sundials were often placed in the vicinity of the clock for this purpose. In Faversham, the Guildhall is an historic building dating back to 1574, where the main southerly façade, overlooking the market square, declines twenty-five degrees to the west. A turret above this, on the west side, supports the town clock. I suggested that this wall would be a suitable site for a declining mural sundial, specifically a painted noon-mark, which would not damage the lath-and-plaster fabric of the building (see Fig. 1).

In due course, I was advised by the Town Clerk that I would need to obtain Listed Building Planning Consent and to this purpose I managed to obtain the support of John Sell, the Faversham Guildhall Architect, who kindly

directed me to the Planning Services department of Swale Borough Council. They sent me the necessary paperwork and John Sell helped me to complete the various forms. However, in addition to these, I was obliged to submit a *Heritage Statement* to the Council, providing details of my proposed Guildhall noon-mark<sup>3</sup> and also a *Design & Access Statement*<sup>4</sup> which explained the practical construction of the instrument. All this took time; but, as it happened, I was also invited to attend the initial part of the forthcoming meeting of the Town Council, on the evening of Monday, 2 July 2012, when the Council would consider my proposal. I would be expected to address the Council in support of this proposition and to answer any questions, although I was excluded from the meeting itself.

Whilst the Mayor and the Town Councillors were friendly and had shown what seemed to me to be a genuine interest in my proposed noon-mark, it did not occur to me that the scheme might actually be accepted. I fully expected a negative response, on the grounds that it would not be in keeping with the nature of the building and that it would clutter up the façade of this particular aspect of the Guildhall. However, the following day, much to my surprise, the Town Clerk informed me that the Members of the Town Council had unanimously agreed to grant permission for me to provide a painted noon-mark sundial on the Guildhall, on the face opposite the NatWest Bank. Two days later, I received her official letter to this effect, with the proviso that “This will of course be subject to you obtaining the appropriate Listed Building Consent and approval of the Conservation Officer of Swale Borough Council for the work to be completed.”<sup>5</sup>

Unbeknown to me, my proposal had also been passed to the planning committee of the Faversham Society and had evidently met with their approval as well. However, my concern was now the question of obtaining Listed Building (Planning) Consent – a problem which I had never before experienced in my 44 years of sundial design work! Whilst I was convinced that this would be the stage when my proposal would be rejected, I duly submitted the eleven-page document to the Planning Services Department of Swale Borough Council.<sup>6</sup> They kindly sent me an acknowledgement, which I received near the end of July, in which I was advised that “If by 4 September 2012 you have not received notification that your application is invalid,...you may appeal to the Secretary of State for Communities and Local Government...” etc.<sup>7</sup>



Fig. 1. Montage of the tentative design for the noon mark on a photograph of the Guildhall.

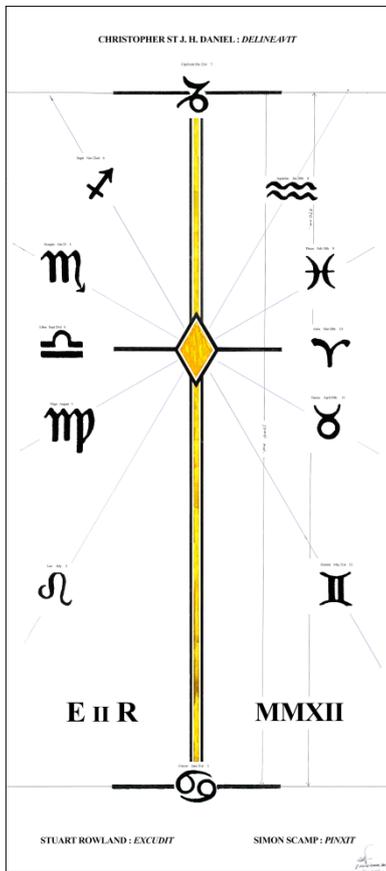


Fig. 2(left). The final design for the noon mark.

Fig. 3 (right) The much-reproduced picture of three French gentlemen observing the time of noon from the book of Bedos de Celles.<sup>11</sup>



Although I consider myself to be something of an optimist, it was almost with a sense of disbelief that, on 5 September 2012, I opened the letter from the Head of Planning at Swale Borough Council giving me *Notification of Grant of Listed Building Consent*, i.e. Grade 1 Listed Building Planning Consent.<sup>8</sup> It took me a little while to come to terms with this surprising situation; but I came to realise that I now had work to do, to produce an accurate delineation of my proposed noon-mark, which, up until this point, had only been a sketch, imposed as a montage on a photograph of the Guildhall. As it happened, at this same time, I was engaged in organising the installation of the *Meridies Media* Mean Time Noon-Mark, on the south wall of the Meridian Building, in the Royal Observatory at Greenwich.<sup>9</sup> Thus, it was not until early November that I completed my full-scale design (Fig. 2) for the proposed Faversham Guildhall Noon-Mark.<sup>10</sup>

In order to put this ‘commission’ in hand, there was much to do. Sponsorship was essential to fund the project, a sign-writer was needed to paint the dial, whilst a blacksmith was required to construct and fit the gnomon in position. It seemed sensible to employ local craftsmen to carry out this work and two were recommended to me, namely Simon Scamp, a Faversham sign-writer, and Stuart Rowland, a Canterbury blacksmith. Jonathan Neame, Chief Executive of Shepherd Neame, the well known local brewery founded in 1698, was the first to provide sponsorship for the enterprise.

The design itself is exceptionally simple, other than some ornamental features, being based on the same principle as

the noon-mark illustrated on the frontispiece of the famous 18<sup>th</sup>-century French gnomonical work by Bedos de Celles (see Fig. 3).<sup>11</sup> The dial-plate of the noon-mark is delineated with a thick vertical gilded meridian line, highlighted in black, on a white background. It features a black transverse ‘T’-bar at the top and the bottom, which mark the winter and summer solstices respectively. The uppermost of these is furnished with the zodiacal symbol for the sign of Capricorn, denoting the winter solstice, whilst the lowest transversal features the symbol for the sign of Cancer, indicating the summer solstice. The remaining symbols, representing the signs of the zodiac, are merely ornamental and serve no specific purpose.

About a third of the way down the meridian line, there is a gilded diamond shape, which also supports a ‘broken’ transversal, marking the equinoxes. The diamond is symbolic of Her Majesty the Queen’s Diamond Jubilee Year. Above and to the right of the dial-plate, there is a gilded metal sun image (Fig. 4), supported by a gnomon in the form of two metal rods attached to the nearby wooden window frame. The ornamental sun image features a small



Fig. 4. The gilded sun

circular aperture at its centre, *i.e.* a *nodus*, through which, in fine weather, near the time of mid-day, the sun's rays may be projected as a spot of light onto the dial-plate. To read the dial, one observes the spot of light as it moves across the face of the noon-mark dial-plate. When it is on the central gilded meridian line, this will mark the instant of Noon (Local Apparent Time). In bygone days, this would have been the mid-day hour of 12 o'clock 'Faversham Time', when the Guildhall clock would have been adjusted to read the same time. Likewise, other clocks and watches in the town would have been regulated in the same manner.

Since Faversham is to the east of the Standard Meridian at Greenwich, at longitude 00° 53' 32" E, the Guildhall noon-mark will be 3m 34s fast on a sundial at Greenwich. Thus, when the sun is on the Greenwich Meridian, a sundial in Faversham would indicate the time to be 12:03:34, if the equation of time is not taken into account. Since it is not uncommon for members of the public to consult their watches when they view a sundial, I produced a small leaflet in which I provided a table of the Guildhall clock times, given to the nearest minute, when the sun would be on the Faversham meridian. These were listed for twelve days in the year, one value for each month/sign of the zodiac, adjusted to take the equation of time into account, as well

as the difference between Faversham and Greenwich. They also allowed for the clock's change to British Summer Time. Accordingly, with a little mental interpolation, the observer may gauge the Guildhall clock time for local noon for the day in question.

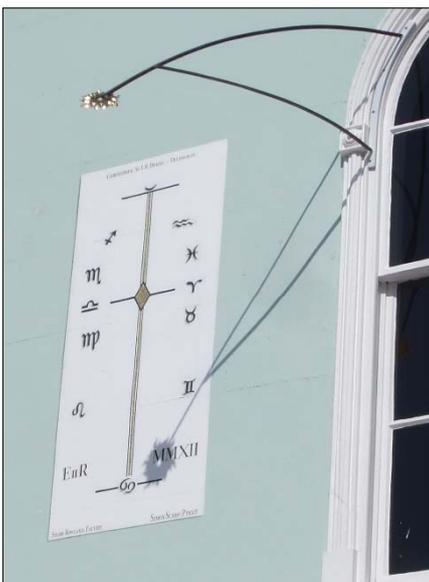
Construction of the noon-mark was hampered not only by the most inclement weather; but also by the fact that the required scaffolding could only be put up on non-market days, *i.e.* Mondays, Wednesdays, Thursdays or Sundays. Nevertheless, the painting of the noon-mark dial-plate was accomplished in the course of three days in March, followed by the initial fixing of the gnomon on the 14<sup>th</sup> of the month. During this time, I had considered arranging a suitable date for the inauguration ceremony by Councillor David Simmons, the Mayor of Faversham, who had chaired the Town Council meeting the previous summer, when the Council had given their unanimous approval for the noon-mark.

Somehow, this information had become known to two local artists, who insisted that I should have an exhibition of my work in the local Creek Creative gallery. I finally succumbed, when they agreed to do all the work in putting up the exhibition, if I supplied the material. Thus, to coincide with the exhibition, the inaugural ceremony was fixed for mid-day on Wednesday, 3 April 2013, when the Guildhall clock should have read 13:03 BST. As it happened, the Mayor nobly addressed the assembly of local councillors, guests and visitors in the market square and they duly clapped in response; but, on this occasion, it was mainly overcast and the leaden sky hid the sun. Nevertheless, it was a happy event and the citizens of Faversham appear to be very pleased with their 'sundial' noon-mark, which celebrates Her Majesty the Queen's Diamond Jubilee!

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*chrisdaniel180@btinternet.com*



*Fig. 5. The finished noon mark in operation, photographed near noon just after installation but before the final adjustments to the nodus position.*



## STORMONTFIELD

# Queen Victoria's Diamond Jubilee Commemorative Sundial

DENNIS COWAN

Stormontfield is a tiny hamlet situated off the A93 a few miles north of Perth on the opposite side of the River Tay. Known as St David's Chapel, the small plain church in Stormontfield was built in 1897, the year of Queen Victoria's diamond jubilee. The architect was Marshall Mackenzie of Aberdeen who also designed Crathie Church, where the Royal Family worship when residing in their northern retreat at Balmoral Castle. He was also responsible for the Waldorf Hotel and Australia House in London amongst many other commissions.

Mounted at the right hand side of the entrance to the church is the most exquisite sundial (Fig. 1). Cast from lead and



Fig. 1. St David's Chapel, Stormontfield.

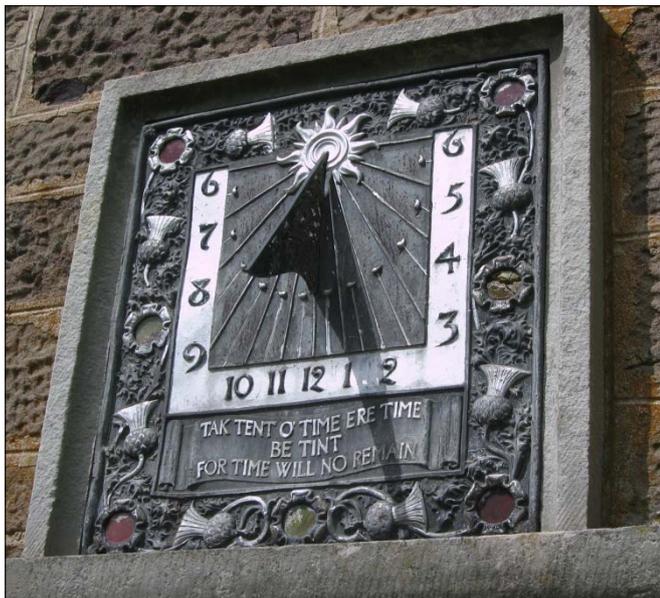


Fig. 2. The Stormontfield dial.



Fig. 3. The gnomon profile.

decorated with thistles and gilding, it has coloured polished pebbles looking like large jewels in the centre of flower heads (Fig. 2). When new and when the sun was shining, it must have been a wonderful sight. The motto on the sundial is "Tak tent o' time ere time be tint for time will no remain", a fairly popular Scottish sundial motto.

When viewed from the church steps, the beautiful pierced gnomon can be seen to its fullest advantage, and it is from here that the reason for the sundial is apparent (Fig. 3) – the commemoration of Queen Victoria's diamond jubilee in 1897. The gnomon incorporates a Scottish lion rampant surrounded by a thistle with a circular stem, with another two thistles above and below. Underneath are the royal monogram VR and the dates 1837 and 1897.

The sundial was gifted to the church by R.W.R. Mackenzie (no relation to the architect) and it is one of my favourite sundials.

The sundial was stolen in 1985 but thankfully was recovered in Perth a few days later.

### Eighth Most Expensive Book in May

According to the Abe Books website, a copy of *Ars magna Lucis et Umbrae in Decem Libros Digesta* by Athanasius Kircher recently made £4,712. Published in 1646, this is the first edition of Kircher's work on light, shadow and optical phenomena. It was one of the first books to reference concepts like the camera obscura and magic lantern.

# BSS PHOTOGRAPHIC COMPETITION 2012–13

IAN BUTSON

Following the now established two year break, the Society again ran its Photographic Competition in 2012 with a closing date at the end of February 2013 for submissions from its Members.

At the entry closing date a pleasing total of 29 had been received from 15 separate members, once again equalling the second highest number of entries in the history of the competition. As time for marking would be short before the conference at the beginning of April, and also in an effort to streamline the process, it was decided that the judging panel would be reduced from six persons, as in previous years, to four persons only. The opportunity was also taken to modify the marking categories to take into account that most cameras are now fully capable of automatically adjusting for focus, exposure and lighting conditions, with these three aspects now being collectively grouped together and marked for 'Technical Quality', and also to reduce the total number of marking categories from those in the previous competitions to simplify the marking process further.

Each entry was marked with a differing number of points available for each category, as follows, with a maximum of 100 points being available for each photo:

- Choice of Dial – 20 Points
- Artistic Impression – 20 Points
- Technical Quality – 15 Points
- Title – 10 Points
- Presentation – 20 Points
- Overall Impression – 15 Points

A number of the qualities upon which each of the photographs is marked are of course subjective, as well as some judges tending to mark somewhat higher than others. To

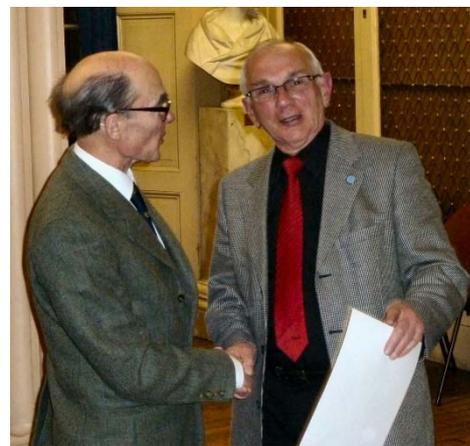
ensure that this can have no resulting effect upon the order of the winning entry, all the results are normalised to allocate a notional thousand marking points to each judge, these then being distributed amongst all entries in proportion to each judge's original markings.

As in previous years, judges were allowed to submit their own entries if they wished, but of course not allowed to mark their own photographs. Instead, marks were awarded to them based on an average of the other judges' marks given for their entry and with the normalisation check factor applied, this further ensured that there would not be any bias from the marking method used.

This year a very close result occurred with only 3 points separating the top five places, with 'decimal points' being required to decide the final positions. Elzbieta Niedbalka's winning entry *Sunny bird feeder* was marked just half a point higher than Mike Shaw's entry *Frozen in Time*.

Not to be completely outdone from his sweeping successes of 2011, Mike Cowham came in at third place with his *Pestle and Mortar Scaphe Dial, Hitchin*. The next seven photographs which make up the Top Ten all scored highly with just a few marks separating them.

Although not obliged to, the judges are encouraged to give their comments about the entries. Their views are never constrained with both praise and constructive criticism being freely given. Their comments about Elzbieta's winning entry included: "A good record shot of an interesting dial", "the bird-seed and the long gnomon shadow lift it to be of interest to a non-sundialler", "Needs a bird!" and "Good shot but a full view of the dial plate would have been better".



Left, Elzbieta Niedbalka with her prize. Jackie Jones (centre picture) and Mike Shaw (right) receive their certificates from Chairman Frank King at the Edinburgh Conference Dinner.

