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EDITORIAL

Diallists are very well aware that you do not have to study sundials for long before you appreciate how useful it is to know a little Latin and Greek. You then come across Islamic prayer times and realise that some understanding of Arabic is helpful too.

This issue begins with an article by Fathi Jarray and others which describes a number of Islamic sundials. By studying the Arabic inscriptions and other features, these dials turn out not to be quite what they purport to be.

In another article, Irene Brightmer notes how rare it is to find sundial inscriptions in Welsh, another language to add to the list.

In the final article, Johan Wikander describes symbols found on ancient Scandinavian Sundials. When reading an early draft of Johan's article I felt the need for further study and quickly found myself investigating Old Norse, one more language diallists need to know! My studies have turned into an article which includes a glossary of Old Norse dialling terms.

Venturing a little further south, our stalwart Scottish regular, Dennis Cowan, has written Part 36 of his Thomas Ross series.

Sue Manston again finds inspiration in a Help-and-Advice enquiry, this time from one of the founders of the British Elephant Polo Association. Studying sundials produces endless surprises.

A slightly different surprise was in store for Graham Stapleton when he investigated a sundial which he spotted when looking at a DVD film. Before long he found himself metaphorically visiting Ealing Film Studios.

For those who prefer something new, Eduard Masana of Barcelona describes an equatorial sundial which exploits some large diameter cylinders and a very small spot of light.

At the time of writing, most Covid restrictions seem to have been eased, in England at least, and we have every hope that the Newbury Meeting will go ahead in September. Our next issue should therefore include reports of the talks.

Frank King

ISLAMIC SUNDIALS SIGNED BY AL-MANSUR CARRYING DATES IN THE LATE 17th CENTURY

An Examination of their Gnomonic and Historical Anomalies

FATHI JARRAY, ERIC MERCIER and DENIS SAVOIE

The original French version of this article is to be published as 'Les cadrans solaires signés al-Mansur (fin du XVII^{e} siècle): Inventaire des anomalies gnomoniques et historiques' in *Cadran Info*, 44 (October 2021).

The Muslim religion prescribes that the faithful perform five daily prayers at certain times of the day and night. In detail, the definition of these times has varied according to countries and periods of history, but it is mainly solar astronomical criteria that have been used.[1] The *Mu'aqqits*[2] therefore used astrolabes, or sundials, to help them in their task of determining the times of prayer each day. Some of these figures are known for their expertise in astronomy and gnomonics, such as Ibn Al-Shatir, the *Mu'aqqit* of the Great Mosque of Damascus, who, around 1371 AD, was the first person known to date to have employed a polar gnomon.[3,4]

Mosque sundials are remarkable in that they present, in addition to time information (in unequal or equal hours depending on the period), additional lines corresponding with the times of all, or some, of the five canonical prayers.[5,6,7] In practice, the crossing of one of these lines by the tip of the gnomon shadow can indicate, depending on the line, the beginning or the end of a favourable period for a prayer that takes place during the day (*Zhur*, *Asr*), or that takes place at night (*Maghrib*, *Isha*, *Fajr*); in the latter case, the indicators announce this prayer several hours in advance, while the Sun is still above the horizon. It can be assumed that the *Mu'aqqit* would then start counting the hours with an hour glass or a clepsydra.

Mosque dials are therefore sophisticated, rare and valuable instruments that have been systematically inventoried in a number of Muslim countries. The inventories for Turkey by Cam,[8] Egypt by 'Abd-l-'âtî,[9] Tunisia by Jarray,[10] Morocco by Kharbouche,[11] and India by Sarma[12] list a few hundred mosque dials in total. Apart from the early centuries of Islam[13,14] and towards the end of the nineteenth century,[15] they are generally instruments of good scientific quality, made by skilled craftsmen with a mastery of the science of gnomonics.

The recent appearance on the art market of a dozen mosque sundials dated in the 17th century has therefore attracted our attention. These sundials are believed to come from North Africa (Morocco to Egypt), according to the Qibla indicated on the dials themselves (see below). But these instruments present a number of anomalies that clearly

Ref.	Hegira year	AD year (approx.)	Size (cm)	Sources of data (sales ...)	Qibla (°)
7	1082	1671	24 × 24	Paris June 2010	105
9	1082	1671	25 × 25	Londres April 2008; London Oct. 2008	107
6	1082	1671	60 × 50	Paris June 2015	116
1	1085	1674	32 × 32	(private property)	113
8	1085	1674	57 × 38	London Oct. 2008	119
2	1085	1674	50.5 × 41	Munich Dec. 2009; London Dec. 2015; London May 2016; Hattem April 2018	135
3	1090	1679	32 × 32	Cannes Aug. 2009	118
4	1090	1679	40 × 60	Paris May 2018; Paris March 2019	120
10	1090	1679	25 × 25	Paris Feb. 2021	119
5	1092	1681	28.5 × 28.5	Paris Nov. 2017; Paris March 2018	100

Table 1. Main characteristics of the dials studied. The numbers are arbitrary and refer to Fig. 1 and the text.

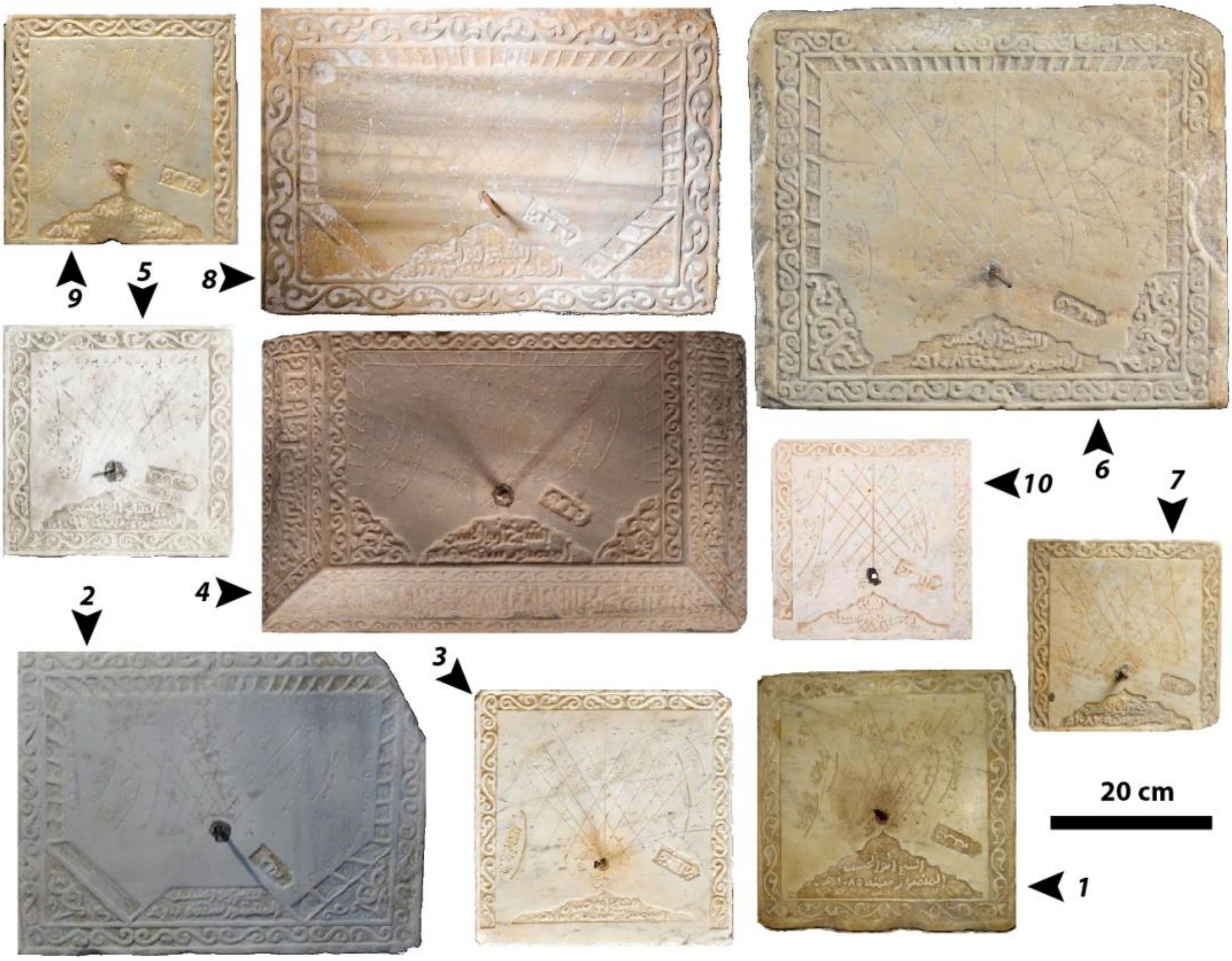

Fig. 1. The ten dials signed al-Mansur illustrated at the same scale.

differentiate them from the rest of the production of the period, which is why we would like to present and discuss them here (Fig. 1 and Table 1).

General Presentation of the Dials Studied

Fig. 1 shows, at the same scale, the ten dials that we will discuss. Nine of them (nos. 2 to 10) were offered at auction between 2008 and 2021 in London (GB), Paris (F), Cannes (F), Hattem (NL) and Munich (D). Some have been sold several times (nos. 2, 4, 5 and 9: see Table 1). Dial 1 is kept in a private collection and we do not know where and when it was acquired, but as it has the same signature and the same anomalies as the other nine, we have chosen to include it in this study.

They are horizontal sundials cut in marble and are characterized by a careful decoration, marked in particular by ornamental friezes, which contrasts with the mosque dials known from elsewhere, which generally do not present any decorative elements in order to avoid any disturbance in the reading of the astronomical information. Furthermore, all these dials are signed by a single gnomonist: al-Shaykh Abu al-Hasan al-Mansur, and dated between 1082 and 1092 AH (i.e. 1671–1681 AD). With ten known instruments, this diallist is by far the best represented in the inventories. He does not appear in the list of authors of astronomical works in the Muslim West,[16] he is not recorded in the *Répertoire des facteurs d'astrolabes*[17] and, curiously, none of his works are known preserved in a mosque. Yet mosque dials are considered *hubous* in Muslim jurisprudence, roughly equivalent to being inalienable. The vicissitudes of history may explain why a handful of these instruments may have left their original location to join private or public collections, but the apparently targeted and systematic nature of the looting that affected the dials of al-Mansur seems quite astonishing. Finally, it should be noted that during the period when the ten dials from al-Mansur were offered for sale (2008–2021), it would appear that no other mosque dials appeared on the art market.

Analysis of the Qibla: Origin of the Sundials

Mosque dials are used to determine the time at which Muslims should perform their prayer. In the case of horizontal dials, they usually indicate the direction of Mecca (*Qibla*) towards which worshippers should orient themselves to pray.

In theory, to determine the Qibla of a place, one needs to have the geographical coordinates of Mecca and the

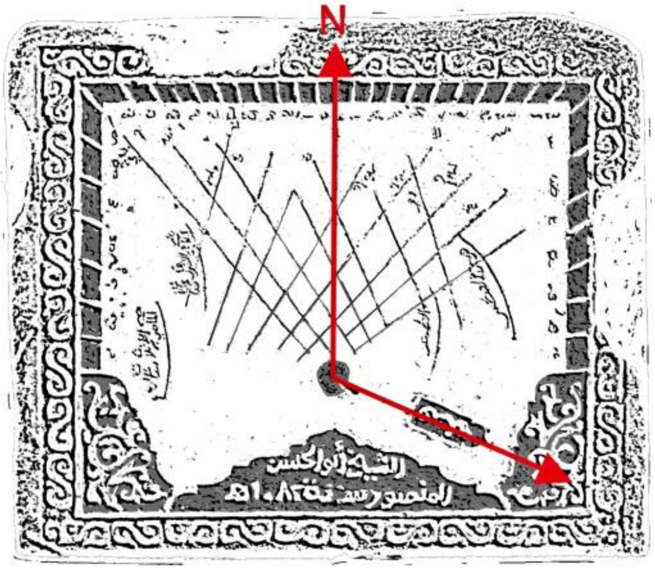

Fig. 2. Principle of reading the Qibla on a dial, illustrated from dial 7.

place in question, and then perform complex calculations using spherical trigonometry. In practice, the geographical coordinates remained very uncertain until the nineteenth century,[18,19,20] and diallists therefore generally used approximate methods for the calculations, so that the direction mentioned on the dials is very usually a 'traditional' value, variable over the centuries and always quite approximate.[21]

It is standard, on the dials of al-Mansur, that the direction of the Qibla is indicated by a small stylised mihrab (Figs 2 and 3) whose orientation with respect to the meridian line is measurable on the dial. What is remarkable is the variability of this orientation. It corresponds to values that were used, in the 17th century, in countries very far from each other, with Morocco and Egypt as extremes. This could suggest, in a first analysis, that al-Mansur had an activity covering the whole of North Africa; but this conclusion is very surprising insofar as diallists listed to date had only a purely regional activity (a radius of only a few dozen kilometres).[22]

Fig. 3. Examples of the Qibla direction indication. The writing is here cursive (dial 6) and geometric kufic (dial 3).

Epigraphic Analysis

These sundials pose problems with regard to the style of writing and the form of the various inscriptions that appear on them (see Table 2).

Like other Muslim sundials of this period, all the instruments signed by al-Shaykh Abu al-Hasan al-Mansur are commemorated by an inscription using the same relatively abbreviated epigraphic form and limiting itself to the essential elements: the name of the craftsman and the date in Hegira year.[23] This text appears, on all the dials studied, in a triangular commemorative escutcheon, written

Table 2. Table of the types of writing used on the dials of al-Mansur

Sundial number	**Date**	**Type of handwriting (C = cursive; K = kufic)**			
		Craftsman's signature	**Qibla**	**Koranic verses**	**Other inscriptions**
1	1085/1674	C	C	-	C
2	1085/1674	C	C	K	C
3	1090/1679	C	K	-	C
4	1090/1679	C	C	K	C
5	1092/1681	C	C	-	C
6	1082/1671	C	C	K	C
7	1082/1671	C	C	-	C
8	1085/1674	C	K	-	C
9	1082/1671	C	C	-	C
10	1090/1679	C	K	-	C

Fig. 4. Example of a commemorative crest typical of those on the dials studied (dial 1). Note the date in the form of 1085 H. at the bottom left.

in cursive script, where the date of manufacture can be read (Fig. 4). This date employs a surprising formalism that consists in indicating the abbreviation of the word *hijri* (of the hegira) by the letter 'H' followed by a dot (e.g. "1082 H."). This form poses a problem since it seems to be known only from the 20th century, when it appeared under Western influence.[24] It should also be noted that such a form is historically improbable. In Muslim countries, in a mosque in the seventeenth century, Muslims are not spontaneously inclined to specify that the date is counted after the Hegira; nor, at the same time, in Europe, do the dates inscribed in churches specify that they are years after the birth of Christ!

Finally, it should be noted that three dials (2, 4 and 6) have inscriptions with Qur'anic verses carved in relief around the perimeter or on the outer faces of the slab. These Qur'anic inscriptions are remarkable for the fact that they are carved in relief in flowery kufic script, very characteristic of medieval inscriptions and particularly of those of the 4th–5th/10th–11th century (i.e. at least six centuries before the studied sundials).

Let us examine sundial no. 2 in detail. The commemorative shield, with the signature and date, is carved in relief in cursive script. The outer border of the instrument contains a Qur'anic text executed in floral kufic script. It is part of verse 189 of Sura II, *al-Baqara* The Heifer ("*Believers ask you about the new moons. Answer them: They are landmarks in time for men and the Pilgrimage*"). It is highly probable that the sculptor was satisfied with this part of the verse, which is very appropriate to the function of this instrument.[25]

The coexistence of different types of writing and historically distinct periods is also evident on dials 3, 8 and 10 where the signature of the craftsman is in cursive script, while the indication of the Qibla is carved in simple kufic or geometric script. This association of two types of writing (cursive, and flowery or geometric kufic) which belong to different periods and influences and which are historically incompatible seems to us to be very curious and has no historicity/historical reference.

Gnomonic Analysis of Dials: the time function

Some of the dials in the series studied (2, 4, 6 and 8) have a band on the outer edge where the hour lines begin to appear. On ancient Muslim dials, the spacing of the hour lines corresponds to 5 drej (= degrees[26]) or 20 minutes of equal time. Three graduations thus correspond to one hour. The drawing of these lines is usually sufficiently precise to calculate, to within one or two degrees, their latitude (in North Africa between 27° and 37°).

The time lines, especially those running East–West and North–South, i.e. 6 am, 12 noon and 6 pm, should intersect at the point where the polar style is located. Usually, on mosque dials of the 17th and 18th centuries, one can observe at this particular point:

- either a hole, or a sealed loop to which a string can be attached which, when properly fixed to a support outside the dial, serves as the polar style,
- or the gnomon (the function of which will be discussed later), the base of which serves as a device for fixing the string-polar style.

Let us insist on the fact that it is absolutely necessary that the string which acts as a style starts from the crossing of the lines noon and 6 h–18 h, i.e. the place where the segments of the hour lines converge, without which one observes a shearing off from the segments by the shadow, instead of a perfect alignment. So if there is even a slight shift, as in the case of dials 2 and 4, where the right style is off-centre, the dial is unusable for reading the time. In the case of dial 2 of al-Mansur that we choose here as an example (Fig. 5), we do not observe any device intended to fix the polar style at the point of convergence of the hour lines; the gnomon is shifted towards the North on the meridian line preventing de facto the deployment of the polar style. A curious fact is that dials 2 and 8 only have extended time segments for the evening (from 6 pm until sunset) and no segments for the part from sunrise until 6 am.