**First place**  
*Sunny bird feeder*  
Elzbieta Niedbalka



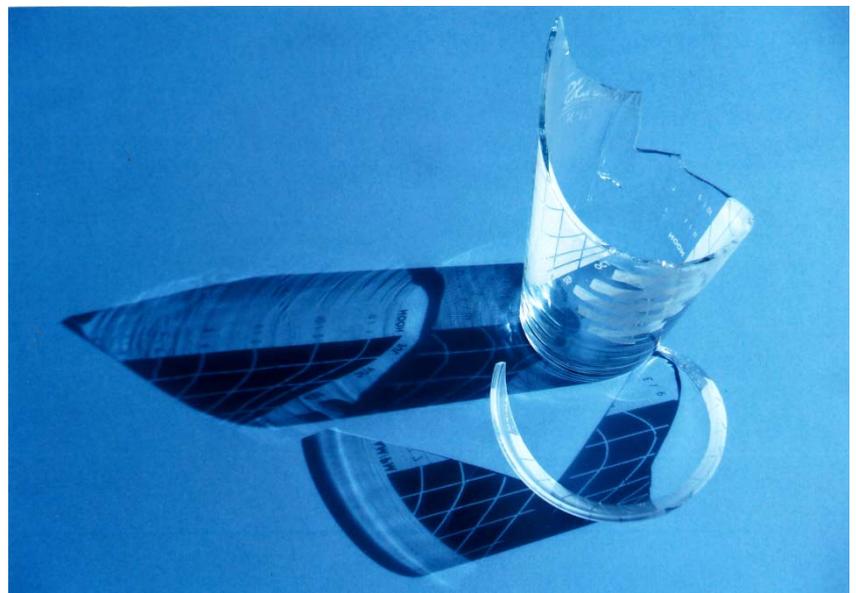
**Second Place**  
*Frozen in time*  
Mike Shaw





Third place  
*Pestle and mortar scaphe dial,*  
*Hitchin*  
 Mike Cowham

Top Ten and Best Newcomer  
*Shattered time*  
 Jackie Jones



Many congratulations to Elzbieta Niedbalka, a new and well-deserved entrant to the Society's competition. Although not attending the conference in Edinburgh, the winning trophy, a replica Universal Ring Sundial, together with a certificate, was presented by our chairman, Frank King. These were subsequently forwarded to Elzbieta in Poland following the conference. Certificates were also presented to the two runners-up.

The next seven photographs that, together with the three winning ones, made up the Top Ten entrants were also identified in the order as selected by the judges as:

- Shattered Time* Jackie Jones
- Dad, this is so cool – can I take it home?* Darek Oczki
- Plaza de América* Doug Bateman
- Dials on a Tower by the Beach at Strandfontein, S.A.*  
Mike Cowham
- Two types of people know how to use shadow* Darek Oczki
- William Pitt's Dial* John Foad
- A School Project* Doug Bateman

Following the 2010–11 competition, it was decided that a certificate would also be awarded to the next highest placed entrant who had not previously been a winner in any of the earlier photographic competitions. This certificate was duly awarded to Jackie Jones for her entry *Shattered Time*. Congratulations and thanks also go to the other entrants in the competition for their contributions that made for an interesting, varied and challenging competition, especially for those judging the entries.

If after reading this and seeing some of the entries here or at the conference you feel that you could match or improve the standards set, then be sure to have your camera with you, ready to seize that winning shot for the next competition. The organiser and judges will be looking forward to receiving and marking that 'winning entry'.

#### The Conference Vote

As in the 2010–11 Photo Competition, delegates at the Edinburgh Conference were once again given the opportunity

**Top Ten**  
*Dad, this is so cool—can I take it home?*  
 Darek Ocзки



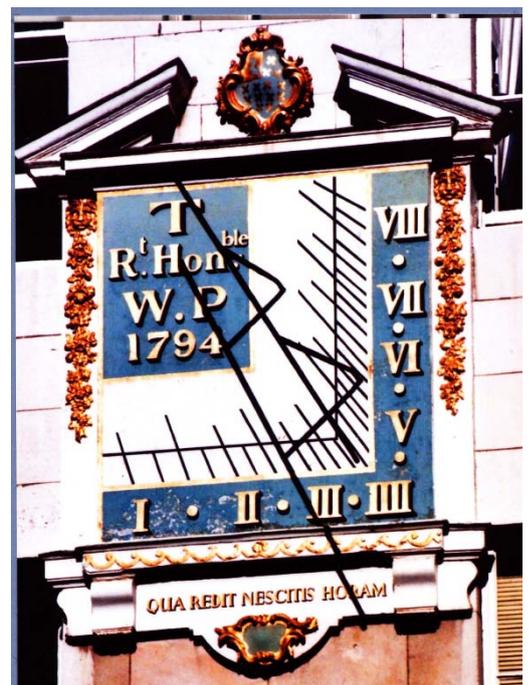
**Top Ten**  
*Dials on a tower by the beach at Strandfontein, S.A.*  
 Mike Cowham



**Top Ten**  
*Plaza de América*  
 Doug Bateman



**Top Ten**  
*Two types of people know how to use shadow*  
 Darek Ocзки



**Top Ten**  
*William Pitt's dial*  
 John Foad

to consider the photographs (before the official judging results were announced) and, by means of a simple vote, to indicate their favoured choice for first, second or third places in the competition. Three points were allocated for the first choice, two points for the second and one point for the third choice of those voting. Ballot papers had previously been prepared and included in the delegate's conference pack, a ballot box provided and all those attending the conference were encouraged to make their choices and enter their votes. Thirty-two voting forms were submitted with votes being cast for 20 of the 29 photos on display, with the following results:

First (36 pts) *Frozen in Time* (Mike Shaw)  
 Second (20 pts) *Plaza de América, Seville* (Doug Bateman)  
 Third (19 pts) *Dad, this is so cool – can I take it home with me?* (Darek Oczki)

The scores given to the other 17 photos ranged from 16 points down to 2 points.

Although only very narrowly failing to achieve first place in the main section of the Photographic Competition, Mike

Shaw's entry, *Frozen in Time* received the highest number of points in this Conference Vote section. Doug Bateman's *Plaza de América, Seville* was in second place with 20 points (6<sup>th</sup> in the main competition) and Darek Oczki's entry, *Dad, this is so cool – can I take it home with me?* was third place, (5<sup>th</sup> in the main competition). Surprisingly, the winning entry in the main section of the competition, Elzbieta Niedbalka's, *Sunny Bird Feeder* was placed in 4<sup>th</sup> position, scoring 16 points.

Although not in full agreement with the results as determined by the judges in the official competition, these results nevertheless indicate just how closely they were also viewed and judged by the conference delegates.

After the results had been announced, the chairman presented Mike Shaw with the winner's prize of a mini replica nocturnal dial and certificate, to celebrate his success.

Congratulations to all those who achieved winning results in this separate part of the competition, and thanks also to those who took part in the voting.

## The Tangram Diallists

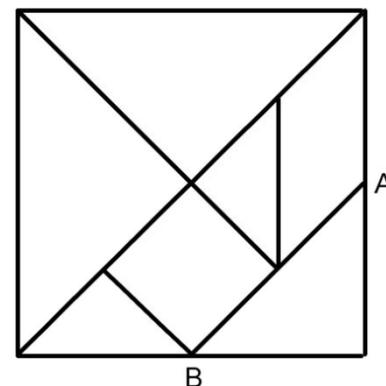
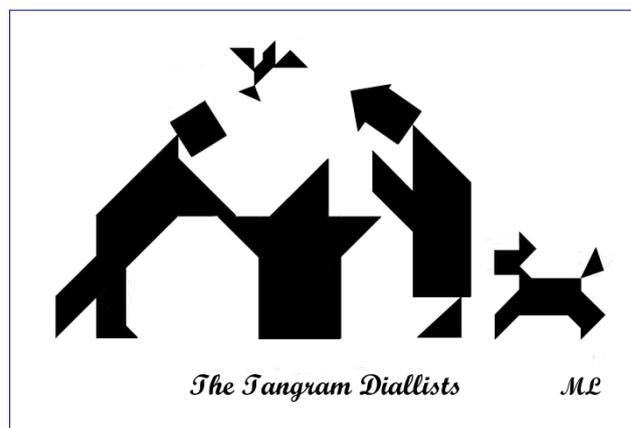
Michael Lowne

'Tangrams' is a nineteenth century name for an ancient Chinese puzzle game, probably originating in the Song Dynasty (960-1279). European and American traders brought it to the West in the early nineteenth century. The game soon became very popular, with recurrent phases of interest to this day.

A set of tangrams is made by the dissection of a square as shown in the diagram, with A and B the mid-points of two sides. The cuts produce two large, one mid-sized and two small right-angled isosceles triangles, a square and a parallelogram. The challenge is to arrange these into figures or patterns in silhouette, using all seven pieces with no overlaps. The possibilities are almost endless: putting 'tangrams' into Google Images will bring up many pages of designs.

My first acquaintance with tangrams was in a book 'Amusements in Mathematics' by H E Dudeney, published in 1917. It is available for download in the online book catalogue 'Project Gutenberg'<sup>1</sup>.

In the picture the main items are formed from three same-sized tangram sets whilst the dog and bird are each from smaller sets. Clearly the individual on the left is studying the dial intently, while on the right the person is comparing the dial time with a wrist-watch. The dog is hoping that his master will soon leave the dial alone and continue their interrupted walk!



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### Reference

1. [www.gutenberg.org/catalog](http://www.gutenberg.org/catalog). Click on 'A' in the titles, scroll down about half-way to locate the book. Download it as HTML, scroll down and click on the section 'Various dissection problems'. Number 169 deals with tangrams.

# BRISTOL THREE-PIECE DIAL

TONY WOOD

This unusual dial has three separate elements; in today's dials, they would all be combined on a single dial plate. It comprises:

- A coat of arms – of the City of Bristol,
- A dial plate with gnomon and chapter ring,
- A topographical representation of the Earth with various locations and a central volvelle, possibly for time differences overseas.

John Edgeler, a local antique dealer and sundial collector, invited me to look at his dials with a view to checking out the names which appeared on four of them. Three were duly confirmed in Jill Wilson's *Biographical Index*<sup>1</sup> and one, a 'Pearson Page' equatorial with "Butler Londini" was now familiar as a respectable dial with spurious date and maker.

Outside, John had a horizontal dial and a piece of wood with three 'shields' nailed to it (Fig. 1). Of immediate interest is the central shield featuring a vertical dial with a hinged gnomon (Fig. 2), unprecedented to my experience.



Fig. 1. The three metal shields on the carved wooden board.

The shields are made from thin copper sheet and nailed to the wood. The engraving is in thin lines made with a scribe and was not that easy to read. However, we can make out the date 1675 and the motto "Now or never" recorded by Gatty on two 17<sup>th</sup>-century dials. The dial is elliptical and roughly cut from sheet copper although the delineation is done quite well given the limitations of using one or two scribes only.

The upper shield carries the coat of arms of the City of Bristol and has the name "R Smurthwaite Bristol" engraved on it (Fig. 3).

The lower shield (Fig. 4) carries a circle (the Earth?) with various location names, including "Egypte", "Chyna" and "Peeeful Ocean". There is a small disc in the centre (Fig. 5) with numerals I to XII arranged clockwise at the rim.

The shields are positioned using iron nails with a consequent small amount of corrosion.

Altogether, a most intriguing artefact – is it a fake? John Edgeler himself was inclined to think so and Andy King of 'M Shed' (formerly Bristol Industrial Museum) also thought so at first sight. However, while it is delineated carefully, the copper outline is cut fairly roughly, the whole giving the impression of being made by an amateur diallist.

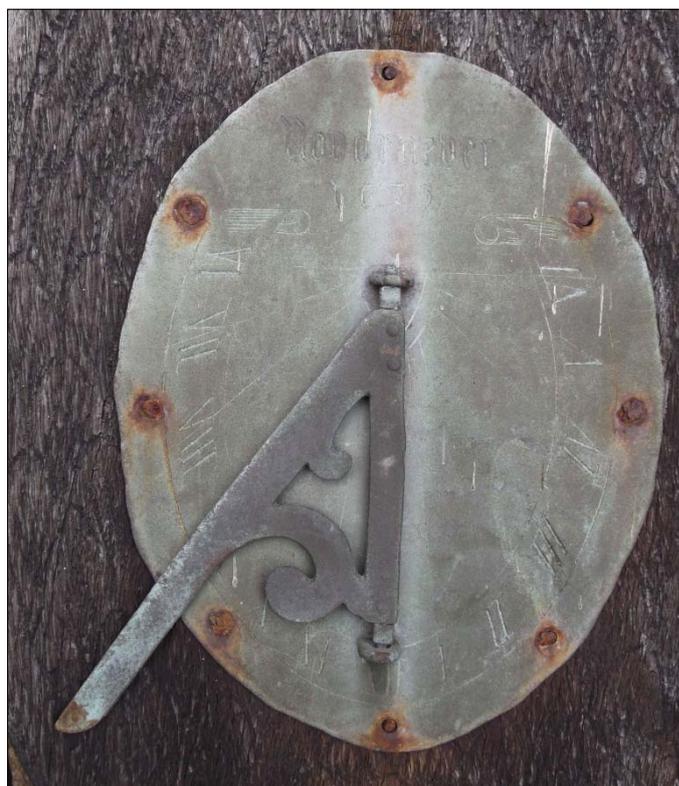


Fig. 2. The central, sundial shield with the folded gnomon.



Fig. 3. The lower shield with place names.

Fig. 4. Close-up of the place-names and the central volvelle.



The implied latitude from the gnomon is  $\sim 55^\circ$ . From the hour line angles, the derived latitudes were scattered but in the low  $50^\circ$ s, consistent with Bristol's latitude of  $51^\circ$ .

Given the Bristol connection and the use of copper sheet a connection with ships seemed possible. The National Maritime Museum at Greenwich advise 'mid 17<sup>th</sup> century' for the first use of copper sheeting on ships but it wasn't adopted immediately after its first use by Dutch shipbuilders and it seems likely that the material was available for house-building purposes anyway. However, a nautical connection still seems likely as the delineation by a trigonometric method would require books readily available on board ship.



Fig. 5. The upper shield with the Bristol City arms.

The folding gnomon is a mystery: it is now very loose and the bearings worn. It may be for transport purposes or possibly an attempt to allow for setting up as a declining dial – which wouldn't have worked too well. The thickness of the gnomon is allowed for as there are distinct origins for the hour lines separate on either side.

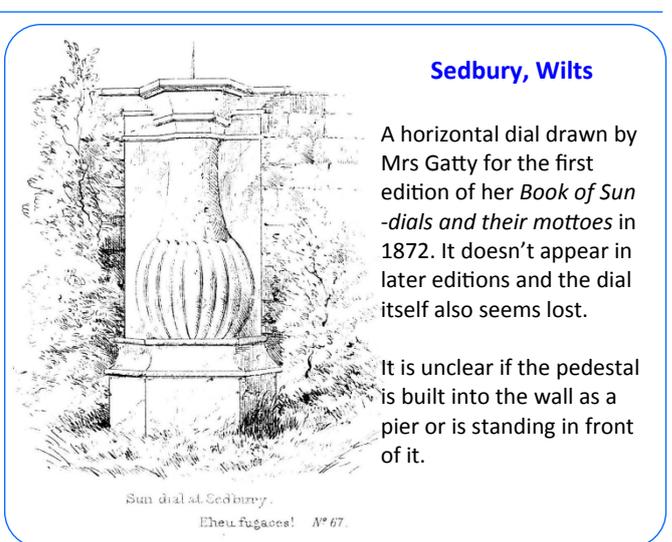
In my original draft penned for this article I concluded that the dial was possibly genuine. The long arm of coincidence has now, in the same month, brought to light a dial which must be related in some way. It appeared on eBay and is treated fully in an accompanying article by Jill Wilson.<sup>2</sup> The points of similarity are the hinged gnomon and the 'earth topograph' with the same names used.

My revised thinking is that the Bristol dial could be a crude copy of the Pearson Page dial described in Ref. 2. Although the metalwork is crude the actual delineation is finely and carefully made; perhaps R Smurthwaite started with the gnomon from a Pearson Page dial and copied or made up the rest on copper sheet instead of brass.

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2. J. Wilson: 'Identity Theft', *BSS Bull.*, 25(iii), 27–28 (Sept 2013).

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## Sedbury, Wilts

A horizontal dial drawn by Mrs Gatty for the first edition of her *Book of Sun-dials and their mottoes* in 1872. It doesn't appear in later editions and the dial itself also seems lost.

It is unclear if the pedestal is built into the wall as a pier or is standing in front of it.

# IDENTITY THEFT

JILL WILSON

There were many instrument makers working in London in the seventeenth century and some of them made sundials of various sorts as well as other types of instrument. Some however did not, or at least up to the present no dials have been credited to them. Amongst the latter, until fairly recently, were the two John Bleyghtons, father and son.<sup>1</sup> The father, having been apprenticed to Elias Allen, became free of the Grocers' Company in 1620 and worked in Tower Street, London from 1626 until 1654. He succeeded Elias Allen as Master of the Grocers' Company, one of the many mathematical instrument makers who has done so.<sup>2</sup>

His son, having been his apprentice and becoming free of the Grocers' Co. in 1654, may well have taken over the family business of making mathematical instruments in silver and brass, working at least until 1663. Both men used a variety of ways of spelling the family name including Blyghton, Bliton, Blaton and Bladon. This was nothing unusual for that period but today proves a bit of a nuisance when compiling an alphabetical index.

In the last two years two sundials have been reported, one signed just 'Bladon Londini', and dated 1655 (Fig. 1), and the other signed 'John Bladon, Dover', and dated 1610. These two reports have produced a great deal of interest and have caused an even greater amount of research. Why should this be? Both were swiftly described as not 'right' for the seventeenth century, and looking further at both suggests that they were actually made in the late nineteenth or early twentieth centuries when there was a great demand for 'antique' dials with interesting names and dates.



Fig. 1. An equatorial dial signed "Bladon Londini 1655".

For the one dated 1610, even before looking at the details of the actual dial, it immediately seems highly unlikely that so soon after the Reformation an English dial-maker would produce a vertical carved wooden monk apparently gripping a sundial. Permission to publish pictures of this dial has not been granted but some images can currently be seen at <http://tinyurl.com/lv84yt2>. At the foot is set a circular disc with the names of faraway places whose local time is presumably intended to be indicated in some way. The signature 'John Bladon, Dover', might, with a very considerable stretch of the imagination, just be interpreted as an early work by a youth who had yet to begin his apprenticeship. The dial, clasped against the monk's breast, does look as though it could have genuinely told the time – for somewhere in the British Isles. Curiously, the gnomon appears to be hinged to enable it to be folded; for ease of transport perhaps, for this would be unnecessary when in use.

The choice of (and the spelling) of the place-names on the lower disc immediately sounds a warning. In each, where applicable, 'i' has been replaced by 'y' – so we find Indya, Chyna, Prussia, Arabya and Persya! And was the Pacific ever really known as the 'Peeceful Oceane'? A map of the then known world dated 1742 indicates that at that time the entire western half of North America, and thus also the northern Pacific Ocean, was still unknown territory, whilst the southern part of the Pacific was then still called 'The

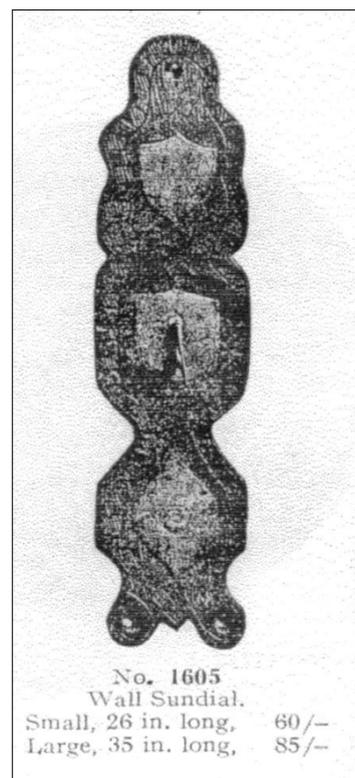


Fig. 2. An illustration of a dial with three brass plates on a wooden plaque from a Pearson-Page catalogue.



Fig. 3. Extract from a sales catalogue of Pearson-Page-Jewsbury Ltd., with the equatorial dial on the right.

Great South Sea'. The angular directions for each name might be supposed to show the number of hours difference from the time in "Britaine". But spellings using 'y' instead of 'i' and suchlike were far less common in Jacobean times than they had been some seventy or so years earlier.

All these doubts as to the true date of making can be confirmed by an examination of catalogues issued by the far more recent instrument maker, Pearson Page. They offered a fine line in 'antique dials' in catalogues as recent as the 1920s when a finely carved wooden monk holding a sundial could be bought for only '120s'. There is no indication as to the text of the inscription but it seems likely that some suitable name and date might well be included – perhaps even to suit the buyer – at extra cost of course.

The second dial (Fig. 1) engraved with the name Bladon and dated 1655 consists of a square metal plate forming the base for an equatorial dial. In addition to the signature and date on this plate, there is a motto:

'I stand amid y<sup>e</sup> Summere flowers  
To tell y<sup>e</sup> Passage of y<sup>e</sup> Houres'

This immediately proves that the earliest possible year in which this dial could have been made was 1860. It was in this year that a friend of Mrs Gatty sent her, for her collection, a rhyme of 8-lines, each pair of which was said to be

set on one of the 4 sides of a sundial. It was described as 'an ingenious practical joke' for the poem 'was invented for the occasion'.<sup>3</sup> The first two lines of this poem are those used by the time-travelling 'Bladon' in 1655!

The design of this dial, inscribed with other names, dates and mottoes is known from other examples, one at least has been shown to date from the 1930s.<sup>4</sup> The square base plate, inscribed with a fairly simple compass rose remains the same, only the attribution to a particular 'maker', date and motto, if any, varying. This must have been a relatively simple dial to make since only the equatorial dial it supported would need to be made specifically for a particular location. And of course those made in the first decades of the twentieth century need not be so meticulously designed.

The question then arises, where did the recent manufacturer of the pseudo-antique dials find the name Bladon? Is it a case of identity theft or is it just a coincidence that somewhere around the dates on these two dials there actually was a family business that was occasionally misspelt Bladon? At present there is no way of being sure. And now another vertical dial with a hinged gnomon on a long wooden base has turned up.<sup>5</sup> Could it be by the same manufacturer or by someone following a then current fashion?

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3. H.F.K. Eden & Eleanor Lloyd: *The Book of Sun-dials, originally compiled by the late Mrs Alfred Gatty*, London (1900), Motto 465, page 288.
4. Tony Wood: 'A Sundial and its Provenance', *Bull BSS*, 23(i), 15 (March 2011).
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## Postcard Potpourri 27 – St Mary and All Saints Church, Conway

Peter Ransom

There have been many postcards of this sundial over the years taken from various angles and it is interesting to see trees appear and disappear! This postcard was posted on May 19<sup>th</sup> 1910 and is the earliest one I have of the subject. The dial itself is still there: I have visited a few times over the years, though it is now very pitted and difficult to make out any details. It is signed by Mereidh (Meredith?) Hughes, Conway and dated 1765 and is recorded as SRN 3262 in the Register.

The reference to the 'We are seven' grave is that there is a railed-off gravestone nearby inscribed with 'We are seven' and it is said that this gravestone inspired Wordsworth to write his poem of the same name.

pransom@btinternet.com



# A UNIVERSAL EQUINOCTIAL DIAL BY T. W. WATSON

MIKE COWHAM

This is a short description of a rather nice precision portable equatorial dial signed on the silvered compass plate “T. W. WATSON”; his address also being given as “4 PALL MALL. LONDON”. Thomas William Watson is recorded as a microscope maker at this address. However, the 1881 Census shows him (age 52) living at 58 Baxter Road, Islington and amongst the people living with him are his son, Thomas (age 26), also a “microscope maker”, and John Stevenson (age 42), “mathematical inst. maker”. Also in the family were two daughters, Ellen (22) and Emma (19), both listed as “machinist” with a note about Ellen, “handicap: deaf & dumb”. Although signed by Thomas Watson he may not have been the actual dial maker. A very similar dial was offered for sale this year by Christies South Kensington that is signed “L Casella, London 1896”. However, it does not have the same complex calibrations on the chapter ring as are found on this Watson dial.



Fig. 2. Compass card laid out for use in both hemispheres.

As can be seen from the picture of this dial (Fig. 1), the chapter ring is laid out in both clockwise and anticlockwise directions and is labelled “←North Lat°” and “South Lat°→”, however, the scale inside the chapter ring is clockwise, suitable for the Northern Hemisphere. Similarly, its compass card is laid out with two sets of directions (Fig. 2). The compass needle is made from a polished rectangular section steel bar with a ‘-’ bar across near its North end. The dial also has a compass needle lifter (set between E and SE) to protect the delicate pivot point and jewelled bearing during transit.

This dial is one of the rare ones made to function in both hemispheres and at almost any latitude. As the hour scale stops a quarter of an hour before IIII and a quarter of an hour after VIII it will only function for the full day in the regions between about 51° North and South. However, its latitude arc is laid out from the Equator to (either) Pole.

Inside the base of the carrying case is glued a circular paper chart detailing the Equation of Time, the dates being shown for each minute of variation (Fig. 3). Note the vee-shaped lines between each month. These allow the chart to be placed inside a concave lid by cutting along one edge of each vee before pasting it in place. For this dial, such an action was not necessary.

Perhaps the most interesting item was found inside the case. It is a



Fig. 1. The equatorial dial by T. W. Watson, c. 1880, set here to 51½°.

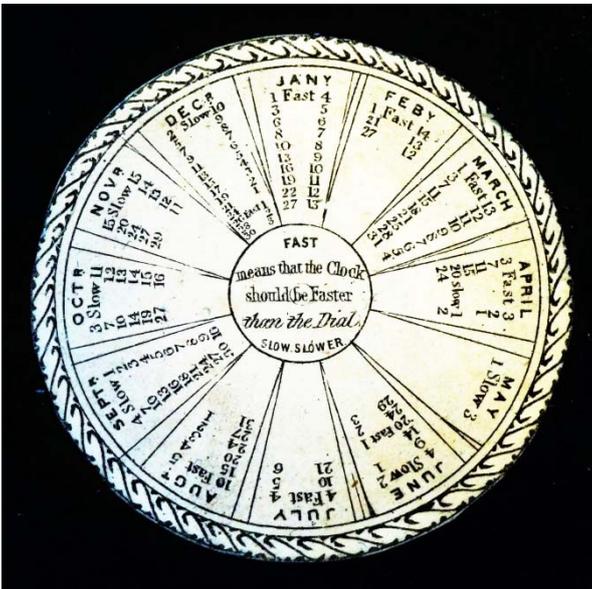


Fig 3. Chart showing the Equation of Time.

paper chart showing the “Lines of Equal Magnetic Variation” (known as Isogonic Lines or Isogonals) for the World between 70°N and about 67°S in the year 1877 (Fig. 5). The chart shows differences down to 1° in places, with thicker lines for zero variation, dashed lines for Easterly variations and solid lines for Westerly variations. Note also the three points, one in the Pacific Ocean, one in the Atlantic Ocean and another north of Australia, where lines cross. At these points the actual variation is given, 9°E, 19½°W and 1½°E respectively. It is not known if this chart was originally supplied with the dial, but this is quite probable. The chart is signed, bottom left, *Norie & Wilson, London*. This firm was established in 1755 and was still operating



Fig 4. Case with the dial inside.

until the 1850s. They are recorded as teachers in navigation.<sup>1</sup> Records of the company as late as 1877, when the chart was produced, have not yet been traced.

When used with this chart plus the EoT and by adjusting the three levelling screws, a very precise time should be obtained. Therefore, in order to set up the dial for a precision time reading it should be mounted on a solid flat surface. The dial should then be turned to the correct compass orientation allowing for the magnetic declinations given on the map. In order to level the dial, the three adjusting screws need to be set so that the two spirit levels are correct. Although this sounds a relatively simple procedure, it can take some time, as adjusting one screw often changes slightly the settings of the others. The chapter ring should then be erected to the appropriate latitude, with the gnomon

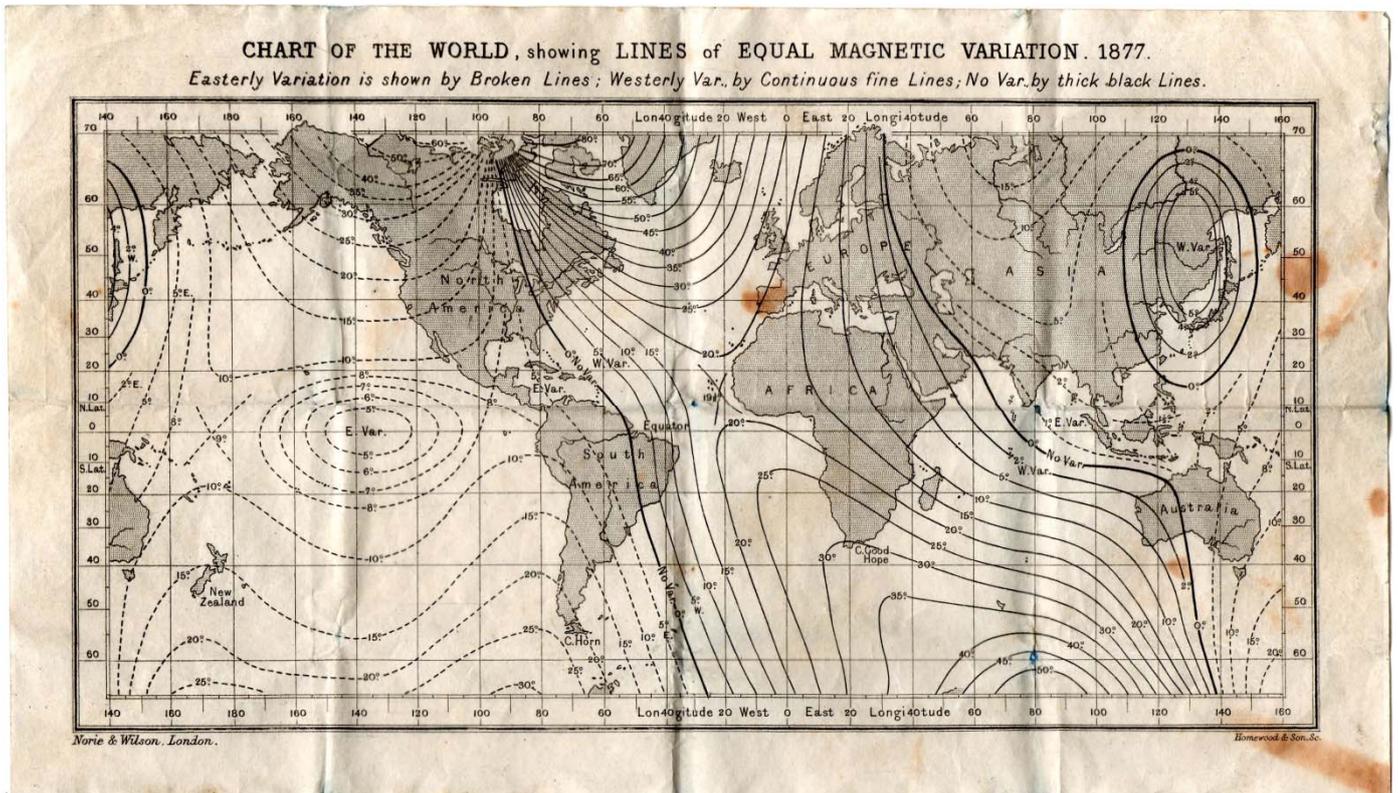


Fig 5. Magnetic declination chart by Norie & Wilson, London, for 1877.

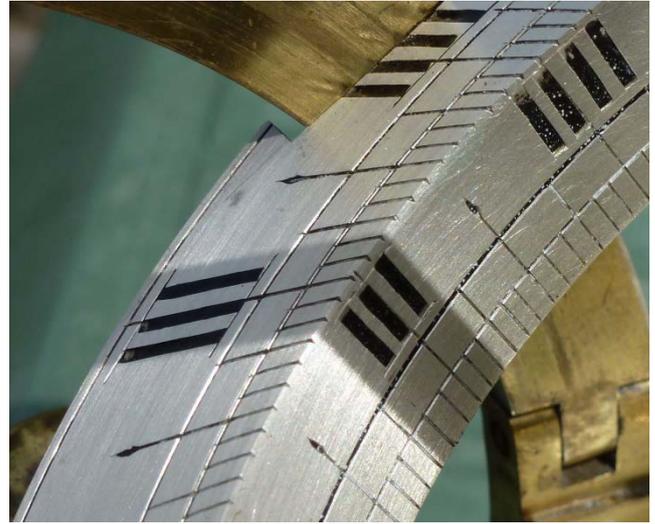


Fig 7. The gnomon shadow at 16:10 BST (15:10 GMT).

Fig 6 (left). A similar but much larger dial by Dollond.

at right angles to it. There is even a small arrow on the edge of the chapter ring to point at the precise value on the latitude scale. Finally, the Equation of Time corrections should be applied to the time provided by the dial.

After writing the above I got to wondering about what sort of accuracy could be expected from a dial of this type. To find out I was able to use a similar dial signed just "Dollond London" (Fig. 6). It is difficult to date the dial but various members of the Dollond family were active from 1752 until at least 1866.<sup>1</sup> Records from the internet also show that Dollond & Co., the opticians, were active until 1927 when they merged with Aitchison & Co. to form Dollond & Aitchison. This dial, from its style, was probably made between 1850 and 1890. It is also much larger than the small Watson dial (the Watson chapter ring is 63.5 mm in diameter and the Dollond is 113 mm) so I hoped that a better accuracy could be achieved. First, I needed to find the current magnetic declination for the location (using <http://magnetic-declination.com>) and then the exact correction for the Equation of Time.

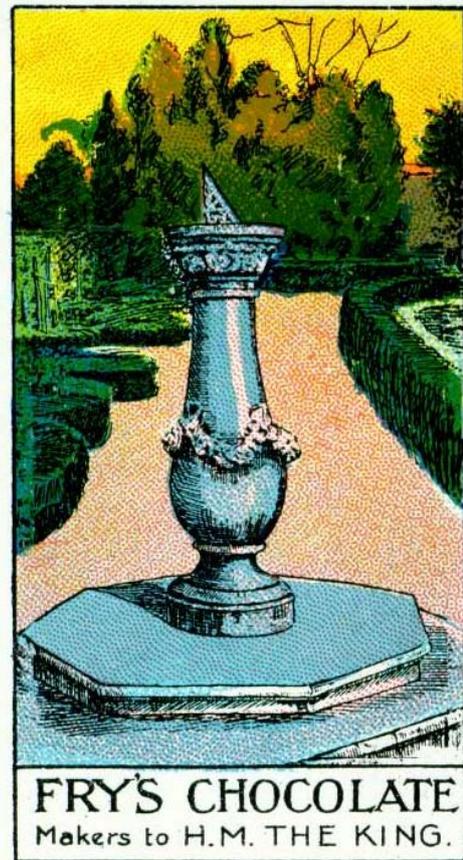
With these set I placed the dial on a window sill and carefully adjusted the three levelling screws and set the needle exactly at 1° 14' West (about five-eighths of one division away from N). The time given was about 15 minutes slow so I moved it to another window sill and this time it was around 15 minutes fast! It was then that I realised that there were probably some iron nails in each window sill. The solution therefore was to take the dial outside the building away from any magnetic material (Fig. 7).

The dial was therefore placed outside on a plastic table and was adjusted so that the two spirit level bubbles were centred. The time was then found to be within 2 minutes of the actual time. Note that as this was 13 June the EoT happened to be virtually zero.