At the other end of the polar style, one expects to find a 'high' hanging point to ensure the tension of the string which is normally located at the 'north' of the dial on the noon line representing the meridian. It is not seen on the

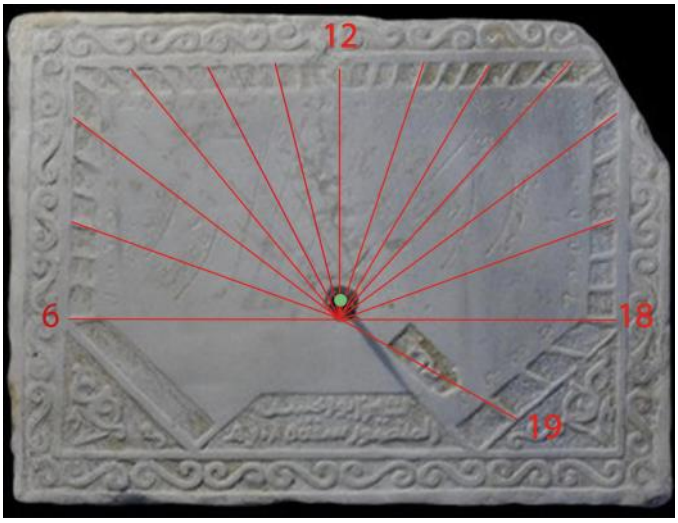

Fig. 5. The hour lines of dial 2; they converge slightly to the south of the gnomon (green circle) which is therefore an obstacle to the installation of the polar style.

al-Mansur dials. It is nevertheless possible that the system is independent of the dial, as is the case on Tunisian dials. The position of this attachment point is fundamental as it ensures the correct inclination of the string, which must be equal to the latitude of the place. If the system is faulty, in other words if the string is not stretched at the correct angle, the reading of the time is sometimes considerably altered: for example, in the case of a horizontal dial drawn for a latitude of 35°, if the string-style is too close to the dial by 5°, the error reaches a maximum of ± 21 minutes in summer for the 8 o'clock and 4 o'clock lines.

Finally, let us note that the drawing of the hour lines of dial 2 (Fig. 5) is very approximate and the latitude that we calculate, according to the measured hour angles, is about 60°, i.e. close to the polar circle! As for dial 6, the same analysis still shows a great inaccuracy in the plot, but provides a latitude of the order of 40°, which is more acceptable. As for dials 4 and 8, the number of graduations is aberrant; between 6 and 18 o'clock, we find respectively 34 and 37 intervals instead of the expected 36 (= 3 × 12). None of these dials can be used to determine a time, even an inaccurate one.

Gnomonic Analysis of Dials: the religious function

Muslim dials of the 17th–18th century are equipped with a gnomon perpendicular to the dial plate, the shadow of which will mark the passage of the prayer hours. It should be noted that these are not always represented every fifth hour, and sometimes the religious indications are reduced. Among the most frequent indications, there is a network of straight lines that indicate hours since sunrise (it is the end of the favourable period for the Fajr prayer), and hours to sunset (it is the beginning of the Maghrib prayer). This network, which is the equivalent of the Italian and Babylonian hours of Western gnomonics, is systematically present on the dials of al-Mansur.

The shadow holder of such a grid is necessarily a gnomon, and this grid must include an imaginary East–West line, through which crossings of the grid pass (this is the line of the equinoxes; see Fig. 6). Note that the Italian 18 and Babylonian 6 lines cross on the noon line and on the equinox line. Moreover, the hour lines cannot be parallel as is the case on several of the dials studied here (e.g. dial no. 3 in Fig. 7).

The numerical values corresponding to the different lines of the network are rarely indicated on the dials of al-Mansur. On dial 3, for example (Fig. 7), only Babylonian 3, 4 and 5 are identified. They are clearly wrong: they are lines 4, 5 and 6. Let us see how to find the correct values by identifying at least two lines (Fig. 6): the oblique lines closest to the right style (gnomon), which start just above (to the North), i.e. very close, and which are the 17 h Italian (or 7 h before sunset) and 7 h Babylonian lines. From here the other lines are easily identified; usually the dial shows the Italian 22 as the extreme right-hand line, while the Babylonian 2 is most often the first line on the left.

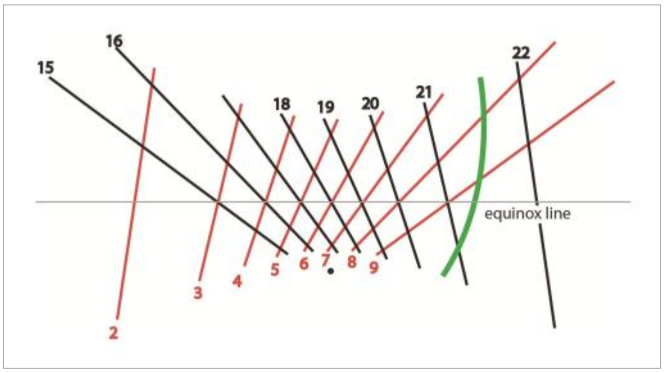

Fig. 6. A correct Italian-Babylonian network. In red the Babylonian lines and in black the Italian. We have added the correct position of the Asr indicator which is entirely included in the space of the Italian-Babylonian grid and intersects the Italian line for the 21st hour.

Most mosque dials indicate the Asr prayer. It takes place in the afternoon, so it should be located in the eastern part of the line: it is a curved arc. Fig. 8 illustrates the curved position of Asr superimposed on the grid of the Italian and Babylonian hours. When the tip of the shadow of the gnomon reaches this curve, it means that its length is equal to the sum of the height of the gnomon and the length of the shadow at noon;[27] it is therefore the beginning of the favourable period for the Asr prayer according to the tradition of the mainstream of Islam.

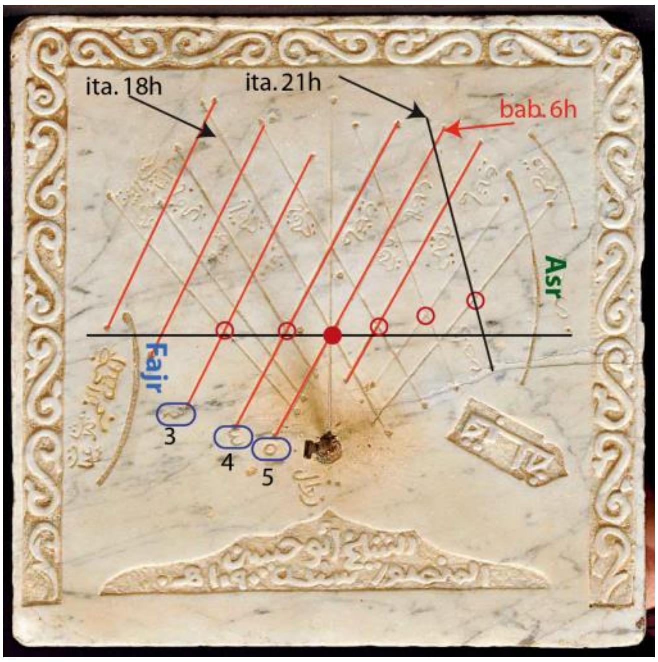

Fig. 7. On this dial by al-Mansur (No. 3 has been taken as the example), the Babylonian lines have been highlighted in red. They are almost parallel which is totally incorrect. Similarly, we have encircled the chaotic intersections of the Italian and Babylonian lines around the straight line of the Equinoxes, although the latter line is not shown on the dial. We have labelled Babylonian hour 6, and Italian hours 18 and 21, and highlighted in blue boxes the labels 3, 4 and 5 for the Babylonian hour lines which are actually 4, 5 and 6. Note also that the Asr line does not intersect the Italian hour line 21. Moreover, the curved Fajr line on the left (probably intended to indicate dawn) is far too low (to the South) to be able to function throughout the year (see the explanation in the text).

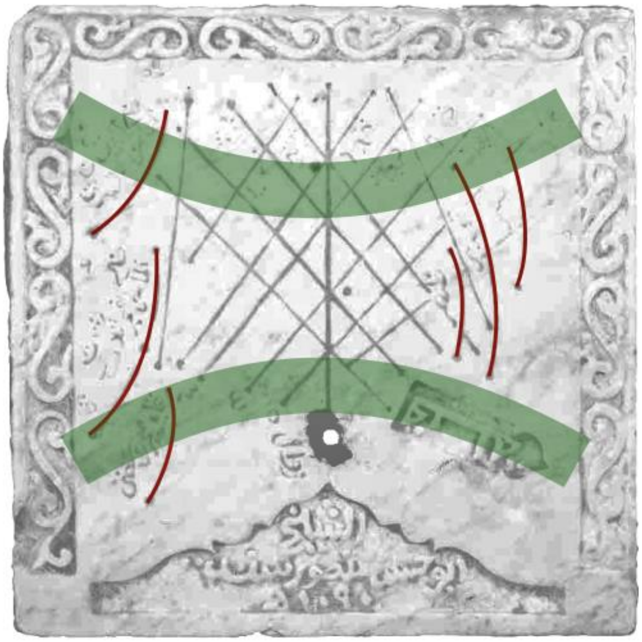

Fig. 8. Example (dial 10) of fanciful drawings of prayer curves which are not limited by the arcs of solstices (in green, positions evaluated from those of the gnomon and the Italian-Babylonian network).

In the area on Earth between the Tropic of Cancer and the parallel of latitude 38° (a portion which includes all of the Maghrib, Egypt, Syria, etc.), the curve of Asr always intersects the Italian line 21 h (or line 3 h before sunset) and always the Babylonian lines 8 h and 9 h, or even 10 h for latitudes which are closer to the Tropic of Cancer. However, it can be seen in Fig. 7 that the Asr curve does not intersect the 21 h Italian line. This curve can never go, in true solar time, below 14 h 27 m (21 h 44 m Italian and 7 h 08 m Babylonian) and beyond 15 h 54 m (20 h 35 m Italian and 11 h 14 m Babylonian) in the range of latitudes 24°–38°. Its curvature is, on a horizontal dial, necessarily turned towards the lower right edge of the dial (south-east direction).

Tables 3 and 4 allow us to determine, according to the latitude, where the two extremities of the Asr curve should be approximately situated in relation to the network of Italian and Babylonian lines. The latitude, the time of Asr in true solar time and the correspondence in Italian and Babylonian time are given successively. None of the dials of al-Mansur respect the indications of these tables.

In addition to the above indications (sunrise and sunset, Asr), one can find, on mosque dials, indications corresponding to other prayers. We will take as an example the Fajr prayer which corresponds to dawn (first light before sunrise). This moment cannot of course be indicated directly by a sundial, but Muslim diallists can indicate it by one or more curves shifted in time (typically 'Fajr' is 3 h, 4 h ...). Their curvature is necessarily South-East. As the vertices of these curves are limited to the two hyperbolas of the solstices (which are not necessarily drawn), it is thus impossible to have curves much shifted in height (see Fig. 8): the bottom of a curve cannot be at the level of the vertex of another one as on the dials studied here. It should be noted, however, that on some horizontal mosque dials of high scientific quality (e.g. the one in Fig. 9), one finds curves that are very much offset in height from each other, but this is due to the fact that the dial works with several straight styles (in Fig. 9: one gnomon for Asr and the

Latitude	Asr time (true time)	Asr time (Italian time)	Asr time (Babylonian time)
24°	15 h 18.8 m	20 h 34.2 m	10h 3.5 m
25°	15 h 21.7 m	20 h 34.9 m	10h 8.5 m
26°	15 h 24.6 m	20 h 35.6 m	10h 13.6 m
27°	15 h 27.4 m	20 h 36.2 m	10h 18.6 m
28°	15 h 30.1 m	20 h 36.6 m	10h 23.6 m
29°	15 h 32.8 m	20 h 37.0 m	10h 28.5 m
30°	15 h 35.3 m	20 h 37.2 m	10h 33.5 m
31°	15 h 37.9 m	20 h 37.3 m	10h 38.5 m
32°	15 h 40.4 m	20 h 37.3 m	10h 43.4 m
33°	15 h 42.8 m	20 h 37.2 m	10h 48.4 m
34°	15 h 45.2 m	20 h 37.0 m	10h 53.4 m
35°	15 h 47.5 m	20 h 36.6 m	10h 58.4 m
36°	15 h 49.9 m	20 h 36.2 m	11 h 3.5 m
37°	15 h 52.1 m	20 h 35.6 m	11 h 8.6 m
38°	15 h 54.4 m	20 h 34.9 m	11 h 13.8 m

Table 3. Time in true time, Italian and Babylonian of Asr at the summer solstice (low point of the Asr curve).

Latitude	Asr time (true time)	Asr time (Italian time)	Asr time (Babylonian time)
24°	14 h 59.5 m	21h 44.2 m	8h 14.9 m
25°	14 h 57.7 m	21h 44.5 m	8h 11.0 m
26°	14 h 55.9 m	21h 44.9 m	8h 6.9 m
27°	14 h 54.0 m	21h 45.2 m	8h 2.8 m
28°	14 h 52.0 m	21h 45.4 m	7h 58.5 m
29°	14 h 49.9 m	21h 45.7 m	7h 54.1 m
30°	14 h 47.8 m	21h 45.9 m	7h 49.6 m
31°	14 h 45.6 m	21h 46.1 m	7h 45.0 m
32°	14 h 43.3 m	21h 46.3 m	7h 40.2 m
33°	14 h 40.9 m	21h 46.5 m	7h 35.3 m
34°	14 h 38.5 m	21h 46.7 m	7h 30.3 m
35°	14 h 36.0 m	21h 46.9 m	7h 25.1 m
36°	14 h 33.3 m	21h 47.0 m	7h 19.7 m
37°	14 h 30.6 m	21h 47.1 m	7h 14.1 m
38°	14 h 27.8 m	21h 47.3 m	7h 8.4 m

Table 4. Time in true time, Italian and Babylonian of Asr at the winter solstice (high point of the Asr curve).

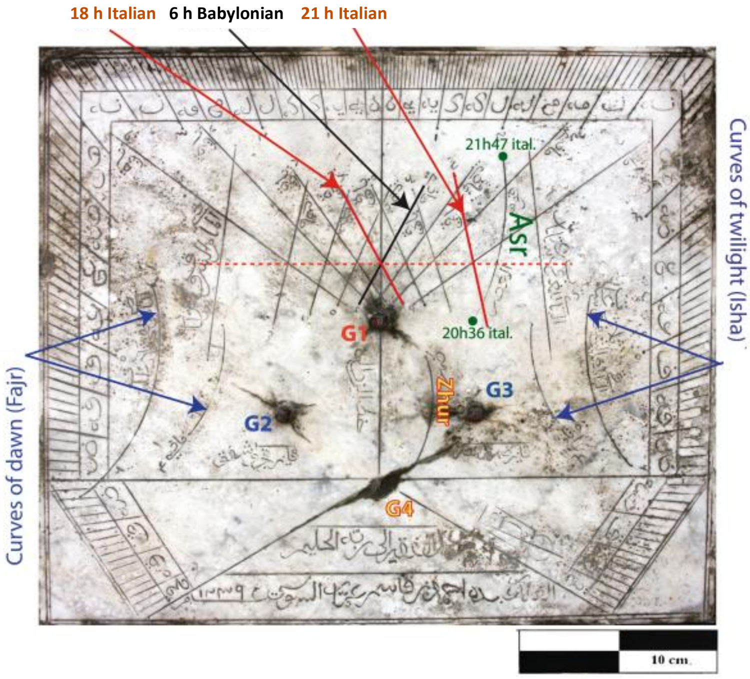

Fig. 9. This correct sundial, kept in the reserves of Sousse Ribat in Tunisia, dates from 1823/1824. It shows that the Asr curve intersects the Italian line at 21 h (or 3 h before sunset); similarly, the equinox line has been drawn in dotted lines where the Italian line at 18 h and the Babylonian line at 6 h intersect. The intersections of the other lines are perfectly aligned with the line of the equinoxes. As for the left and right side curves, they work with the right styles G2 and G3; and indicate the time elapsed since dawn (Fajr) or how long it takes for night twilight (Isha). At the two vertices of the Asr curve the correspondence in Italian time has been indicated. Furthermore, the time band is correctly calculated and corresponds to the latitude of Sousse.

Italian–Babylonian network (G1); one for the dawn (Fajr) curves (G2); one for the dusk (Isha) curves (G3); and finally one for the Zhur curve (G4)). The curve shifts observed on the dials of al-Mansur, which have only one gnomon, do not of course fit into this type of explanation.

Conclusions

The ten mosque dials studied in this article are all signed by the same diallist. Nine of these dials were offered for sale over a short period of time (13 years), while no other mosque dials were apparently sold during the same period. Furthermore, no sundial signed by this gnomonist is currently known to be in place in any mosque in the Arab-Muslim world. As mentioned above, this first observation poses a problem, especially as these dials present an epigraphy that is full of anomalies (association of historically incompatible spellings, and improbable date style).

Moreover, and this is probably the most significant fact, these dials are not at all functional and cannot fulfil their mission (indicating the civil time and the division of the day according to the Islamic prayers). While the mosque dials that are still in place, or preserved in museums, testify to the fact that their authors mastered the rules of gnomonics perfectly, particularly elaborate in the case of the indications of prayer times, we have here completely fanciful layouts. This concerns both the drawing of hour lines, when they exist, and the indications of periods favourable for Islamic prayers.

All these dials signed by the same craftsman, sold in Europe, in which anomalies and serious errors are accumulated, must be considered with the greatest circumspection. In fact, they can probably be qualified as ‘fakes’, like those astrolabes found in the ‘souks’ (covered markets) of the Arab world and which are unusable. There remains the problem of when these pseudo-sundials were made. Were they made for the first tourists at the end of the 19th century, and introduced at that time in Europe? Or were these objects made much more recently? Only analyses of the dials themselves, with, for example, studies on the metallurgy of the gnomons, or on the traces of engraving could give us this information.

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23. The *Hijra* era counts from the date of Muhammad's departure (*Hijra* = migration), from Mecca to Medina on 16 July 622 which thus became 1 Muharram *Hijra* year 1 in the Muslim lunar calendar.
24. The same anomaly appears on an inscription on a funerary piece that was seized by the Tunisian security services a few years ago, which turned out to be a fake archaeological piece.
25. The translation of the whole verse is as follows (translation: Muhammad Asad): "They will ask thee about the new moons. Say: 'They indicate the periods for [various doings of] mankind, including the pilgrimage.' However, piety does not consist in your entering houses from the rear, [as it were,] but truly pious is he who is conscious of God. Hence, enter houses through their doors, and remain conscious of God, so that you might attain to a happy state" (2:189).
26. A drej corresponds to the time it takes the Sun to travel one degree in the sky during the day, or 4 minutes: (24 h × 60 min) / 360° = 4 min.
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POSTSCRIPT

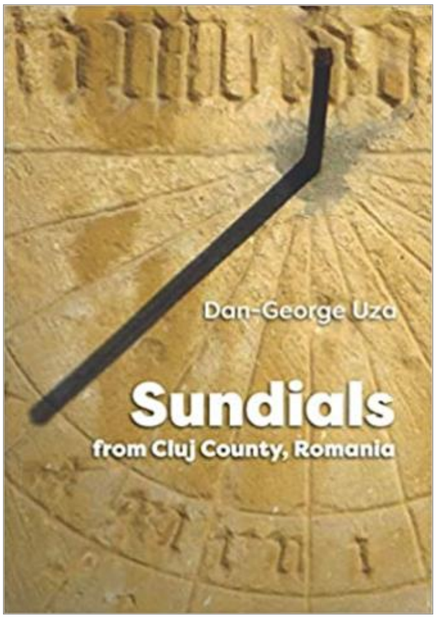
Since the above study was completed an eleventh dial has been found in a private collection (pictured below). This example has not yet been examined.