## REFERENCE

1. Gloria Clifton: *Directory of British Scientific Instrument Makers 1550-1851*, Zwemmer (1995).

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Another in the Fry's Chocolate series of cards, this one (number 25) showing a horizontal dial at Minley Manor, Hampshire. The Grade II listed Manor and its landscaped pleasure gardens were built in the 1880s but it was taken over by the War Department in 1934 and is still under MoD control. What has happened to the dial?

# MYSTERIES OF THE ASTROLABE

## An Exposition by Rule and Compasses

PETER I. DRINKWATER

[The astrolabe has been the subject of numerous publications, including in particular the series by Tony Ashmore in the *Bulletin* issues 19(ii) to 20(iii). The standard modern text is James Morrison: *The Astrolabe* (Janus, Rehoboth Beach, 2007). Nevertheless, this article by Peter Drinkwater is included here as it is a more personal view and includes a straight-forward geometric construction method more similar to the methods which would have originally been employed than the mathematical ones typically seen in modern publications. It follows naturally from the author's recent *The Arts of Urania* in the previous issue. Ed.]

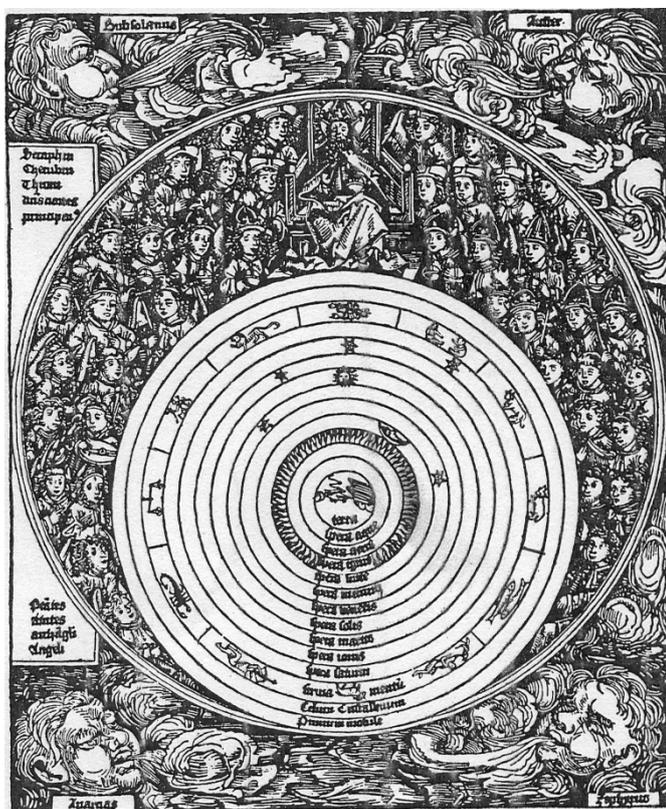


Fig. 1. *The Court of Heaven presiding over all of Creation, within the rete of an astrolabe. From the Nuremberg Chronicle, 1493. Note the Islamic form of the sign of the fishes.*

There is no mythical or historical ‘inventor’ of the astrolabe nor (so far as I am aware) any ancient treatise on either its construction or use; but odd surviving artifacts indicate that the ancient Greeks certainly had the technology to make and use it.

Later commentators (for example, Rodney Dale in his *The Book of WHO*) have fathered the astrolabe onto “Hipparchus or possibly Apollonius of Perga” (who else is there?) in around 200 BC. The ‘possibly’ indicates the spec-

ulative nature of this belief. More credible is the tradition that Hypatia of Alexandria, the famous lady philosopher and astronomer, carried out improvements to the astrolabe in c. 400 AD. Her one hostile biographer, John, Bishop of Nikio, says that she “was devoted at all times to magic, astrolabes and instruments of music”<sup>1</sup> More graciously, Synesius (later Bishop of Cyrene and author of the hymn ‘Lord Jesus think on me’) gratefully acknowledge the assistance he had received from his “revered mistress, the philosopher Hypatia” in drawing up plans for an astrolabe to be constructed in silver for a military patron.<sup>2</sup>

Islam, which, although inherent since the time of the patriarchs, via Ishmaël, did not emerge as a distinct religion until around 600 AD, took up the instrument with enthusiasm at an early date. Christian Europe was not slow to follow. It is recorded that an early Frankish ruler (I have forgotten which) once got hold of a large silver astrolabe, which he had cut up to pay his troops with: never make anything valuable out of precious metals!

The first Latin treatise on the astrolabe which I know about is that of Herman the Lame (or Hermanus Contractus, fl. 1030), a monk who composed the *Salvé Regina* (Hail Holy Queen) and at least one of the other three seasonal anthems to Our Lady.

Peter Abelard, the famous theologian and hymn-writer, and Héloïse, by turns his pupil, mistress, wife and (after his castration) soul-mate, thought so highly of the instrument that they named their son ‘Astrolabe’ in consequence.

Science remained a legitimate province of religion throughout the Middle Ages and beyond. The only secular writer on the astrolabe (that I am aware of) was the poet Geoffrey Chaucer. He wrote in English and his work is still readily accessible. Despite what one reads about it, it is *not* an ‘elementary’ treatise but fully explores the possibilities of the instrument. Chaucer’s prose is easier to follow than his verse.

Mediævals wishing to learn the ‘hour of the day’ (temporal hour: but they were losing interest in these by the time of Chaucer) had other methods, all less accurate than the astrolabe. Examples are the arithmetical shadow scale, the scratch dial, and the *instrumentum horarum*. Did they compare results? Most astrolabes actually incorporate an *instrumentum horarum*, whose readings can only conflict with those of the astrolabe proper, especially at high latitudes in summer. At low latitudes it would be handier and its errors not noticeable.

Encyclopædists, and other semi-enthusiasts have written much tosh on the astrolabe. One is told that ‘it is typically mediæval instrument, combining a crude altitude-taking device with a sophisticated computing mechanism’. Also, that it is ‘designed for use by astrologers’ but ‘is also of use to those who are not astrologers’.<sup>3</sup> But neither function of the astrolabe (which is not mediæval and makes no claim to be a computer) is either particularly crude or sophisticated, and, unless ‘astrology’ is synonymous with ‘astronomy’ (as anciently it was). ‘Astrologers’ only form one branch of its legitimate users.

### Description of the Instrument

The essential astrolabe has two faces: one having a skilfully balanced (usually, but not always) sighting bar, with scales round the edge for taking, rather accurately, the altitudes of the sun, moon and stars. Also around the edge is a complete calendar with a zodiac concentric to it, so that dates may be converted into degrees (or hours and minutes of right ascension). In the middle it will have an *instrumentum horarum* (the only geometrically dodgy part of an astrolabe) and shadow square (for converting angles into tangents (*umbra recta*) and co-tangents (*umbra versa*)) and sometimes the sine/cosine curves or a sine grid.

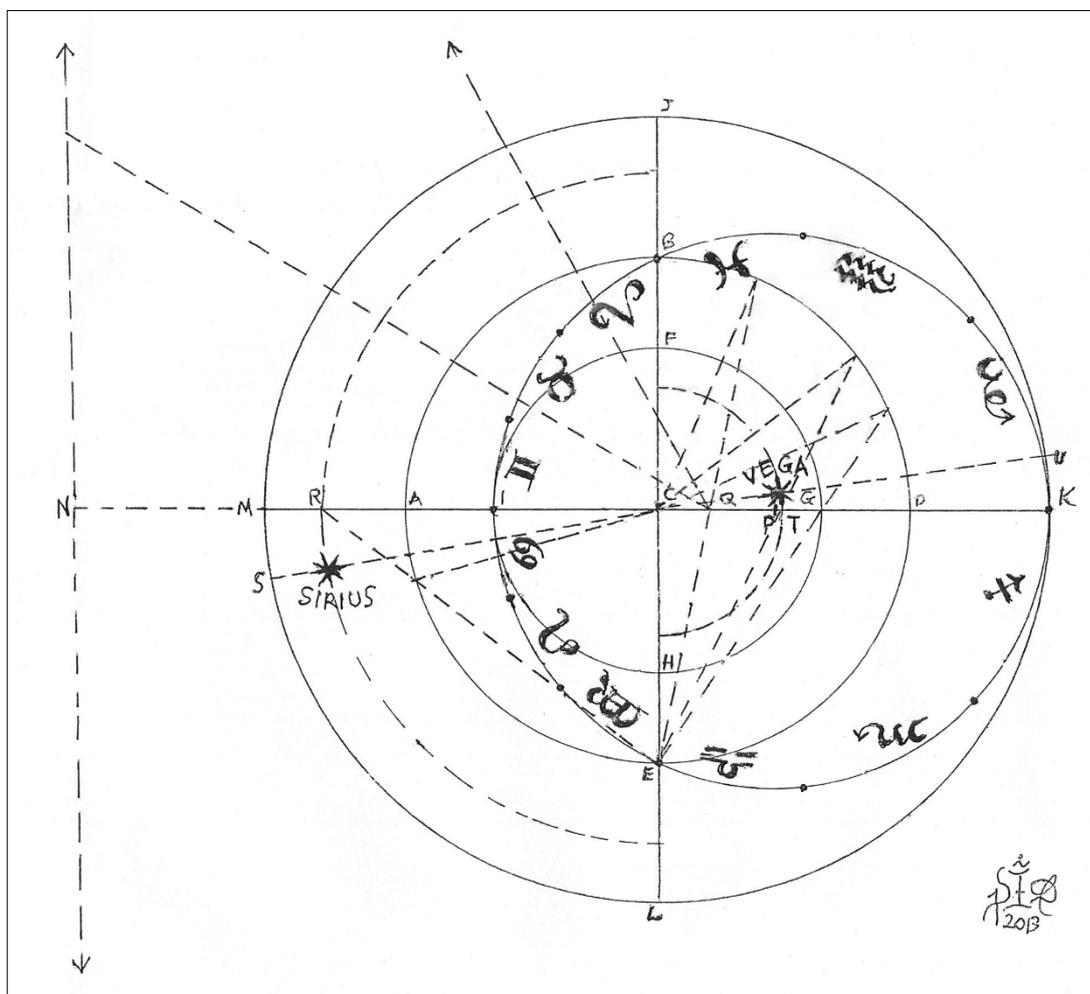
On the other side will be a circular recess (the ‘matix’) containing stack of stereographic plates (each one drawn for a particular latitude and all interchangeable) and above this

the ‘rete’ a fretwork map of the heavens (showing the greater part of the Sphære) containing a fully-calibrated ecliptic, and little pointers giving the positions of any number of bright stars: there is no definitive list; some perfectly good astrolabes (not many and not typically) have only the calibrated ecliptic. Around the edge of the matrix are the hours of right ascension. A pivoted rule over all may well be calibrated with a scale of declinations. Each individual plate contains the seasonally unequal hours of the day and night.

This second side of the astrolabe forms the main topic of this article.

The back of an astrolabe presents the Cœlestial Sphære (celestial sphere) view from outside and above – God’s eye view, not man’s. (See Fig. 1.) Man’s eye view just doesn’t work. There is one large mechanised astrolabe (astronomical clock) at Münster in Germany which insists on taking man’s eye view of the heavens, from below and within. Because of this the whole thing has to run retrograde (anti-clockwise) and, since the turning rete is in this instance underlaid by a stereographic projection of the terrestrial sphere, this has to be drawn as a mirror image, back to front. Man now has even greater difficulty in taking God’s eye view. I possess a modern commercially made celestial globe, a ‘starfinder’, apparently very carefully and accurately made – until one realizes that the globe is inside out and the whole thing quite useless! The mediævals never made this mistake.

Fig. 2. Laying out the template for the rete of an astrolabe.



The more famous, and apparently more modern example of an astrolabic clock at Prague does run clockwise; but has a fundamental error: the signs of the zodiac have the solstices transposed, with the summer signs low and the winter signs high! (This is easy to do when half asleep. I once added the signs of the zodiac to an elaborate diagram for an article in the *Bulletin* – and got it right. Then I convinced myself that I hadn't and changed them round. By the time of publication I realized I should have left them alone and waited for the flak – not a twitter! Now that I've tipped the hint, can anybody tell me which article this was?)

### Drawing an Astrolabe

I have never seen, or even heard of, a treatise on constructing an astrolabe, but the stereographic projection, with its perfect circles, is of natural occurrence – a divine gift from heaven to man – and the principles of its construction are inherent in the human mind – from whence I pluck them.

To make a template for the rete, with reference to Fig. 2, first draw the Prime circle A-B-D-E on centre C. Quarter it with B-C-E and (at right angles to this) A-C-D. On centre C, set out the obliquity of the ecliptic ( $23\frac{1}{2}^\circ$ ) from point D towards point B. Draw a line from this point to E, to determine G. Draw circle G-H-I-F on centre C for the Tropic of Cancer. Find a centre (Point P) through which an arc can be drawn linking points E, I and B. Draw E-I-B-K on centre P for the ecliptic. Set out the obliquity of the ecliptic from B towards D. Draw a line from this point to E to determine Q, the Pole of the Ecliptic. This ensure that the three lines crs-ising at B and E do so elegantly.

On C as a centre, draw K-L-M-J for the Tropic of Capricorn. Find a centre (point N) along an extension of C-I-A-M from which an arc could be drawn linking B, Q and E. Draw a line through N at right angles to N-M-A-I-C. From centre Q, set out angles of  $30^\circ$  and  $60^\circ$  to mark points on this tangent line. Using these points as centres, with radii extending to point Q divide the ecliptic into its 12 signs. Mine are based on mediæval scribal contractions derived from earlier pictograms (which still continue in a parallel tradition) and have since been amended by later scribes. To remember the names and order of the 12 signs, the mnemonic composed by Isaac Watts, the 18<sup>th</sup>-century hymn-writer, is still the best:

The Ram, the Bull, the Heav'nly Twins,  
And next the Crab, the Lion shines,  
The Virgin, and the Scales  
The Scorpion, Archer, and Seagoat,  
The man who pours the water out  
The Fish with glitt'ring tails.

The symbols have varied origins. The Ram, Bull and Lion represent the heads of those creatures, that of the crab its claws; those of the sea goat and scorpion the whole creature; that of the archer his bow and arrow, and that of the scales a balance. The balance was originally the claws of the scorpion which originally held the position of the sev-

enth sign, leaving the now extra-zodiacal constellation 'the serpent bearer' to hold the position of the eighth sign. The serpent bearer still extends into the zodiac, treading the body of the scorpion. The twins are a Roman numeral II and the water pourer's symbol is plausibly of ancient Egyptian origin. The virgin's symbol is, appropriately enough, a mediæval monogram of Our Lady, replacing the original Ceres. The adjacent Libra (the balance) also has a Christian connotation, being alluded to in Fortunatus's hymn *Vexilia Regis* (for Holy Cross Day, celebrated near the autumnal equinox): "on whose dear arms, like balance true / he weighed the price for sinners due / the price which none but he could pay / and spoiled the spoiler of his prey".

The symbol for the fishes is derived from a pictogram, not of the fishes as they appear in the classical zodiac – two widely-separated fish facing in the same direction with ribbons extending from their tails to join at a remote knot – but of a purely Islamic grouping, showing a much extended northern fish, facing north and flanking a second fish drawn over the body of Andromeda and facing south; an artistic ligature joining the two mouth-to-mouth. One still sees this pictogram frequently.

The signs remain in their places; the constellations after which they are named have, due to the precession of the æquinoxes, long since drifted along the ecliptic. More significantly, all of the 'fixed' stars have similarly drifted from their ancient places. This means that every astrolabe made in the Middle Ages has out of date positions for the fixed stars and that aspect of it no longer 'works'. *Sic Transit Gloria Cæli* (Even the glory of the heavens is transient). Do we need to add that the Julian calendars on the face of the astrolabe are incompatible with the modern Gregorian calendar?

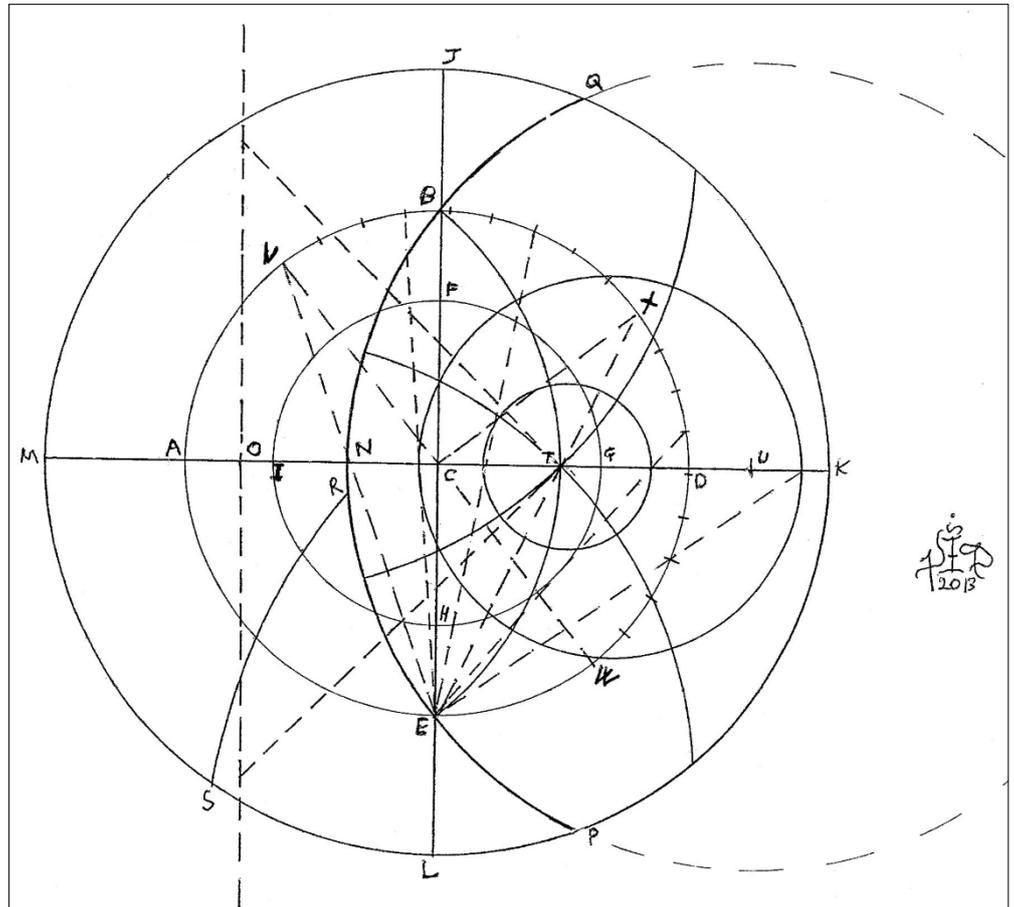
To mark fixed stars on a modern working astrolabe, one needs up to date positions from a modern star atlas. The process – provided one knows one's way around the sky – is easy – see Fig. 2.