ACKNOWLEDGEMENT

We thank Anthony Turner for communicating this article to the *Bulletin* and for help with the English translation.

NEW BOOKS (1)

Sundials from Cluj County, Romania by Dan-George Uza, 2020. 69 pp., A5, soft covers, illustrated in colour. ISBN 978-9-730-328783. Price €10 (p&p incl.) from the author with Paypal: *uza@upcnet.ro*



This is the second book Dan-George Uza has written; both books are inventories of sundials.

The first one, *Cadrane Solare*, with text in Romanian and published in 2014, ISBN 978-9-730-176988, is also available direct from the author. It is a nice little book covering quite a large region, the North West part of Romania. Each sundial has a colour picture and a description; latitude and longitude are given. The small size of the book (15 × 15 cm) makes it the perfect companion for dial hunting in Romania.

In this second book, which is published in English, Dan Uza covers a smaller region of Romania: the Cluj County where he was born. Each sundial has a QR code, colour picture and description. So again if you travel in Romania, this small book is a must-have for a sundial lover.

Francis Tamarit

IN THE FOOTSTEPS OF THOMAS ROSS

Part 36: Some East of Scotland Sundials

DENNIS COWAN

Starting off in Hawick in the Scottish Borders, Thomas Ross says in volume 5 of *The Castellated and Domestic Architecture of Scotland*[1] that:

"*On the 25th of December 1888 a sundial was found built into one of the grates in the house of Mr. Francis Scott, 26 High Street, Hawick, who kindly sent us a sketch of the dial. It is a square block of stone with two face dials; the third side contains indistinct lettering, and on the fourth side there is the date, in clear large letters, 1683. On the upper and lower surfaces there is a hole as if for a dowel. In the newspaper report of its discovery considerable importance is attached to the dial, as it was apparently used by the inhabitants, a clock not having been introduced till eleven years later, when the tollbooth was erected.*"

Surprisingly, although Ross says above that he had a sketch of the sundial, he did not include it. This sundial has since disappeared, but interestingly across the road at no. 25 there is an old Scottish sundial motto built into the dormer level of the tenement which was built in 1898 (Fig. 1).

Fig. 1. The old Scottish sundial motto built into the dormer level of the tenement in Hawick.

The website of Historic Environment Scotland[2] states that at no. 25:

"*The escutcheon between the dormers is inscribed: 'TAK TENT O' TIME ERE TIME BE TINT'. No date is visible but published sources state that it is a fragment of a 1683 sundial which had been incorporated into a mid-18th-century building that previously stood on the site.*"

This motto is a Scottish one appearing on a number of sundials and means roughly "take care of time before it passes".

Underneath the motto is a monogram, possibly JG, but I can find no reference to it. So there is a wee bit of a mystery here although it must have been a large sundial going by the size of the escutcheon at no. 25. Ross states that it had holes for a dowel at the top and bottom surfaces so that probably confirms that it was a fair size.

Ross did say that the sundial had large clear letters and certainly the escutcheon does too, so it is quite likely that they may well have been part of the same structure.

Figs 2 to 4. The three stone sundials in Hawick museum. Unfortunately none of them was the missing partner to the sundial motto.

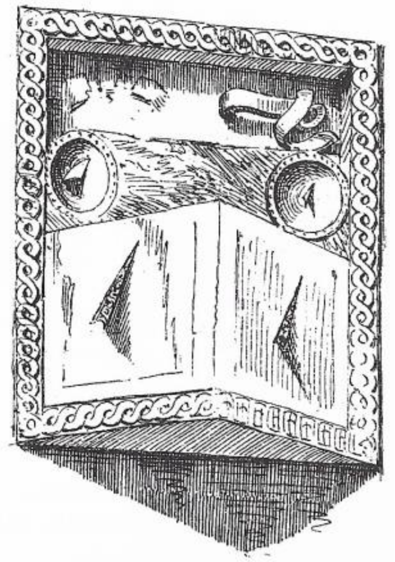


Fig. 5. *Ross's sketch of the Jedburgh sundial.*

The tenement at no. 25 was built in 1898 just ten years after the fragment was found at no. 26. Maybe the builders or architect obtained the escutcheon at that time and incorporated it into their building.

I got quite excited when I heard that the small museum in Hawick had three examples of stone sundials on display, one of which had been presented to the museum after it was found when a house in the High Street was being taken down. Unfortunately when I visited the museum I found that it was dated 1748 and it was a horizontal dial. The two other sundials were dated 1736 and 1823 (Figs 2 to 4).

Staying in the Borders, but moving to Jedburgh around twenty minutes away by car, one can see a vertical sundial on the front elevation at second floor level of Bonnie Prince Charlie's house in the Castle Gate. It was never Prince Charlie's house, but he was reputed to have stayed there in 1745 on his way down south to attempt to regain the Crown for his father, so from then on it was known as his house. Ross has the following to say of it:

"*This is a peculiar dial* [*Fig. 5*]*; it is wedge-shaped in the lower part so as to form a double dial like those of Heriot's Hospital,*[3] *and above this there are two cup-shaped dials on a surface parallel with the wall of the house on which it stands. The dial is in rather a dilapidated condition; it is undated, but has the remains of a riband in high relief bearing the words FUMIT CUNCTUS NOVANTHUS.*"

This sundial still exists today as can be seen at Figs 6 and 7, but is in a much poorer state than it was in Ross's time. The riband with its motto has now virtually disappeared and the diptych (double) dial has all but gone, but on the plus side, the two cup-shaped dials are still there, albeit without any numerals or hour lines.

In her book,[4] Mrs Gatty tells us that:

"In the Proceedings of the Berwickshire Naturalist's Club, 1885, there is a paper by Walter Laidlaw, Esq., on 'Armorial bearings and inscriptions in Jedburgh and its vicinity,' and in this Mr Laidlaw states: 'On the front of Blackhills house in Castlegate is a stone, having the appearance of armorial bearings. Having examined it, I found two rather peculiar sun-dials with an inscription on an iron scroll, Fuerat cuncta novanthus.' No suggestion is made as to the meaning of the words."

Fig. 6. Prince Charlie's house in Jedburgh with its sundial.

Fig. 7. Close-up of the Jedburgh sundial.

The inscription is on stone and not on iron, but this is without doubt the sundial referred to by Ross as the British Listed Buildings website[5] tells us that the property was originally owned by the Blackhills family. There is a differing interpretation of the Latin motto and I cannot come up with any meaningful translation of either version, but perhaps neither interpretation is actually correct. The above noted website also tells us that the crest of the Blackhills family could at one time be seen on the sundial.

Further north, the harbour town of Dunbar sits at the entrance to the Firth of Forth. A few miles inland, Ruchlaw House is on the outskirts of the small village of Stenton. Ross describes two sundials here, the first of which is a fine example of the lectern type. He says:

"*This most graceful dial* [Figs 8 and 9] *stands in the garden of the old house at Ruchlaw. It has a plain octagonal shaft, with a base and capital supporting the dialstone, which contains about thirty-five gnomons. The shaft is 7½ inches in diameter, and is 3 feet 5½ inches high, and the total height is 5 feet 8 inches. There are two carved window pediments on the old house, one of which has the arms and initials of Archibald Sydserf and the date 1663; the other has the same date and initials, with the addition of those of*

Fig. 8 (left). Ross's back view of the Ruchlaw lectern dial.

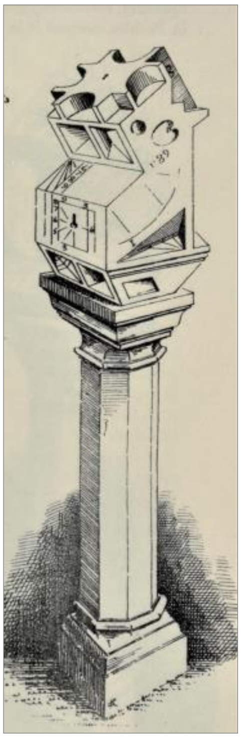


Fig. 9 (right). Ross's front view of the Ruchlaw lectern dial

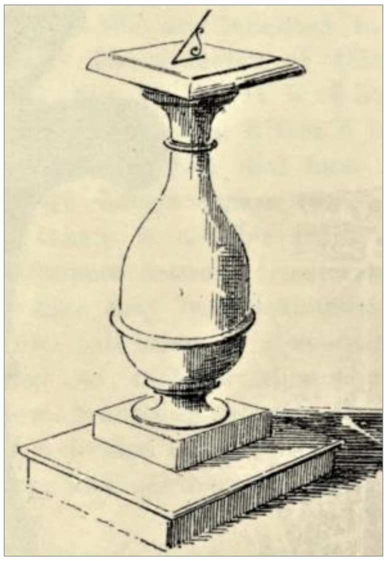


Fig. 10. Ross's sketch of the Ruchlaw horizontal dial.

his wife, also a Sydserf, and in all likelihood this is the date of the construction of the dial. It was broken and cast aside, till, about the beginning of this century, it was restored and put up where it now stands, and for security the dial-stone was clasped to the capital with iron bands."

A graceful dial indeed, but unfortunately it no longer exists. According to Andrew Somerville,[6] the owner in 1981 said that it had collapsed before he bought the property more than twenty years previously, and that it had been buried beneath the greenhouse! A photograph exists showing the sundial *in situ* in 1920, so it must have been buried sometime between 1920 and 1961. When I spoke with the current owner, he was aware that there had been an old sundial, but that was all he knew. When I told him the story, he said that there was no greenhouse now, but he would try to find out where it had been. Who knows, the sundial may still exist under the soil somewhere and be recovered. Let us hope so.

But there is another sundial at Ruchlaw House and it stands in the centre of the walled garden. Ross says simply:

"*This is a typical example of the class* [Fig. 10]. *It has a marble face inserted in the stone table, which bears the name ARCHIBALD SYDSERF, ROUGHLAW.*"

The class referred to by Ross is the horizontal type. This dial sits on a fine baluster pedestal (Fig. 11) but it is in extremely poor condition with no hour lines, numerals or inscription visible today. There is not much left of the gnomon either (Fig. 12)! We can, however, still make out the marble face inserted into the stone table.

Moving west to Monkton House near Musselburgh, Ross comments simply that:

"*There is a plain dial on the west wall of this house, which probably dates from about the beginning of last century.*"

Monkton House in its current configuration actually dates from around 1680 with parts of the house being of 16th

Fig. 11. The Ruchlaw horizontal dial on its baluster pedestal with Ruchlaw House in the background.

Fig. 12. The extremely poor condition of the Ruchlaw horizontal dial with the remnants of the gnomon.

century origin. Again, Ross does not provide a sketch of this sundial, and it is no longer in place. There is, however, a sundial on what was the stable block (Fig. 13) across the courtyard from the house. It is a fine vertical declining sundial but it faces due south (Fig. 14). This probably

Fig. 13. The Monkton sundial in situ above the door.

Fig. 14. Close-up of the Monkton sundial.

confirms that it is not original to the building, and came from elsewhere. It almost certainly is not the sundial referred to by Ross as it is not a plain dial and is not designed for a west wall.

It is fairly large, around 600 mm by 300 mm, with gilded numerals and with quarter, half and hour lines. The numerals are Arabic running from 7 am to 6.30 pm except unusually for X, XI and XII, and there are gilded sun and star motifs. At either side of the dial face are representations of thistles in green and blue with gilded crowns above. There are two mottoes also gilded, with "Jamais Arriere" in a semi-circle around the gnomon root and "Through storm & sunshine Lord abide with me" below the sundial.

Jamais arrière, meaning "Never behind", is the motto of the Clan Douglas (a Lowland clan) but I can find no reference to that family or clan at this house. The BSS Fixed Dial Register 2020 notes that this sundial (SRN 1872) appears to be mounted indoors on a chimney breast above a fireplace, but as can be seen from Fig. 13 this is clearly not the case.

We travel north and across the Firth of Forth to Pitreavie in Dunfermline, where there was a fine lectern sundial next to the house. Ross says:

"*This dial* [Fig. 15] *stood on a terrace which ran along the south front of the old house of Pitreavie. A flight of stone steps led up to the dial, which had a wide octagonal paved space around it. This, with the stair and terrace, gave a finished and dignified air to the dial. It stands on a square pedestal, instead of the usual shaft, with carved escutcheons on each face containing the initials of Sir Henry Wardlaw, the family arms, a heart-shaped figure, and the date 1644. This dial is not quite so elaborate as others of the type, but it contains all the permanent features, and is fitted gracefully to the pedestal with a bold, flowing moulding. The pedestal is 10¾ inches square, and*

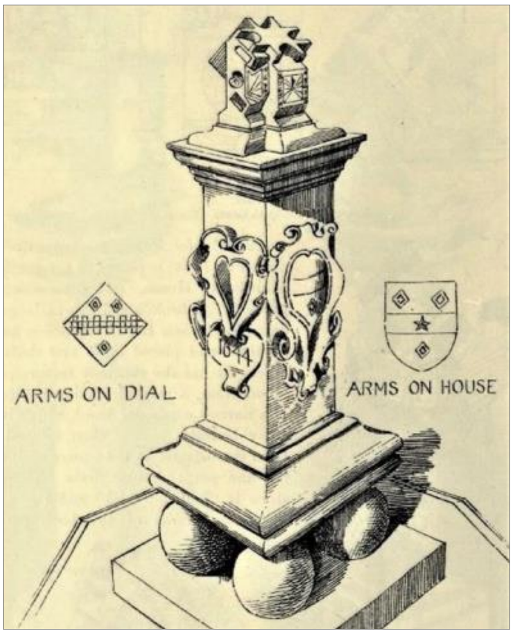


Fig. 15. Ross's sketch of the Pitreavie sundial which was later moved to Inveresk.

Fig. 16. The Inveresk sundial today.

Fig. 17. The Inveresk sundial showing the poor restoration work.

Fig. 18. The star on top of the Inveresk sundial.

measures from floor to top of cornice 4 feet 5¼ inches, and the whole height is 6 feet 1¼ inches."

This sundial is no longer at Pitreavie as it was removed from there in 1968 to the National Trust for Scotland's garden at Inveresk Lodge (Fig. 16), not too far from the previous sundial at Monkton House. It was restored in 1991 but it appears that a rather poor job was made of it as can be seen in Fig. 17. Lectern sundials come in two main types, those with and those without a star on top. This one has a star (Fig. 18) and has dials in every available space. It is worth a visit and the gardens are superb.

A little further west, but on the northern bank of the Firth of Forth is the village of Torryburn. Ross identifies a sundial here, but only says that: "*it is recessed in a square niche*".

Looking at Ross's sketch at Fig. 19, we can see that it is a stone cube of the usual Scottish type with dials on the south-east and south-west faces. It is topped with a head with what appears to be fairly long straight hair. Torryburn is only a few miles from my house and I visited there several times looking for this sundial. Ross did not give any indication of where it was so I wandered through the old

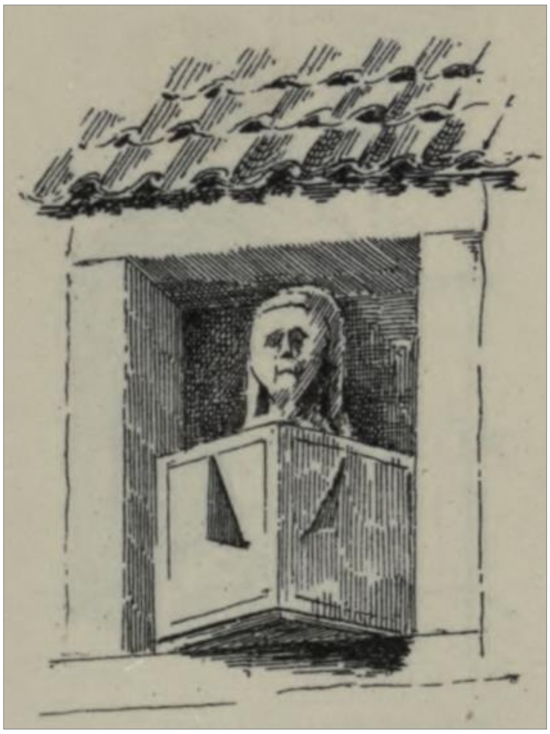


Fig. 19. Ross's sketch of the Torryburn sundial.

Fig. 20. The head and half of the Torryburn sundial on the brick pillar.

Fig. 21. The Torryburn sundial from the south-west.

Fig. 22. The Torryburn sundial from the south-east.

part of the village, but unfortunately never ever found it. No one that I asked had heard of it, so I assumed that it was long gone.

Then at the end of March this year, I parked the car in the small car park in the village and my wife and I started to walk along the coastal path. Almost immediately I saw what appeared to be a head sitting on a brick pillar

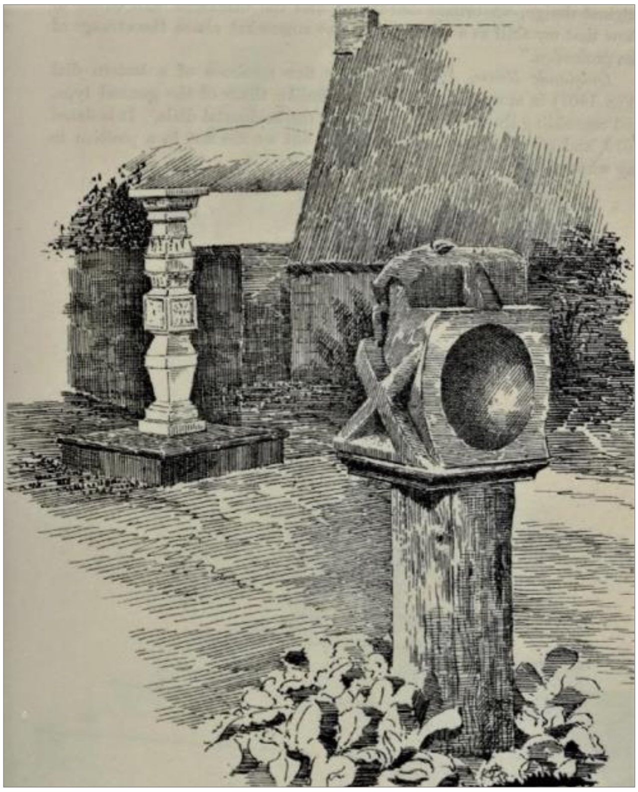


Fig. 23. Ross's sketch of the Cromarty sundials.