To mark Sirius, the brightest star in the sky, set its southerly declination from the centre C to your prime circle A-B-D-E. Draw a line through this point to mark point R. Draw an arc through R from centre C. Set out the right ascension of Sirius from C around your prime circle. Draw a line through this point to mark point S. Where C-S crosses the arc is the true position of Sirius.

You follow the same procedure to mark Vega, only this has a northern declination and its right ascension is marked by C-U. Do the same for a many stars as you fancy.

You are now ready to actually construct your rete. This will be a crude, or artistically fanciful, framework supporting the ecliptic with its signs or pictograms, each finely divided into three decanates and then into individual degrees – all by stereography; with named pointers for as many stars as you have patience for. But when you have done all this you have merely created a piece of long-term ephemera (although it will last beyond your own lifetime) not some-

Fig. 3. Laying out the plate for an astrolabe (to the same scale as Fig. 2).



thing eternal. For the true pedant, you would need to make each star pointer with a double hinge – like the cursor of a Regiomontanus dial – to allow for long-term adjustment: and who has the patience for that?

The home bird will need only one plate, the traveller a good selection! Each is an entirely separate problem! See Fig. 3.

First transfer your Æquator and two Tropics from your rete layout. Then set your required latitude along the prime circle from point B. (I set it from point A by mistake; so that instead of drawing a plate for Shipston (at 52° N) I drew one instead for Athens (at 38° N): I am sure the Ancient Greeks would have enjoyed this Freudian slip!)

Draw a line from the point thus determined from E to determine N. Find a centre along C-D-K (point U) from which an arc can be drawn through E, N and B. Draw P-E-N-B-Q; this is your horizon. Prolong the oblique line passing through centre C to divide the prime circle in two (V-C-W). Draw a line at right angles to this: C-X. Draw E-X to determine point T: this is your zenith. Divide arc V-B-X into small divisions: 10s, 5s and 1 degrees, as is practicable. Do the same with arc W-D-X.

From the two points nearest to X draw lines to E to determine two points on M-C-K. Bisect the distance between the two points thus determined and draw a circle of altitude. Carry on doing this right down to points V and W. For the purpose of demonstration I have drawn circles of altitude 30° and 60°. In practice, a circle of altitude at every 10° is essential and one every single degree is desirable. There should be at least one and ideally three lines of negative

altitude beyond the horizon to mark the various grades of twilight.

Find a centre (point O) from which an arc can be drawn linking points B, T and E: this is your East-West line. The North-South line already exists. Draw a line through O at right angles to M-C and set the distance O-T along it both ways. Upon these two centre draw two further arcs through point T: these are your NE-SW and NW-SE lines. Unless you are very fussy, these are all the azimuths you need.

Divide arcs P-M-Q, B-A-E and the corresponding arc of the Tropic of Cancer into 12 equal parts each. Find centres from which arcs can be drawn linking the corresponding points on each of the three arcs: these are your seasonally unequal hours. For the purpose of demonstration, the line for the 3<sup>rd</sup> hour is drawn as R-S.

### Using an Astrolabe

After all the trouble taken to make an astrolabe, its basic use (providing one knows the sky) is childishly simple.

If working at night, first sight the altitude of the Pole Star to obtain your latitude. Sort out a plate for that latitude (hard cheese if you haven't got one) and put it under your rete; with the pivoted rule over all. Choose a visible star which you recognize and which is on your rete. Take the altitude of that star and turn the rete until the pointer for that star is in its correct place amongst the circles of altitude: you have to know East from West to do this. Turn the pivoted rule until it lies over the exact position of the sun in the zodiac. That point now indicates the correct hour of the night on the

plate; or, via the pivoted rule, the correct clock hour around the rim of the astrolabe.

If working during the day, keep the plate you sorted out at night in place. Take the solar altitude (don't look at the sun – do it by shadows). Mark the sun's exact place in the zodiac with the pivoted rule and turn both the rete and the rule together until this point lies in its correct place amongst the circles of altitude (again, you need to know East from West). The point now marked by the rule on the opposite side of the zodiac will now give you the correct hour of the day on the plate or, by extension, the correct clock hour around the rim.

If you are a muezzin charged with calling the Hazzan for morning prayers, you first set the pivoted rule over the exact position of the sun in the zodiac. You then sight your chosen star periodically, moving both rete and rule together to keep its pointer in the correct place among the circles of altitude, noting always the position of the hidden sun. As soon as that hidden sun crosses the twilight line you begin: "God is great, God is very great / Come to prayer, come to worship / to pray is better than to sleep!"

I once knew the best-thought-of muezzin in England who gave me the above interpretation and demonstrated musical settings of it as used in Morocco to Outer Mongolia. No-one who has studied the astrolabe, the universe in miniature, whatever their own religious position, would dissent from its sentiments. As Synesius himself prayed in his famous hymn "... through darkness and perplexity / point though the heav'nly way".

#### ACKNOWLEDGEMENT

I am grateful to Maggie Howe for accessing the material related to Hypatia. Also to John Davis for his editorial work and to the anonymous referee for his perceptive and (hopefully mutually) enlightening comments.

#### REFERENCES and NOTES

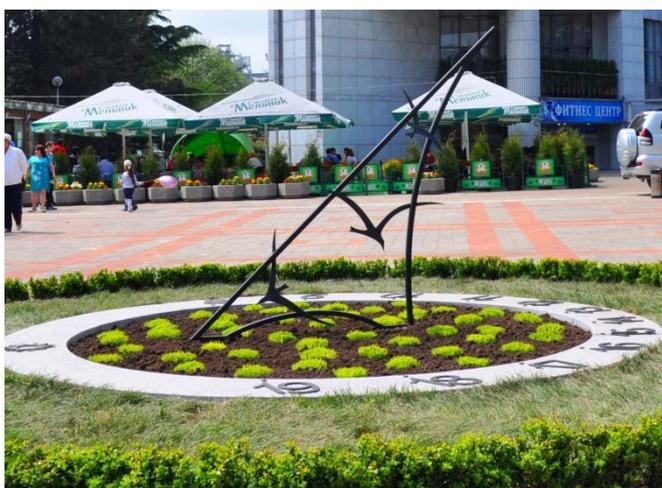
1. Contemporary documents translated in Michael Deakin's work on Hypatia, cited also elsewhere.
2. *ibid.*, and several 18th and 19th century classical dictionaries.
3. For example, *Everyman's Encyclopedia* and numerous 'popular' works on astronomy.

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## NEW RUSSIAN DIALS

### VALERY DMITRIEV

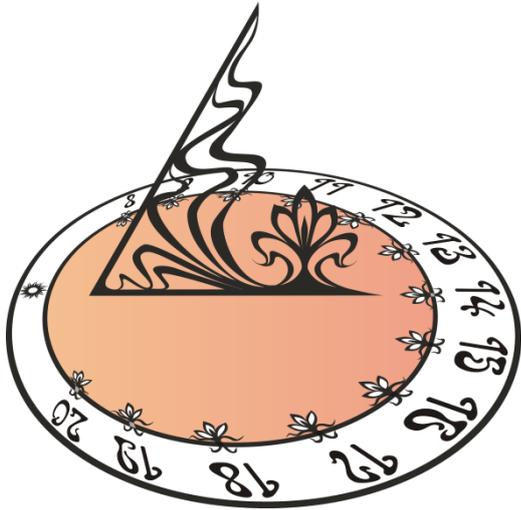
I would like to tell and show you some of my new sundials built in 2012–2013.



**Sail and Seagulls.** Tuapse city is located far from St Petersburg, in the Black Sea region. (44°06' N, 39°04' E). The sundial is located in a seaside parkway, on the Black Sea coast. It has a diameter of 3.8 m and a gnomon height of 1.8 m. The theme of the dial was defined by its site – a sail and seagulls. It has an hour ring of granite, with metal hour marks and figures, and a gnomon in the form of a sail with decorative seagulls. After installation, the area around the dial was carefully landscaped.

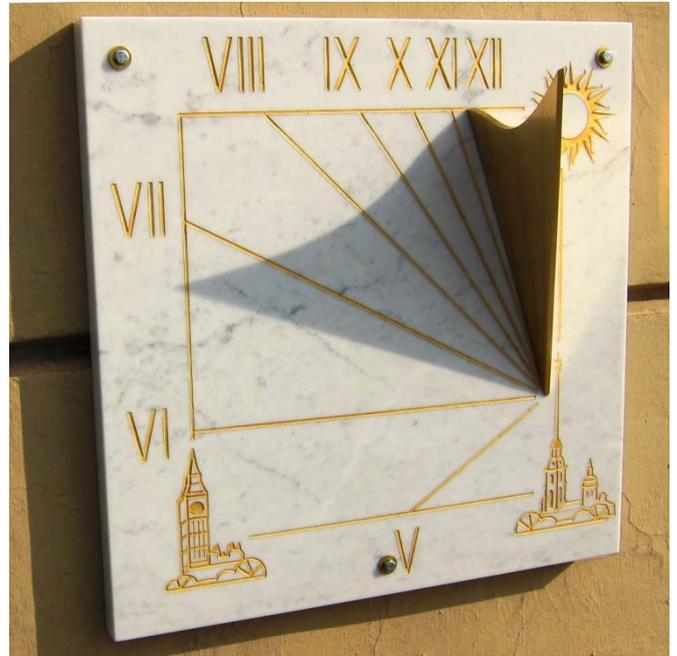
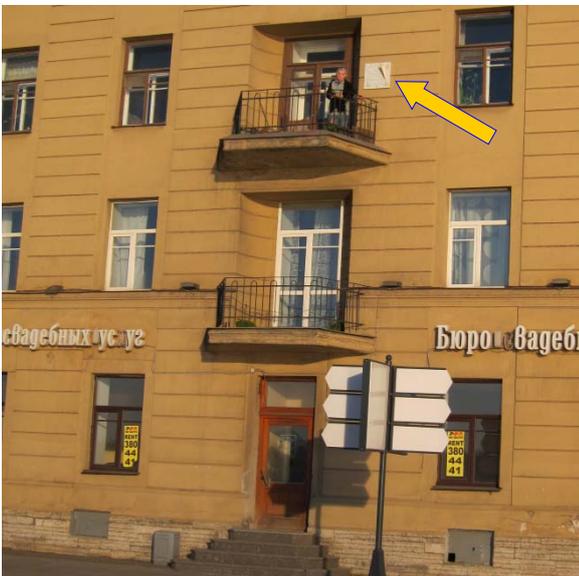


**Leopold Cat.** The site is a new settlement in the North-West region – the Kareliya Republic. (61°06' N, 32°58' E). The dial diameter is 1.0 m and the fishing-rod gnomon is 0.7 m tall. The material is steel. The site – a resting place for tourists and fishing enthusiasts – has set the theme: a cat fishing on the bank of a small pond. Leopold is the fantastical cat from the modern Russian fairy tale *The adventures of Leopold the cat*.



**Solar Flower.** Nearer to St Petersburg, in the Toksovo settlement (60.2°N, 30.54°E) is the location for this dial. It has a diameter of 3.75 m and a gnomon height of 1.6 m. The materials are artistically worked steel and coloured gravel. The hobby of the mistress of the house is the cultivation of flowers and this has defined the theme. Flowers are present in both the gnomon and dial design.

**St Petersburg – London.** In the centre of St Petersburg, at 18 English Embankment (59.56°N, 30.18°E), there is a new sundial with symbols of St Petersburg (Sts Peter and



Paul's Cathedral) and London (The Elizabeth Tower, 'Big Ben'). Also on the dial is the sun, not too frequent a visitor to the sky of St Petersburg. The sundial is established in honour of the 85<sup>th</sup> birthday of the well-known historian of St Petersburg, Elena Krasnova, on the house in which she lives. The new sundial is located opposite to the 18<sup>th</sup>-century sundial on the other bank of the river Neva at the Menshikov Palace (*BSS Bull.*, 21(i), March 2009).



**Composition with a sundial: "In a shelter of lonely muses".** The basis of this composition is the drawing of the sundial 'Pushkins' by Irina Shimolina, a graduate of Siversky Children's Art School, who were winners of the first Russian childrens' competition for the best drawing of a sundial (*BSS Bull.*, 24(ii), June 2012). The composition was made for Siversky village (59°21'N, 30°05'E). It is the symbol of the School – a place for creativity in painting, literature and music.

Валерий Дмитриев, [sundials\\_spb@mail.ru](mailto:sundials_spb@mail.ru)



# ALFRED RAWLINGS' SUNDIAL PAINTING

JOHN FOAD

The *Bulletin* for June 2013, page 6, showed a painting by Alfred Rawlings of a stone dial draped by a female figure, mounted on a carved pillar (Fig. 1). The painting was used as the frontispiece for, and on the dust-jacket of, *A Book of Sundials and their Mottoes* (1914).<sup>1</sup> The dial is described there as “In the possession of Sir Frank Crisp, Friar Park, Henley-on-Thames”, as are those (so far unidentified) in four other Rawlings paintings in the book. The volume is probably best known to members for the many fine sundial drawings by Warrington Hogg, but Rawlings’ frontispiece is our current interest.

Frank Crisp bought Friar Park in 1889. He pulled down the few original small houses on the land and built the present imposing residence in the French Renaissance manner, with Gothic details. He also started on a massive exercise of developing the grounds in elaborate style, with lakes, a maze, a Japanese Garden, an Elizabethan Herb Garden, an Alpine Garden which included grottoes and a model of the Matterhorn, and many more garden areas and features. By 1914, the date of the publication of Rawlings’ painting, the gardens had matured and Crisp welcomed visitors. He prepared his *Guide for the use of Visitors to Friar Park*,<sup>2</sup> an informative and entertaining document, which was accompanied by a *Plan for the Guidance of Visitors*,<sup>3</sup> a large and fanciful map in mock medieval style. A small portion of this map is shown in Fig. 2, and Rawlings’ dial can be seen towards the upper right corner of ‘Ye Dial Garden’. Also visible are what are probably a van Nost Blackamoor pedestal, possibly a Pilkington & Gibbs Heliochronometer, a cross dial, an armillary sphere, and others. Matthews<sup>4</sup> said in 1922 “[the Dial Garden] is laid out on the plan of the Versailles labyrinth, but in place of the statuary groups are thirty-nine sundials, each having its motto or epigram”. He includes a plan of Versailles, and it is clear from Google Earth that the path layout of the Dial Garden was indeed quite a close copy. Mottoes for the thirty-nine sundials are listed in the *Guide*,

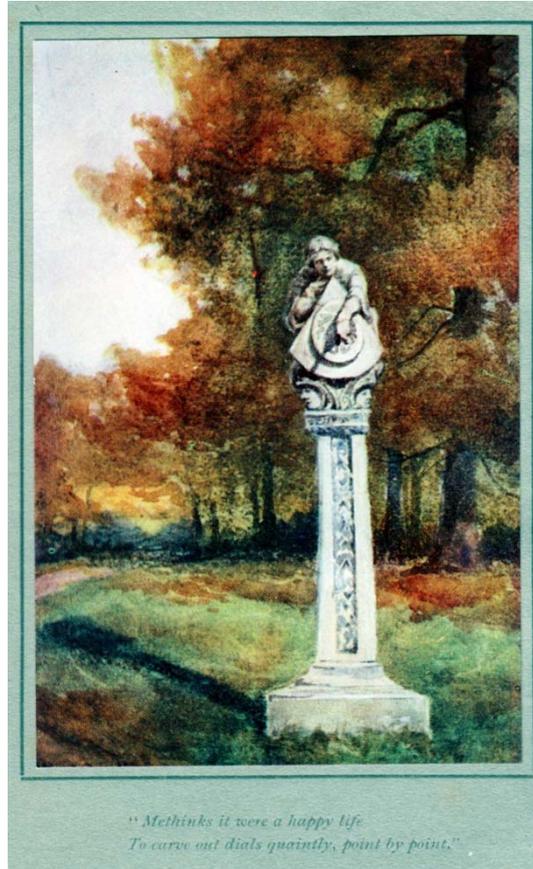


Fig. 1. Alfred Rawlings’ painting, Friar Park.

but unfortunately there are no descriptions or photographs.

The gardens were Grade II listed by English Heritage in 1984, when they were described as having “formerly thirty-nine sundials”. The date of the disappearance of the dials is not known. The property is kept intensely private, and no attempt should be made to contact the owner.

Turning back to the dial in the painting, it is remarkably similar to one that can be seen in a *Country Life* article on Reigate Priory of 1918 (Fig 3).<sup>5</sup> The dial, apparently about six feet in height overall, stood on The Monks’ Walk, in the centre of a herbaceous plot known as The Tea Garden, immediately to the West of the house.<sup>6</sup> It would appear by 1918 to have suffered some significant weathering, though part of the motto can still be read – an extract from Shakespeare’s Sonnet 115, where

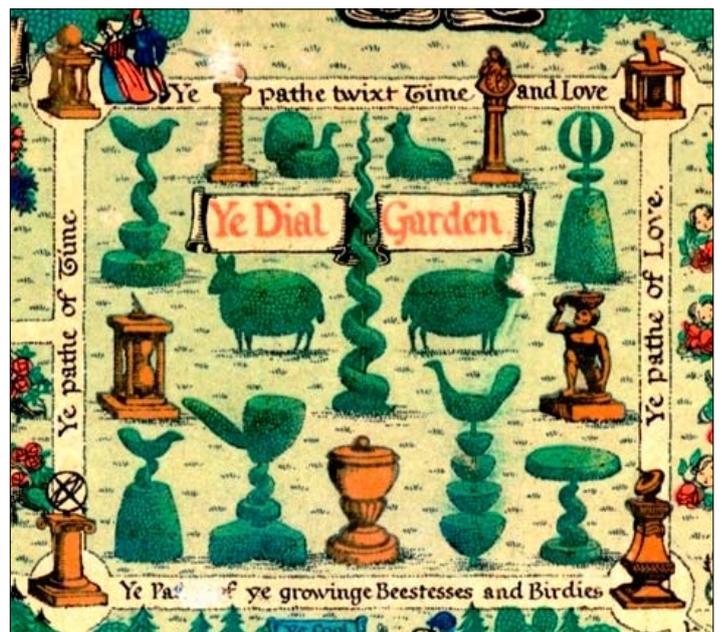


Fig. 2. Ye Dial Garden, Friar Park.  
© British Library Board, Shelfmark Maps 1240 (123).

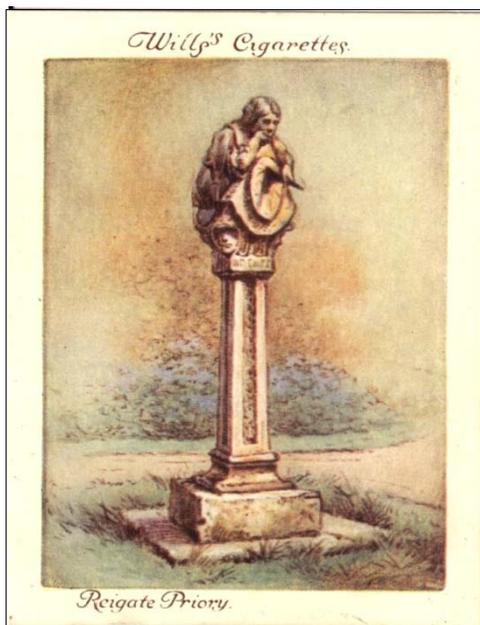


Fig. 3. Reigate Priory.  
© Country Life.

Fig. 6. Barker's advertisement.

he speaks of "reckoning Time, whose million'd accidents creep in 'twixt vows, and change decrees of kings".

It was also illustrated on a Wills Cigarette card of 1928 (Figs 4 and 5),<sup>6</sup> where it was still described as being at the Priory. So was it spirited from Henley to Reigate some time during the First World War, or were there perhaps two versions of the dial? It is remarkable that nothing seems to be known about the maker, or about the installation and possible later movement. From the dates, it could have been commissioned from Francis Barker and Son, who supplied 'Monumental Sundials' (Fig. 6) as well as their better-known bronze horizontals and verticals,<sup>8</sup> but there is no evidence of this.



**Old Sundials**  
A SERIES OF 25 No 24

**WILLS' CIGARETTES**

SUNDIAL AT  
REIGATE PRIORY, SURREY.

Reigate was formerly a Priory of the Augustinian Order, like Newstead. Few traces of the mediaeval Priory remain however, for the place has been completely transformed by more recent building in the Late Renaissance style. Under the Tudor and Stuart Sovereigns the estate was held by the Howards and the Mordaunts. Subsequently it was acquired by the first Earl Somers, whose descendant, the late Lady Henry Somerset, did so much to enhance the charm of the Priory by laying out the beautiful old-world gardens. This fine sundial, with its graceful female figure, forms the central feature of the western alley.

**W. D. & H. O. WILLS**

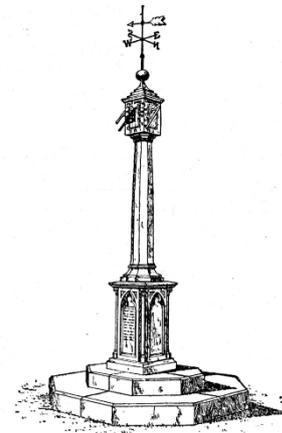
ISSUED BY THE IMPERIAL TOBACCO COMPANY  
(OF GREAT BRITAIN & IRELAND), LIMITED.

Figs 4 & 5. Reigate Priory, Wills' cigarette card.

## SUN-DIALS AS MEMORIALS.

THERE are many forms of Sun-dials which are suitable for erection as Memorials.

The illustration shows a design suitable for an open space in a Town, Village, Park or Church-yard. The Dials face east, south and west respectively. On the north face might be carved a Coat of Arms, Regimental Crest or similar ornament. The Gothic panels being inscribed with the name or names of the Departed and other data, for which an estimate would be prepared upon receipt of particulars. The Monument as here illustrated



is made in Portland Stone with Base of York Slabs, Octagonal Shape, 5 feet in diameter, the height from ground to top of Ball Finial being 15 feet; the Wind Vane is of Copper polished; the Dial Faces being in Gunmetal, deeply engraved, polished and lacquered. The Hour lines and numerals could be cut direct upon the stone instead of gun-metal plates.

The Monument made in Marble or Granite, etc.  
The Price varying accordingly.

ESTIMATES FOR THE ABOVE ON APPLICATION.

The dial is not at Reigate Priory now, and attempts to trace its history through the Redhill and Reigate History Society have been unsuccessful. If anyone can throw light on any aspect of this story, I would love to hear from them.

### REFERENCES and NOTES

1. Launcelot Cross: *The Book of Old Sundials and Their Mottoes*, T N Foulis (1914).
2. Sir Frank Crisp: *Guide for the Use of Visitors to Friar Park*, privately published (1914). It can be seen at the Royal Horticultural Society's Lindley Library in Vincent Square, London.
3. Alan Tabor: *Plan for the Guidance of Visitors*, (1914). A copy is held in the British Library, London.
4. W.H. Matthews: *Mazes and Labyrinths*, (1922) Ch XIV. The quote is from page 121, the Versailles map is on p. 118.

5. *Country Life*, April 6 and 13, 1918. Image from original glass plate negative.

6. *Sale by Auction of Reigate Priory*, Knight Frank and Rutley, (9 September 1919).

7. *Old Sundial Series*, Wills Cigarette Cards, 1928

8. *Advertisement*, Francis Barker & Son Ltd, approx 1925 to 1927.

[registrar@sundialsoc.org.uk](mailto:registrar@sundialsoc.org.uk)



# PLANETARY HOURS

MICHAEL LOWNE and JOHN DAVIS

‘Planetary hours’ is a term quite often seen on dials and related instruments of the 16<sup>th</sup> century or earlier, particularly on portable dials and continental wall dials. Generally, the term has been taken by most modern writers to be synonymous with temporary or seasonal hours, dividing the daylight period into 12 equal ‘hours’. Because the term ‘planetary hours’ brings with it connotations of astrology, now discredited as unscientific and not worthy of consideration, it is normally ignored and one of the other terms used instead. However, if the origins of planetary hours are studied in more detail it can be seen that they started out as having a different, and astronomically valid, basis to the other forms of unequal hours. The use of this earlier definition has not been widely studied.<sup>1</sup>

## ‘Unequal Hours’

There are numerous synonyms for hour systems which divide the daylight period on a given day into 12 equal periods, giving rise to much confusion for novice diallists as they study old dials, books and manuscripts. These terms include

- Unequal hours
- Temporary hours
- Temporal hours
- Seasonal hours

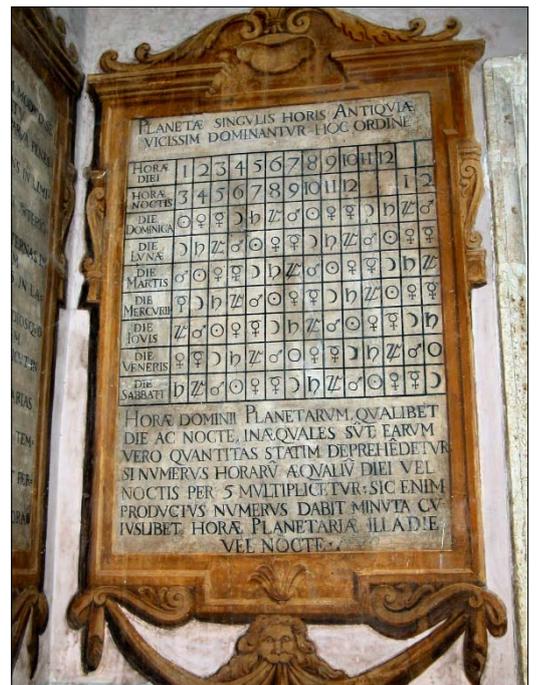
- Antique hours
- Jewish hours
- Welsch (*i.e.*, foreign) hours
- Zodiacal hours
- *hora artificiales*
- *horæ inequales*

and so on. Thus it would not seem necessary to introduce another term, planetary hours, meaning exactly the same thing. Also, note that these hours are only unequal over the seasons; on a given day all 12 daylight hours, starting at sunrise and ending at sunset, are equal although of a different duration to the night-time hours. Thus the term ‘seasonal hours’ is preferred here to ‘unequal hours’. One hour can be defined as the time it takes for the sun to pass through one-twelfth of the diurnal arc. The sequence is continued through the night, so that the sunset-sunrise interval is divided into 12 hours, which (except at the equinoxes) are of different duration to the daylight hours. By contrast, the normal equal hours are the time it takes for the vertical through the sun to pass through 15° of the equatorial circle (*i.e.*, 1/24<sup>th</sup> of a day).

One of the main reasons why the medieval diallist may have been interested in planetary hours is through their supposed astrological influence. The hours of the day were said



Francesco Caviglia



Tony Moss

Fig. 1a. Example of (left) dial with (seasonal) planetary hours at San Benigno Canavese in Piedmont and (right) a planetary table at the Palazzo Spada, Rome.

to be ‘ruled’ by the seven astrological planets (which included the Sun and Moon), in the Ptolemaic sequence of their apparent period of revolution about the stationary Earth, in decreasing order: Saturn ♄, Jupiter ♃, Mars ♂, Sun ☉, Venus ♀, Mercury ☿ and Moon ☾. The days of the week have names derived from the ruling planet of the first hour. Starting on Saturday with Saturn as the first hour, throughout the 24 hours of the day and night the sequence runs three times plus the next three hours and ends with Mars as the last hour. Continuing the sequence gives the Sun as the ruling planet for the next day (Sunday). The last hour of Sunday is Mercury and the first hour of the next day is therefore Moon (Monday). The day names continue in this way until the end of the week and Saturn is the first hour again. This familiar sequence of the days of the week has its origin in Roman times when the Jewish week of seven days came into use in the Christian calendar and the coincidence with the seven astrological planets led to the adoption of the first hour as names for the days. The sequence has continued without alteration, special arrangements being made at the changes from the Julian to the Gregorian calendar. However, the names of the Roman deities Mars, Mercury, Jupiter and Venus have been replaced in the Teutonic languages by their Norse near-equivalents Tui, Woden, Thor and Freya. Tables of these planetary sequences can still be seen on some old continental wall dials (Fig. 1a) or on 17<sup>th</sup>-century portable dials (Fig. 1b). In these cases, though, the associated planetary hours are the seasonal ones, rather than the true ecliptic ones.

The vertical dial (delineated for seasonal hours) shown in Fig. 1a is one of four dials on a building at San Benigno

Canavese in Piedmont. The other three are for French (*i.e.* equal), Italian and Babylonian hours. The seasonal hours are numbered 1–12 and the initial letters for the days of the week appear on either side at the top. The alternately-coloured bands for each day contain the planetary hour symbols in the sequence described above. To use the dial the day of the week is found in the initial letters and the coloured band for that day is followed round until it meets the gnomon shadow. On Fig. 1a the shadow falls in the sector between lines 9 and 10, the tenth hour. Suppose the weekday is Friday (initial V for Venerdi), the band for that day shows the symbol for the moon which is therefore the ruling planet at that time.

### (Ecliptic) Planetary Hours

The earliest description of planetary hours (at least, as known to the authors) is attributed to Sacrobosco’s *Tractatus de Sphaera*.<sup>2</sup> Written around 1240,<sup>3</sup> ‘*The Sphere*’ became the standard astronomy starter text for several centuries, attracting many commentaries which extended its usefulness. In it, Johannes de Sacrobosco (also known as John of Holywood, see Biographies) notes that ‘a natural hour is the space of time in which half a sign rises’. Since the zodiac signs are distributed at 30° intervals around the ecliptic and there are always 6 signs above the horizon, this means that a planetary hour (also known sometimes known as a zodiacal hour) is the time for 15° of the ecliptic to rise above the horizon. Although, like seasonal hours, there will always be 12 hours from sunrise to sunset, these ecliptic planetary hours will be of unequal duration during the day with the distribution of the durations depending on the time of year. As a consequence, the 6<sup>th</sup> hour will not, in general, equate to midday. The detailed characteristics of ecliptic planetary hours are discussed later in this paper.

The complicated characteristics of true ecliptic planetary hours make them very difficult to use on a sundial, though it can be done. In the late-medieval period, it seems that diallist/astrologers (which included such respected names as Regiomontanus) wanted to display planetary hours but without the complications. Thus they made dials with lines labelled for planetary hours but using the simpler definition for the seasonal hours. Planetary and seasonal hours became synonymous: the original ecliptic definition was gradually lost. The English-language edition<sup>4</sup> of a mystical work by Heinrich Agrippa (written in 1509, first published in 1531 and published in English in 1631) contains the passage:

“.....almost all Astrologers divide all that space of time from the Sun rising to setting into twelve equall parts and call them the twelve hours of the day; then the time which followeth from setting to rising, in like manner being divided into twelve equall parts, they call the twelve hours of the night, and then distribute each of those hours to every one of the Planets according to the order of their successions.....but in the partition of the hours some do different, saying, that the space of the rising and setting is not to be divided into equall parts,



J Davis

Fig. 1b. An ivory diptych dial by Paul Riemann of Nuremberg (after 1602) with a (seasonal) planetary hour scale as one of its subsidiary scales. Courtesy of the Whipple Museum, Cambridge, inv. no. 1687.

and that those hours are not therefore called unequal because the diurnal are unequal to the nocturnal but because both the diurnal and nocturnal are even unequal amongst them-selves.....for as in artificial hours, which are always equal to themselves, the ascension of fifteen degrees in the equinoctial constituteth an artificial hour: so also in planetary hours the ascension of fifteen degrees in the Eclipticke constituteth an unequal or planetary hour, whose measure we ought to enquire and find out by the tables of the oblique ascensions of every region.”

The distinctions drawn between the three time systems are clear: although most astrologers at that time were dividing the daytime and night-time intervals into equal (seasonal) hours, some were still using the planetary hours based on the rising of the ecliptic, giving hours which vary in length throughout the day and night. ‘Artificial hours’ are the normal equal hours of apparent solar time based on the rising of the equinoctial (the celestial equator).

Geoffrey Chaucer, writing his *Treatise on the Astrolabe* at the very end of the 14<sup>th</sup> century, explicitly labels the spaces between the seasonal hour lines of his astrolabe drawing with the planets.<sup>5</sup> In section 12 of the *Treatise*, (“Special declaracioun of the howres of planetes”) he explains how to convert the sun’s altitude measurement on a specified date to the appropriate (seasonal) planetary hour. In his *Canterbury Tales*, Chaucer uses both planetary hours and the more ‘modern’ equal hours for timetelling as well as using planetary and zodiacal references to imply dates.<sup>6</sup>

A nineteenth-century analysis of Chaucer’s works by A.E. Brae<sup>7</sup> goes so far as to call Sacrobosco’s definition of an ‘unequal’ (planetary) hour as a 15° rise in the ecliptic as a “grossly absurd mis-description” and “monstrously untrue” so clearly all memory of ecliptic planetary hours had been lost in Victorian Britain.

Only a very few descriptions of ecliptic planetary hours can be found in the early-modern period and it is not until the scholarly study of sundials by Joseph Drecker<sup>8</sup> in 1925 that a proper analysis was published. Since then, a few modern authors, notably Fer de Vries,<sup>9</sup> have noted their existence.

Another definition of planetary hours due to Peter Apian and reported by his son Philip is discussed later.

These multiple definitions of planetary hours beg a number of questions. For example,

- were ecliptic planetary hours ever really used?
- are there any instruments (extant or in drawings) using ecliptic planetary hours?
- when, or over what period, did the change-over from the ecliptic to the seasonal definition of planetary hours occur?
- are there any modern uses of planetary hours (of either form) that could be exploited?
- how do you recognise the type of planetary hours used on old sundial, quadrants, etc.?