(Fig. 20). I said to my wife "that's the head of the missing sundial!" When we got closer I could see that not only was it the head, but it was sitting on the top half of the sundial. She said "are you sure it's the sundial?" I must admit, she put doubts into my head.

I did not have my camera with me, but I did have my phone and so took a few photographs. When we got home, I compared them to Ross's sketch and it was clear to me that they were one and the same. It was particularly the hair on the back and sides of the head that were so similar they had to be the same. This was backed up by what appeared to be gnomon remains on the south-east and south-west faces (Figs 21 and 22), although there was not much in the way of hour lines and no numerals at all. What had happened to the bottom half of the sundial?

Frustratingly I have not been able to find out where it had been all these years and who had put it there and when. It had to have been within the last twelve months or so as it was not in place the last time I had been there. I am still investigating though.

Next, we travel much further north to Cromarty in the Black Isle near Inverness, and again to a National Trust for Scotland site, where we see a horizontal sundial made by Hugh Miller,[7] the famous geologist, palaeontologist and writer. It is located in the garden of what was once his home and which is now a museum. Ross comments:

"*The dial seen nearest in the view* [Fig. 23] *was dismantled and lost, when, early in this century, Hugh Miller, then a boy, dug it out of the earth, and set it up in his uncle's garden as shown. He states that it 'had originally belonged to the ancient castle garden of Cromarty', and remarks about it that as it exhibited in its structure no little*

Fig. 24. Photo of a painting in the Hugh Miller museum showing him sculpting the column for his sundial. Photo taken with the permission of NTS staff.

Fig. 25. The square dial plate of Hugh Miller's sundial.

mathematical skill, it had probably been cut under the eye of the eccentric but accomplished Sir Thomas Urquhart.' This is not an unlikely supposition, but, as we see from this treatise, there is nothing remarkable about the dial, there being many others of more complicated design; so that it does not necessarily follow that its construction required any very special skill. He mentions an interesting episode of his life in connection with the dial. When standing beside it, and discoursing on it to some friends, he first saw for a brief moment the young lady who ultimately became his wife.

"*The other dial seen in the background is interesting as having been made by Hugh Miller himself* [Fig. 23]. *He refers to it with some pardonable pride. During a period of convalescence, while still a young man, he tells us that he amused himself in hewing for his uncles, 'from an original design, an ornate dial-stone; and the dial-stone still exists to show that my skill as a stone-cutter rose somewhat above the average of the profession'.*"

Obviously Ross mentions two sundials above, but the first was lost again and then subsequently found in the garden of a nearby house, but unfortunately I have been unable to make arrangements to see it. It is thought to be in a poor condition.

Fig. 26. Hugh Miller's Cromarty sundial and column.

As Ross says, the sundial's column at the back of the view in Fig. 23 was sculpted by Hugh himself (Fig. 24) and when it was restored in 1998 his name was discovered underneath the metal dial plate, so quite possibly it was also made by him. The dial plate is square (Fig. 25), has Roman numerals from 4 am to 8 pm and is dated 1825. However, the elaborately carved column is inscribed HM MDCCCXXX (1830), so maybe he had acquired the dial plate earlier. The column is of sandstone and looks as though it may have been painted white at some point (Fig. 26).

Hugh Miller started his working life as an apprentice stonemason before moving into banking and writing, but it was as a geologist and palaeontologist that he made his name. He was a troubled soul, though, and committed suicide in 1856 at the age of 54.

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THE WINWICK HALL SUNDIAL

SUE MANSTON

The BSS Help and Advice Service was contacted by Bruce Green in April 2019. Bruce said "Help! I have a 30-foot telegraph pole at the top of a hill and I want to turn it into a local landmark. It is on the Jurassic Way and there are lots of walkers every weekend. I want it to be a feature of the landscape for everyone to enjoy."

The telegraph pole is on a small hill to the south-east of Winwick Hall.[1] Winwick is a small village in Northamptonshire, about nine miles east of Rugby. The Jurassic Way, a long-distance footpath that connects the Oxfordshire town of Banbury with the Lincolnshire town of Stamford, follows an ancient ridgeway along a band of Jurassic limestone.

Early discussions established that Bruce wanted a sundial that was LARGE and something that walkers would enjoy. We discussed a few options, including:

- A simple noon line.
- An analemmatic dial similar to the one at Blickling (SRN 7524). There would be a plaque telling the user how many paces to walk from the pole, depending on the date. The user's shadow would point towards (but not necessarily reach) the appropriate hour numeral.
- An azimuth dial.

The first idea, a noon line, was not considered to be sufficiently ambitious. The second idea was also ruled out as Bruce wanted to make use of the pole's shadow. The third proposal was to have an azimuth dial based on a stereographic projection (Fig. 1). This can be scaled up or down so that the local horizon circle can be whatever size is required. The sloping ground is not an issue; if the design is held level above the site then all the points project vertically downwards onto the ground below.

I prepared a paper with a description of a stereographic dial, ideas for the size of the dial and materials, advice about maintenance and additional ideas for walkers such as a path around the outside of the dial with seating. I also thought a grid reference written vertically on the pole would be useful. Also included was an explanation of the difference between solar time and clock time, and suggested explanatory signage on how to use the dial – perhaps at the bottom of the hill, next to the Jurassic Way public footpath. This would encourage curious walkers to enter the field and walk up to the sundial.

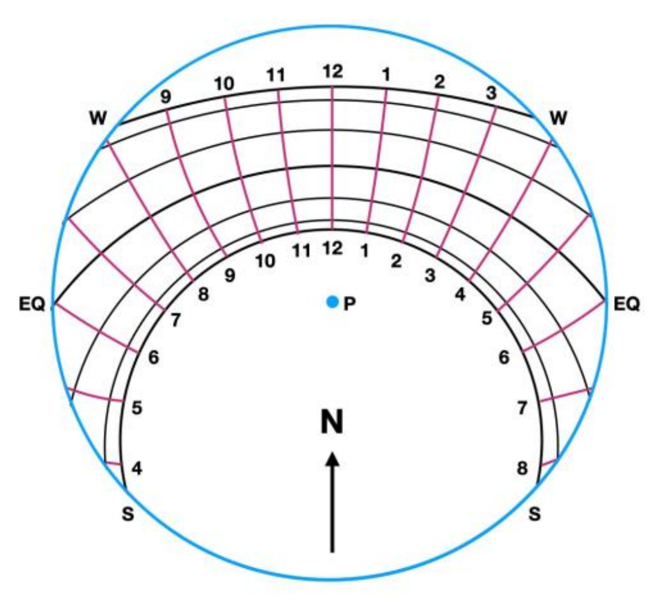

Fig. 1. Diagram of a dial based on a stereographic projection

Bruce invited me to visit the site, so in July 2019 we met up and made the short trip to the location[2] of the proposed dial. In Bruce's car there was a shoe box on the seat and I was instructed not to open it. The box was full of clouded yellow butterflies which he intended to release when we reached the top of the hill. In association with the Cambridge University Entomology Centre, Bruce releases around 2000 butterflies each year in a plan to re-introduce clouded yellows to the area. As it turned out, when we got to the top of the hill it was too windy to release them.

Bruce is a dedicated philanthropist, film buff and one of the founders of the British Elephant Polo Association (the elephants of Sir Robert Fossett's Circus were regularly brought to Winwick for team practice). Several events are held on the estate throughout the year, including open air theatre, cinema and firework displays. After a quick tour to see the elephants, fountains and the mermaid-shaped lake, it was back to the office for a detailed discussion about the sundial proposal.

Bruce showed me a layout for a simple horizontal dial, with Roman numerals in a circle, and said that was what he wanted. I explained how this would need a polar gnomon to work properly. With a vertical pole the shadow at any given time would fall in a different direction throughout the year. Bruce understood the difference between a polar and a vertical gnomon, but the difference in the direction of the winter and summer shadows was larger than he expected, so we agreed on a compromise: a summer arc with numerals from 4 am to 8 pm and a winter arc with numerals from 9 am to 3 pm. A metal box section could be laid along the noon line, with signs of the zodiac at the appropriate positions. There was to be no fencing or hardstanding as sheep and cattle are regularly in the field.

The correct way to use the dial would be for the user to find the current date on the noon line, then stroll round the dial along the imaginary arc of constant declination to find the shadow of the pole and estimate the time. In reality, it is much more likely that people will go up to the pole and then walk along the shadow to find the time. With only winter and summer arcs, it is going to be challenging for users to decide where to stand on any other date, but Bruce was not particularly worried about this. He sees the dial as a bit of fun, and is not overly concerned about accuracy.

Bruce asked me to prepare the necessary calculations and diagrams for positioning the numerals and zodiac signs. The starting point was to decide the size of the dial and we agreed a radius of 18 metres (about 60 feet). In the meantime the telegraph pole, which had been knocked by the cattle, was fixed to ensure it was truly vertical. The pole is about 30 feet high, with another 6 feet buried in the ground. Bruce also set out the North–South line by finding the clock time when it was local solar noon at Winwick.[3] Bruce emailed me in September 2019 to say he had set out the North–South line with only a small problem when one of his cows ran off with the string.

Next, there was some in-depth analysis of the sizes for the numerals. Bruce wanted Roman numerals (including IIII

Fig. 2. The numerals have arrived — October 2020. Photo courtesy of Bruce Green.

Fig. 3. Compass directions — April 2020. Photo courtesy of Bruce Green.

Fig. 4. Shadow at XII — March 2021. Photo courtesy of Bruce Green.