## The Mathematics of Ecliptic Planetary Hours

As mentioned earlier, the durations of planetary hours are based on the rising of 15-degree intervals of the ecliptic (in celestial longitude) and are unequal, both from day to day and within one day. The annual path of the sun is confined to the ecliptic (within very narrow limits) and its position in the sky due to the diurnal rotation of the earth can be taken as an indicator of the planetary hour. Two intersecting great circles on the sphere (in this case the ecliptic and the horizon) mutually bisect each other, so that as the sun sets a point on the ecliptic 180° distant is rising, and the sunrise-sunset period (the diurnal arc of the sun) is divided into 12 intervals of 15° of rising longitude. The system of planetary hours commences at sunrise and from then until 15° of the ecliptic have risen is hour 1. Hour 2 runs from 15° to 30° and so on until hour 12 ends at sunset. The night-time hours also run from 1 to 12, hour 1 commencing at sunset and hour 12 ending at sunrise, but here only the daytime hours are considered. The hours are not subdivided; each represents a period of certain astrological influences.

The zero point of the longitude is the First Point of Aries, the position the sun occupies at the northern hemisphere spring equinox. At the summer solstice the sun’s longitude is 90°, 180° at the autumn equinox and 270° at the winter solstice.

The inequalities in the hours are caused by the inclination of the ecliptic to the celestial equator (the obliquity angle of 23.5°). The declinations of points on the ecliptic vary between +23.5° (north of the celestial equator) and -23.5° (south), depending on the longitude. The azimuth on the horizon of a point on the ecliptic which is rising depends on its declination, so that through the sequence of 15° ecliptic points their azimuths at rising are continually variable, and the angle at which the ecliptic intersects the horizon is also variable. The maximum inequalities occur at the equinoxes.

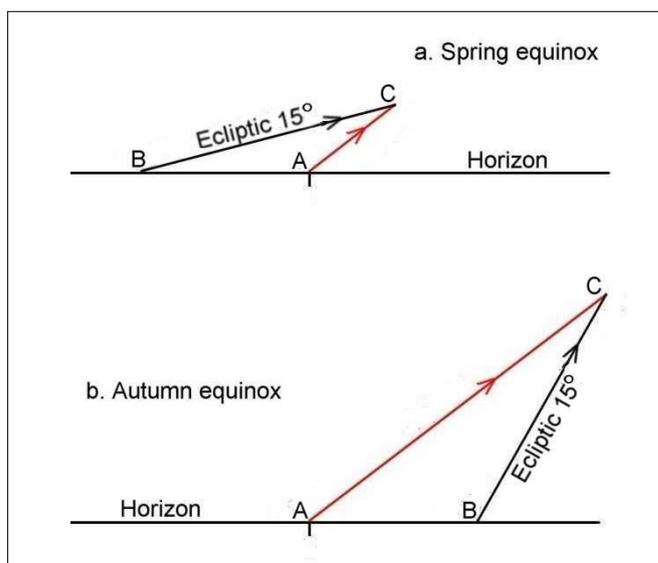


Fig. 2. Seasonal effects on the rate of rise of the ecliptic above the horizon.

Fig. 2 shows schematically the effect of these changes upon the interval between the rising of successive 15° ecliptic points. Fig. 2a is drawn for the spring equinox when the declination is increasing and the azimuth change is to the north. The rising azimuth of an ecliptic point is at A and that of the next 15° point is at B. Between A and B the point A will have risen to C, and it is obvious that the arc AC is less than the 15° of BC on the ecliptic. The conditions for decreasing declination (azimuth changing to the south) is shown in Fig. 2b, where the arc AC is now greater than 15°. In each case the arc AC represents the change in the hour angle measured at the pole of the sky, and the inequalities in the planetary hours are the consequences. Note that in Fig. 2a the ecliptic makes a shallow angle with the horizon and the angle in Fig. 2b is much steeper.

From longitude 90° to 270° the declination is decreasing, so the effect of Fig. 2b is always present to a greater or lesser extent when the longitude which is rising is within this range. Similarly, the effect of Fig. 2a occurs for the longitude range 270° to 90°. The overall effect of the combination of these factors is a set of hour lines of varying shapes, and the lines for longitudes 270° to 90° are a reversal of those for longitudes 90° to 270°.

To plot the planetary hours on a sundial it is necessary to know the latitude and the hour angle and declination of the sun, from which the coordinates of points on the dial can be found. The following method is used to perform this, using the latitude and the daily longitude of the sun.

Notation:

- $\varphi$  Latitude
- $\varepsilon$  Obliquity of ecliptic, taken as 23.5°.
- $\lambda_s$  Longitude of sun.
- $\delta_s$  Declination of sun.
- $\lambda_r$  Longitude of rising point of ecliptic, in multiples of 15° >  $\lambda_s$
- $\delta_r$  Declination of  $\lambda_r$
- $h(\lambda_r)$  Hour angle of  $\lambda_r$  at rising.
- $\Delta h$  Difference of hour angle corresponding to increase of 15° in  $\lambda_r$
- $h_s$  Hour angle of sun.
- $N$  Nodus height for gnomonic projection on a horizontal dial.
- $x, y$  Coordinates of sun on this.

Formulae:

- $\delta_s$   $\arcsin(\sin \lambda_s \sin \varepsilon)$  1
- $\delta_r$   $\arcsin(\sin \lambda_r \sin \varepsilon)$  2
- $h(\lambda_r)$   $-\arccos(-\tan \varphi \tan \delta_r)$  (always negative) 3
- $\Delta h$   $\arcsin\{(\cos(\lambda_r - \lambda_s) - \sin \delta_s \sin \delta_r) / (\cos \delta_s \cos \delta_r)\}$  (always positive) 4
- $h_s$   $\Delta h + h(\lambda_r)$  5
- $K$   $(\sin \varphi \sin \delta_s + \cos \varphi \cos \delta_s \cos h_s)$  6
- $x$   $N \cos \delta_s \sin h_s / K$  7
- $y$   $N (\cos \varphi \sin \delta_s - \sin \varphi \cos \delta_s \cos h_s) / K$  8

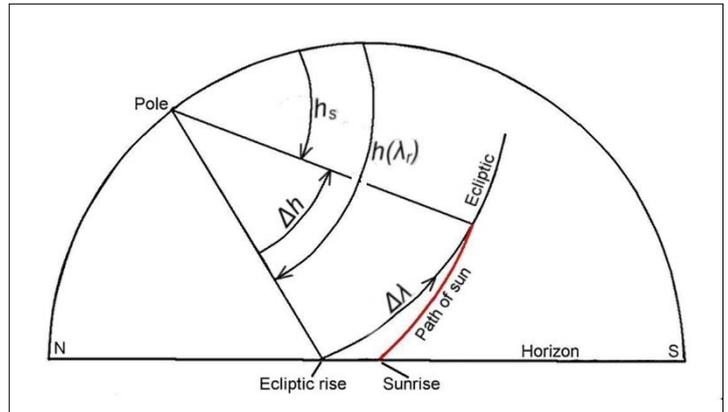


Fig. 3. The derivation of the ecliptic planetary arcs for the latitude of 51.5° N.

To examine the properties of the planetary hours the latitude of London (51½°) has been selected. The diagram of Fig. 3 shows the relationships of the various arcs, labelled with the symbols shown in the notation. Since sunrise, the sun has followed the path shown in red, centred on the pole of the sky. The ecliptic arc is centred on the ecliptic pole, 23.5° distant.

It is difficult to visualise the appearance of the hour lines on the sky. Fig. 4 may help: the lines are shown in terms of altitude and bearing on a horizon-based Mercator projection. The lines drawn are for solar longitudes 90°–180–270°, (summer to winter solstice) and would need reversal as a mirror image for the other half-year. Note the variable separations and that the earlier and later lines are approximately parallel to the horizon. For a large part of its length line 11 is very close to the horizon, within four degrees of altitude. The only positions of hour 6 which coincide with the meridian are those for the solstices.

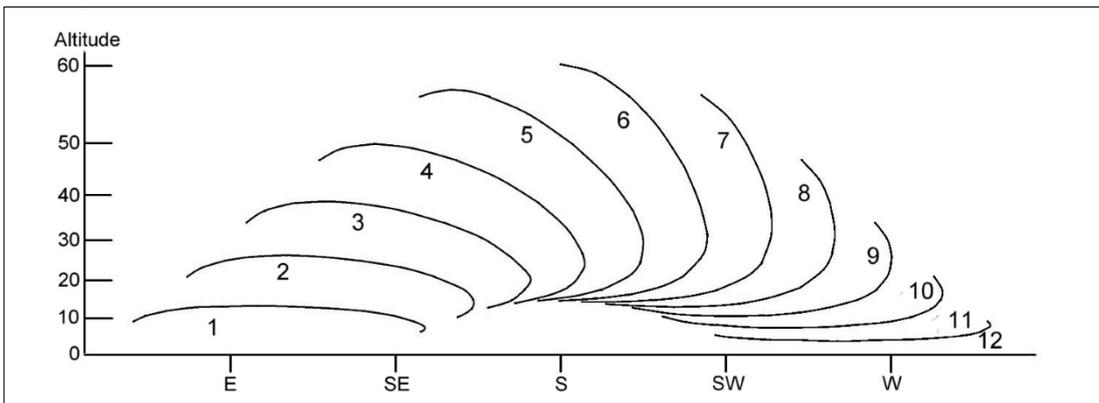


Fig. 4. The appearance of the ecliptic planetary hours on the sky, based on the Mercator projection.

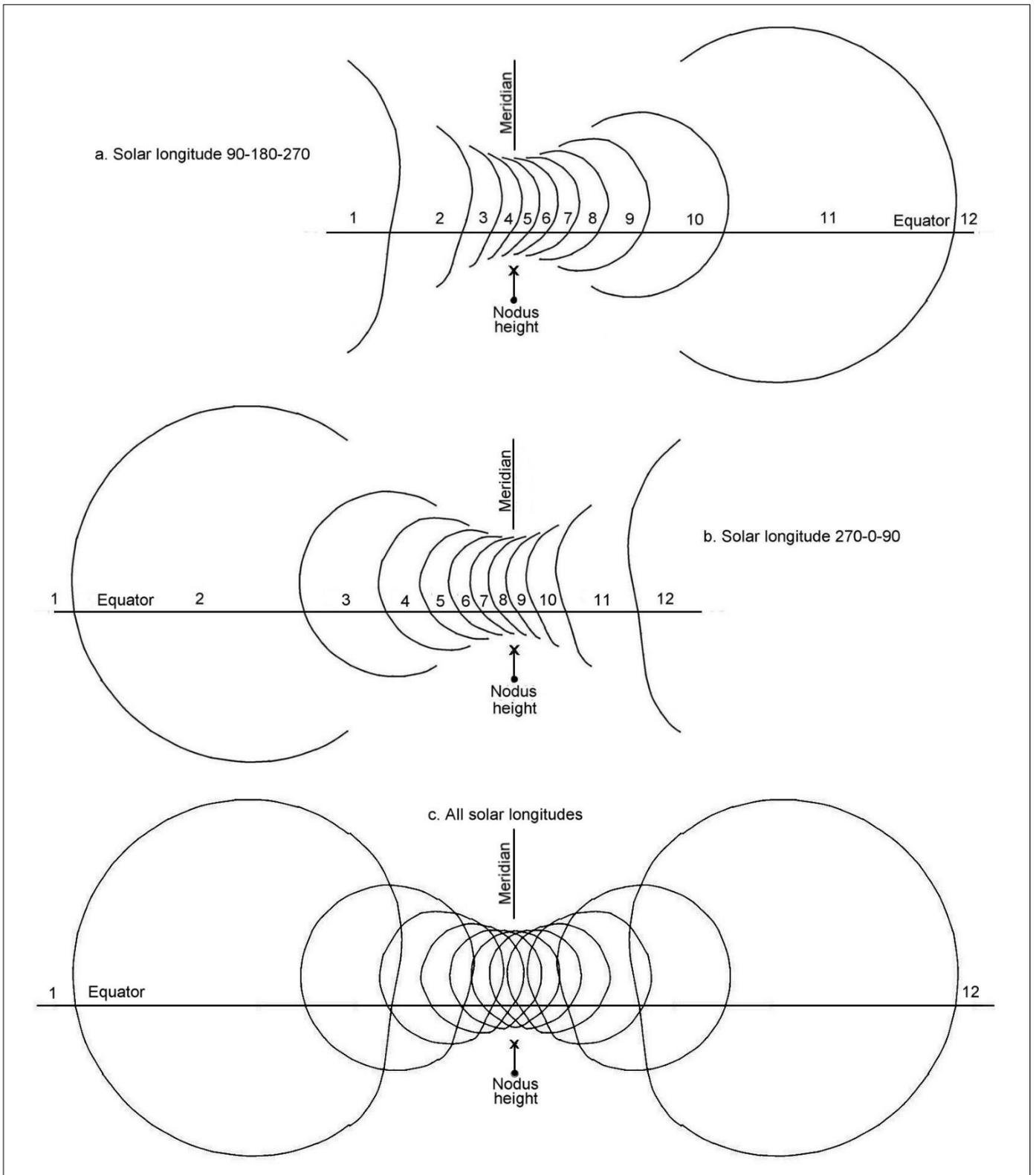


Fig. 5. The ecliptic planetary hours lines on a horizontal dial using the gnomonic projection. (a) for the Autumn half of the year, (b) for the Spring half and (c) combined for the whole year. The X marks the location of the vertical gnomon with the nodus height shown.

The appearance of the lines on the gnomonic projection of a horizontal sundial (viewed from the south) with a vertical gnomon and shadow-casting nodus is shown in Fig. 5a for longitudes 90–180–270°, with the equator indicated. Sunrise and sunset cannot be shown on this projection, and only the lines for the end of hour 1 and the beginning of hour 12 are present. The sub-nodus position is shown by a cross and

the nodus height is indicated. Radial distance on the projection is proportional to the tangent of the zenith distance ( $90^\circ - \text{altitude}$ ) which accounts for the exaggerated spread of lines near the horizon. Fig. 5b shows the projection for the longitudes 270–0–90° half of the ecliptic, the reversal of the other half.

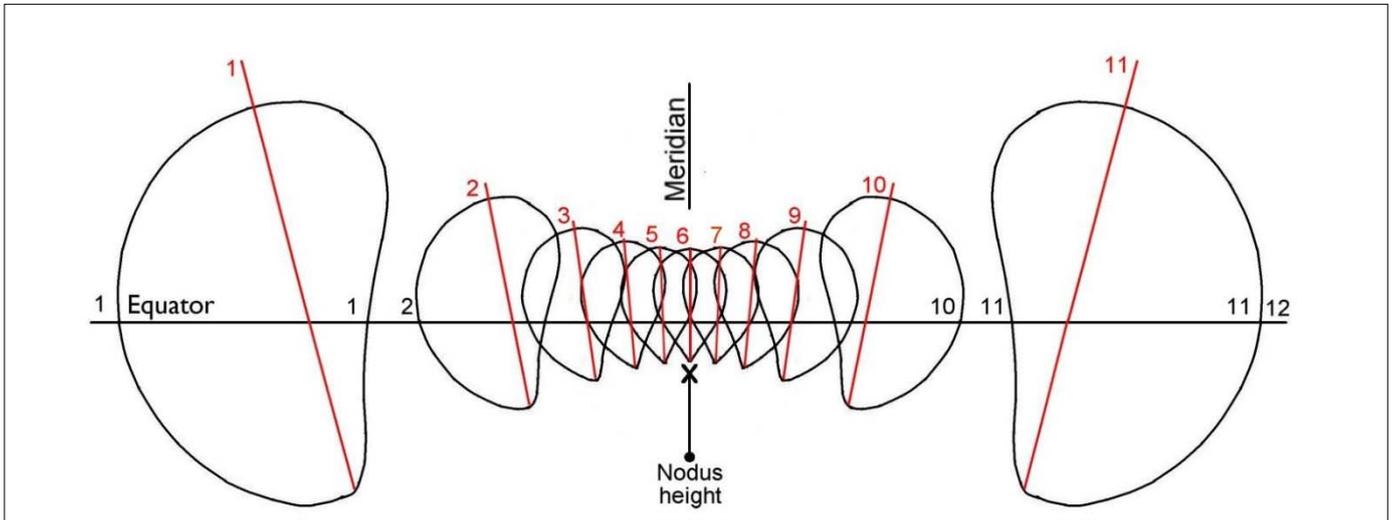


Fig. 6. A horizontal dial with ecliptic planetary hours for a latitude of  $32^\circ$ . The red lines represent the seasonal hours. The X marks the location of the vertical gnomon with the nodus height shown.

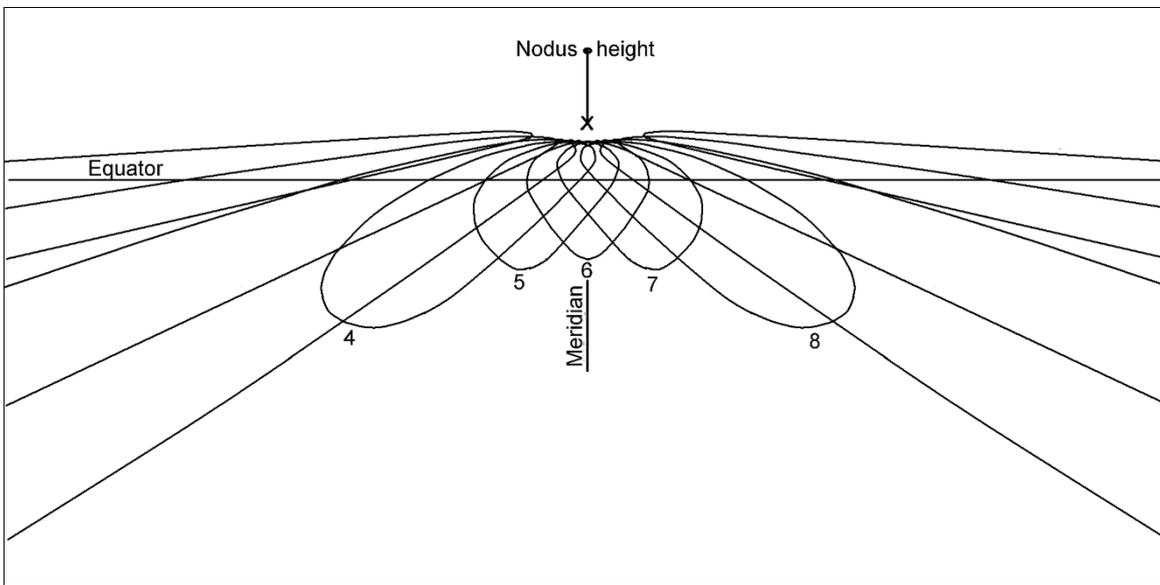


Fig. 7. A south-facing vertical dial showing planetary hours for latitude  $51\frac{1}{2}^\circ$ .

The combination of the hour lines for all longitudes is shown in Fig. 5c. It is obvious that such a dial with overlapping hour lines would be very difficult if not impossible to read. On the drawing it was found quite impracticable to label the lines with the appropriate hour numerals! The alternative would be to provide separate dials for each part of the year.

The system of these planetary hours is thought to have originated in lower Mesopotamia, at a latitude of perhaps  $32^\circ$ . Fig. 6 is a horizontal dial drawn for this latitude. Although the overlap of the lines is reduced, the appearance is still very confusing. The red lines on Fig. 6 represent the equally-spaced seasonal hours and it is not surprising that eventually the seasonal hours displaced the complexity of the old planetary hours in astrology and assumed their name.

For public display of planetary hours it is likely that vertical sundials would be preferred. In common with equal-hour south-facing dials, those parts of lines which lie north of or close to the east or west points cannot be shown. Fig. 4 indicates that this excludes a large section of hour lines 1

and 11 and smaller parts of lines 2, 3, 9 and 10. Fig. 7 is a south-facing vertical dial for latitude  $51\frac{1}{2}^\circ$ . Around the time of the winter solstice (closest to the cross marking the sub-nodus) the lines are very compressed and would be virtually unreadable. Fig. 8 is a south-facing dial for latitude  $32^\circ$ . Here, although the winter lines are better separated, the early and late hours are even more truncated (only 5, 6 and 7 are fully shown) and the high altitude of the sun in summer implies that a vertical dial to carry the full extent of the lines would need to be excessively tall. Vertical dials for planetary hours are not really a practicable proposition.

The Romans were very dependent upon astrology in their daily lives and many Greco-Roman dials are known. The majority appear to carry delineations for seasonal hours: can any of them be interpreted as planetary hours?

Tables of planetary hours which correlate them with local apparent solar time as shown on an equal-hour sundial can be prepared for every day of the year. Extracts from such a table are given by de Vries,<sup>9</sup> from a work by Crätschmairum (1626).<sup>10</sup>

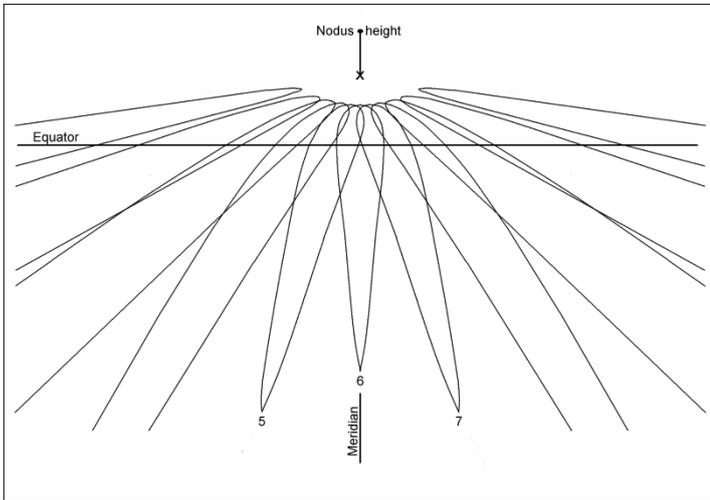


Fig. 8. A south-facing vertical dial showing planetary hours for latitude 32°.

### The Planetary Hours on the Apian Triens

The zenith-centred stereographic projection of the triens showing the PLAN and JUDE (planetary and Jewish or seasonal) hours (Fig. 9) occurs among a number of other illustrations published by Philip Apian but due to his better-known father Peter.<sup>11,12</sup> This is the only example of this definition of planetary hours known to the authors. The triens projection is folded in half along the meridian AH and each line carries hour identifications for the morning and afternoon hours. Other features are a note of the design latitude (AD POLE ELEV. 47.48.49 GR.), a scale of degrees around the limb, lines of declination of the sun for the start of each zodiacal sign, an altitude scale (GRAD. ALTITUDE),

and two apertures for sighting the sun. Alongside the meridian the zodiacal signs are identified and the declination range of each is divided into three.

From analysis of the positions of the PLAN hours it is found that they represent arcs of great circles which pass through the celestial equator at intervals of fifteen degrees and also through the north and south points of the horizon. On a horizontal dial they appear as straight lines parallel to the meridian.

For use, the triens would be fitted with a plumb-bob and cord passing through an aperture at A. With the instrument held vertically, the sun is sighted through the apertures and the altitude of the sun read from the freely-hanging cord on the limb scale. A bead on the cord is then set to this reading on the altitude scale and moved around until it meets the arc of declination appropriate to the zodiacal sign of the sun's current position. The planetary hour or the seasonal hour is found from the position of the bead among the hour lines, knowing whether the sun is before or after the meridian. The azimuth of the sun (measured from the east or west points of the horizon) can be found from the intersection of the limb scale with the cord.

On the stereographic projection of Fig. 9 the planetary hour arcs are centred on a line orthogonal to the meridian passing through the apex of the projection (representing the zenith) at distances and radii (where R is the radius of the arc of degrees):

$$y = R \cos \varphi / \tan h$$

$$r = R / \sin \{ \arctan(\tan h / \cos \varphi) \}.$$

If continued beyond the declination lines they would intersect the meridian at point H, the projection of the south point of the horizon. On a horizontal dial the north and south points of the horizon are at infinity and the hour lines are parallel to the meridian and spaced at  $N \tan h_s / \cos \varphi$ ,

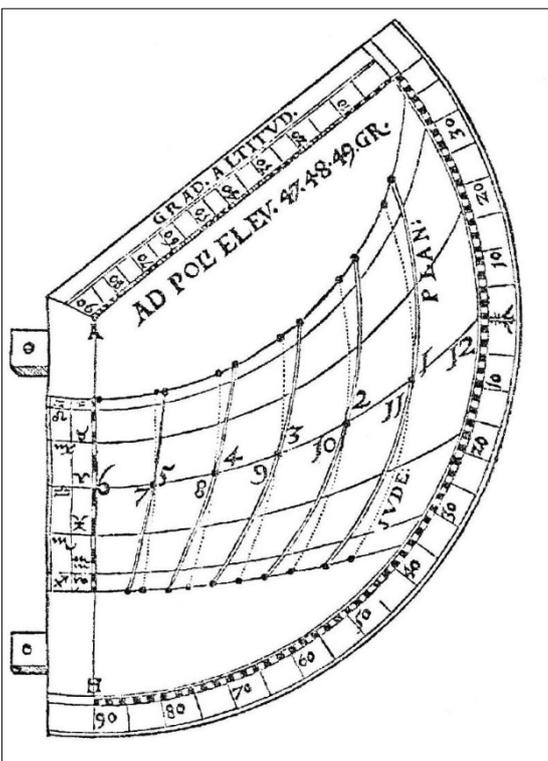


Fig. 9. A version of a 'triens' by Peter Apian delineated for planetary ('PLAN') and seasonal ('JUDE') hours.<sup>12</sup> It uses the horizontal stereographic projection.

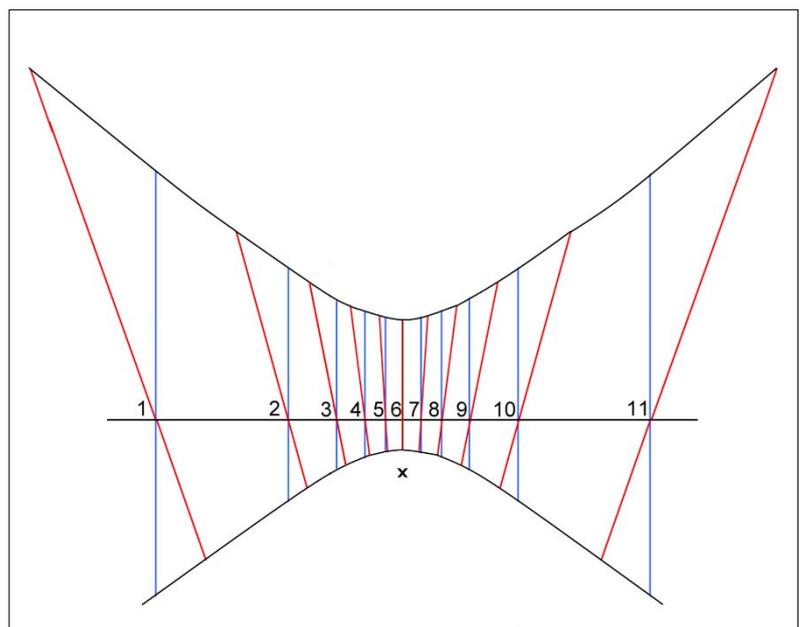


Fig. 10. Comparison of seasonal hours (red lines) and Apian planetary hours (blue lines) on a horizontal dial for latitude 51½°.

with a vertical gnomon and nodus height  $N$ . On a south-facing vertical dial the lines radiate from the base of a horizontal gnomon at angles  $\arctan(\tan h_s / \cos \phi)$  from the noon line.

### Comparison of Seasonal Hours and Apian Planetary Hours

Although no such dial is known to the authors, it is possible that some dials apparently with seasonal hours are actually delineated for Apian hours. The appearance of both on a horizontal dial for latitude  $51\frac{1}{2}^\circ$  is shown in Fig. 10 with red lines for seasonal and blue for Apian hours. Both sets pass through the 15-degree points on the celestial equator, but the seasonal hours are inclined to the meridian instead of parallel. This inclination is dependent on the latitude, becoming less at lower latitudes and (to take the extreme case) for a location on the equator, where the semi-diurnal

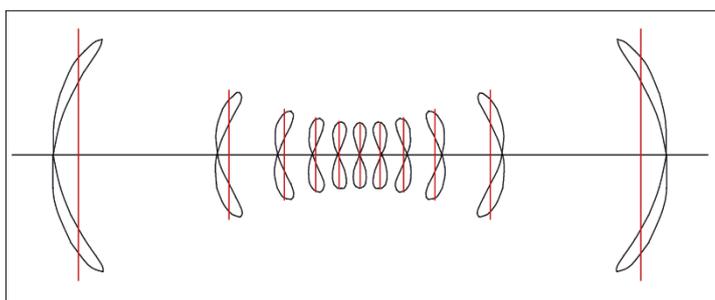


Fig. 11. A horizontal dial for a location on the equator. The distorted figure-eight shapes are the ecliptic planetary hours: the red lines indicate the seasonal and Apian hours.

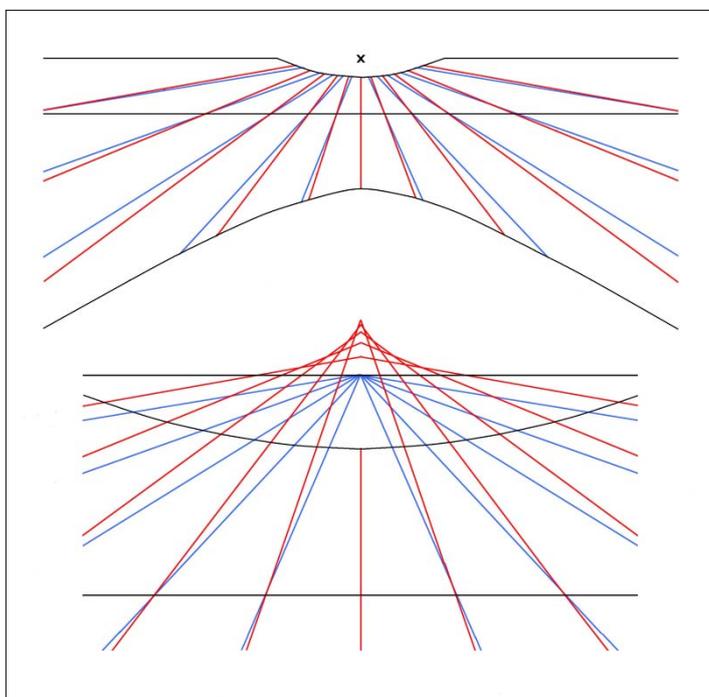


Fig. 12. Comparison of seasonal hours (red lines) and Apian planetary hours (blue lines) on a vertical south-facing dial at latitude  $51\frac{1}{2}^\circ$ . The upper diagram shows as much of the layout as can be conveniently included: the lower diagram is an enlargement of the central section showing how the lines intersect.

arc is always  $90^\circ$  and the poles are on the horizon, the seasonal, Apian, equal, Italian and Babylonian hours would all coincide in lines parallel to the meridian. But the ecliptic planetary hours would appear as distorted figure-eight shapes, as shown in Fig. 11.

Seasonal and Apian hours on a south-facing vertical dial for latitude  $51\frac{1}{2}^\circ$  are shown in Fig. 12. The distinction between the two sets is not very obvious and for a real dial careful measurement might be necessary. One distinguishing feature is that the Apian hours if extended intersect in a point on the projection of the horizon, but the seasonal ones have no common intersection, as shown in the enlarged central section on Fig. 12.

Of course the majority of vertical dials will not face due south, having greater or lesser declining angles, but the above rule concerning the line intersections will still apply. The dial shown in Fig. 1a declines about  $12^\circ$  west and is drawn for seasonal hours.

### Other Instruments:

The British use of seasonal hours appears to have been relatively limited. We have previously described<sup>13</sup> two horizontal dials by Isaac Symmes which carry them and two examples on unusual altitude dials by Humphrey Cole are known.<sup>14</sup> These use the shadow of a 45-degree gnomon to find equal hours and seasonal hours.

### Conclusion

It is not really possible to give definite answers to most of the questions posed above. No dials carrying ecliptic planetary hours have come to the notice of the authors, but manuscript diagrams have been located.<sup>9</sup> If ever they were used, it seems possible that planetary hours were superseded in Roman times or earlier, and the extract from Agrippa indicates that in his time they were considered obsolete. It is difficult to envisage any current use for planetary or seasonal hours but some modern dials may carry them merely for interest. The hints given in this article may help to resolve any problems with identification of hour lines on old dials.

### Brief Biographies

Heinrich Cornelius **Agrippa** von Nettesheim (1486–1535)<sup>15</sup> was a German occultist, natural philosopher and medical writer. He is also described as a magician, theologian, astrologer and alchemist. He was an exact contemporary of Nicholas Kratzer, whom he met at the University of Cologne and later, in 1510, in the English Court of Henry VIII, where Agrippa was a servant of Louis of France.<sup>16</sup>

**Peter Apian** (1495–1552, Petrus Apianus) was born in Saxony and studied at the University of Leisnig. He was a mathematician, cosmographer and also a printer of high-quality geographic and cartographic works. He is best-known for his 1524 *Cosmographicus Liber*, a work renowned for its diagrams with working volvelles. Also of

importance is his *Instrument Buch...* (1533) describing the construction of astronomical instruments. One of his 14 children was Philip Apian (1531–1589) who was also a mathematician and who did much to promote the work of his father. For a list of their works, see Zinner.<sup>17</sup>

**Sacrobosco** (c. 1195–c.1256, John of Holywood) was a monk and astronomer who taught at the University of Paris. He is believed to have been born in England, though there is considerable mystery about the full details of his biography.<sup>3</sup> He is credited with introducing the Hindu-Arabic number system into Europe and he also accurately described the defects of the Julian calendar centuries ahead of its replacement by the Gregorian one. His short book *Tractatus de Sphaera* ('The Sphere', c.1230) was hugely influential throughout the medieval period as an introduction to astronomy, providing a readable description of the Ptolemaic universe.

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We are grateful to Nick Orders for photocopying parts of Drecker's book from the BSS Library. Walter Hofmann, and Annelies Schranz of Prutz, Tyrol, provided much assistance searching for lost and extant Continental wall dials. The photograph of the San Benigno Canavese dial (Fig. 1a) was kindly supplied by Francesco Caviglia.

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## NEW DIALS

### Barrington Court, Ilminster, Somerset

Some of the sundials at the National Trust property of Barrington Court were shown in *BSS Bull.*,

25(i), p.15. Missing from these was

the early-19<sup>th</sup>-century horizontal dial by Cary of London on a stone pedestal, which was stolen early in this century. After a number of false starts involving several BSS members, the NT commissioned a reproduction dial which has just been installed on the original pedestal by *Flowton Dials*.

As the stolen dial was probably not made for this location, the reproduction is 'signed' "After CARY, LONDON" and is based on a variety of known dials by the maker. The cartouche to the south is adapted from an early 20<sup>th</sup>-century garden plan. The dial plate is patinated three-eighths-inch marine brass and the fixings go deep into the pedestal.



JD

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