Fig. 5. Some of the numerals on the summer arc — March 2021. Photo courtesy of Bruce Green.

Fig. 6. The author with Bruce Green checking the time — June 2021.

instead of IV). We looked at the height and width of all the numerals in both Arial and Times New Roman fonts. A range of heights were considered (300, 600 and 800 mm), the largest sizes for the numerals furthest away from the pole. I was slightly concerned that some of the larger numerals might be too close to each other – for example, in Times New Roman font, 800 mm high, VII and VIII are 1.76 metres and 2.24 metres wide respectively – but scale drawings showed that it would not look too crowded. In the end, the heights chosen were 600 mm for the summer arc and 750 mm for the winter arc; the font was to be Times New Roman. The numerals were made by a local blacksmith using 5 mm galvanised sheet steel with backing ground fixing lugs from 12 mm rebar anchored in the ground with quick set cement. The numerals weigh around 7 kg for the smallest, up to around 25 kg for the largest (Fig. 2). I also suggested having compass points on the dial, either close to the pole or on the dial's horizon, 18 metres from the pole. Bruce chose to have both (Fig. 3).

In theory, the radius of the summer circle is 13.88 metres, and the circle's centre is 9.24 metres South of the pole. The radius of the winter circle is 41.91 metres and its centre is 27.89 metres South of the pole. These calculations are precise, but we knew early on that it was going to be difficult to achieve such accuracy without professional surveyors. However, Bruce and his builders were up for the challenge and the numerals were positioned and cemented in at the end of March 2021 (Figs 4 and 5). A few days before the 2021 summer solstice I made another trip to Winwick. It rained very heavily around 2:30 pm BST, but after a short walk uphill to the sundial the sun decided to appear long enough for us to check the time at 3:30 pm

Fig. 7. The sun finally came out — June 2021.

Fig. 8. The time at 3:30 pm BST — June 2021.

Fig. 9. An aerial view of the sundial — April 2021. Photo courtesy of MLE Pyrotechnics Limited, Daventry.

Fig. 10. A panoramic view of the sundial with the mermaid-shaped lake in the background — April 2021. Photo courtesy of MLE Pyrotechnics Limited, Daventry.

BST (Figs 6–8). Aerial photographs are shown in Figs 9 and 10.

There is more work to be done. The zodiac signs and an explanatory plaque are in progress and the local Druids have been in touch. Bruce asked me what we could add to the dial to make it more interesting for the Druids, so I suggested having markers, on the dial's horizon, for sunrise and sunset on the solstices (Yule, Litha), the equinoxes (Ostara, Mabon) and the cross-quarter days (Imbolc, Beltane, Lammas, Samhain). I know very little about Druids, so any other suggestions will be welcome.

The necessary facilities for tired and hungry walkers are available at the Polo Pavilion Tea Room[4] which is on the North Lawn in front of the Hall. The Tea Room offers local produce including champagne made from grapes grown in the estate's vineyard. It is open at weekends and the proceeds go to local charities.

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3. *http://timeanddate.com*
4. *http://thebrucegreenfoundation.org*

suemanston@outlook.com

ANCIENT SCANDINAVIAN *ÁTTIR*
Time-Keeping Without Numbers

FRANK H. KING

Having attended several of Johan Wikander's conference talks and having helped in the editing of two of his *Bulletin* articles,[1,2] I felt the need for a *Beginner's Guide* to the time-keeping system used by the ancient Scandinavians; this article is an attempt to provide such a guide. At the end, there is a glossary of some of the Old Norse terms that were used for specifying the time of day.

The most scholarly paper on the subject that I have found on the Internet is *On the Ancient Scandinavians' Division of the Times of the Day* by Finn Magnusen, a noted Icelandic scholar who lived in Denmark and published in Danish. An English translation by John M'Caul was published in 1839.[3,4] There is a Review by Margaret Stanier in the October 1998 issue of the *Bulletin*.[5]

For those who prefer an easier introduction, there is an excellent illustrated document published by Harvard University and intended for school teachers: *Telling Time without a Clock: Scandinavian Daymarks*. This is also available on the Internet.[6]

Setting the Scene – Seafarers

Neither Magnusen nor the Harvard document provides a detailed chronology but we know that the terminology used was Old Norse; this language developed from Proto-Norse in the seventh century and developed into various

North Germanic languages by the 15th century.[7] Even after Old Norse went into decline, the time-keeping system continued in use and, Magnusen asserts, it was in use in Iceland at the time he wrote his paper in the 1830s.

Norsemen were prosperous traders and adventurous seafarers. They established settlements in the Faroe Islands around 800 AD,[8] in Iceland in 874 AD,[9] and in Greenland in 986 AD.[10] Magnusen refers to Leif Erikson,[11] the noted Norse explorer who is said to have been the first European to set foot in North America. Around 1000 AD he reported visiting a place he called *Vinland* whose location, although not firmly established, may have been in Newfoundland where archaeologists discovered signs of a Norse settlement in 1960.[12]

The inference from this background is that Norsemen were skilled mariners who thoroughly understood how to use the sun and the stars for navigation. This understanding was passed on to those who lived ashore and extended to farmers who lived inland, in clearings in the mountains; they knew about the points of the compass and knew about dividing the solar day into 24 equal hours.

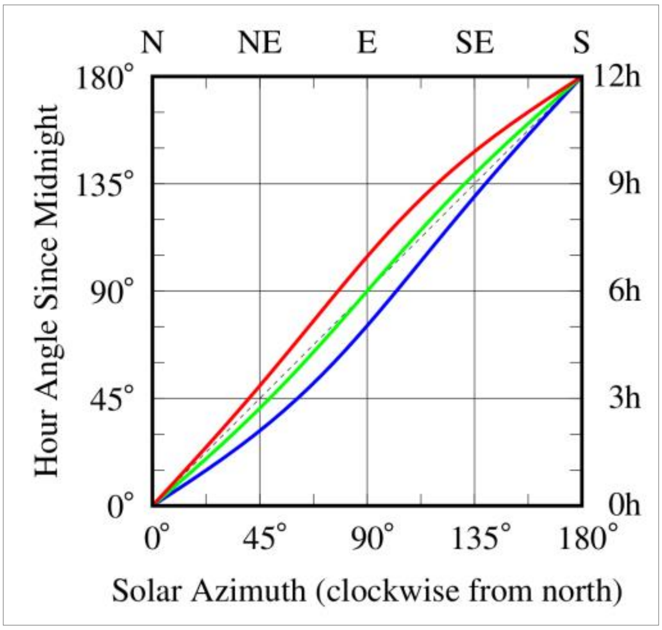

Fig. 1. Morning plots of solar hour angle against solar azimuth at 60° N. The relationship is approximately linear at an equinox (green curve) but is less so at the solstices (red curve for summer and blue curve for winter).

Setting the Scene – Farmers

The Old Norse term *sólarhringr*, or sun-ring, was used to describe the apparent daily path of the sun. Norsemen farmers noted that, during daylight, the sun was always directly above some point on the horizon and they reasoned that, during the night, the sun was always directly below some point on the horizon. At a latitude of 60° N in high summer one can, even at midnight, see a glow on the northern horizon confirming the sun's approximate position.

There is a strong implication that the farmers assumed that the point on the horizon directly below (or above) the sun moved round at an approximately uniform rate, so this point could be used as the hand of a 24-hour clock. Magnusen gives a specific example of the direction ESE indicating 7:30 am whatever the time of year. This suggests that due east indicated 6 am and south-east indicated 9 am. Fig. 1 provides a means of judging how acceptable this approximation is at 60° N.

Fig. 1 shows morning plots of solar hour angle (degrees since midnight) against solar azimuth (degrees clockwise round from due north). The broken black line is the ideal, a linear relationship between time and azimuth. At the north pole, the relationship really is linear, and at 60° N it is not far off being linear at an equinox (the green curve). The assumption is less good at the summer solstice (the red curve); for example, when the sun is due east, the hour angle is about 105° or 15° greater than the assumed 90° or 6 am. The sun takes about seven hours from being due north to being due east but only about five hours from being due east to being due south. At the winter solstice (the blue curve), the sun takes about five hours from being due north to being due east and then about seven hours from being due east to being due south. Of course, at that time of year, it is dark for most of the time so the error would probably not be noticed.

As an aside, the plots are not very different in British latitudes. This suggests that the sundials that one occasionally sees with fixed vertical gnomons need not be hopelessly beyond redemption, especially around the equinoxes and around midday!

Daymarks – Introduction

Although Magnusen assures us that the ancient Scandinavians knew about the points of the compass and knew about dividing the day into 24 hours, this is not how they normally chose to think about the passage of time. Instead of using numbers (as in '7:30 am'), different periods of the day were given *names*. This was a rather more formal version of our informal use of terms such as morning, afternoon, evening and night.

Those of us who still use 12-hour clocks have been dividing the day into two parts from when we first learnt to tell the time and heard about A.M. and P.M. It was probably a little later before we learnt that these initials stand for *Ante Meridiem* and *Post Meridiem*.

Fig. 2 shows how the ancient Scandinavian system might be adapted to divide the day into two parts. Implicitly, north is at the top and south at the bottom. The broken circle represents the horizon and a farm or other settlement is assumed to be at the centre. The two dots are at the centres of the morning and afternoon halves of the horizon circle. The two gaps, marking where one half ends and the next half begins are labelled Midnight and Midday. Time progresses clockwise.

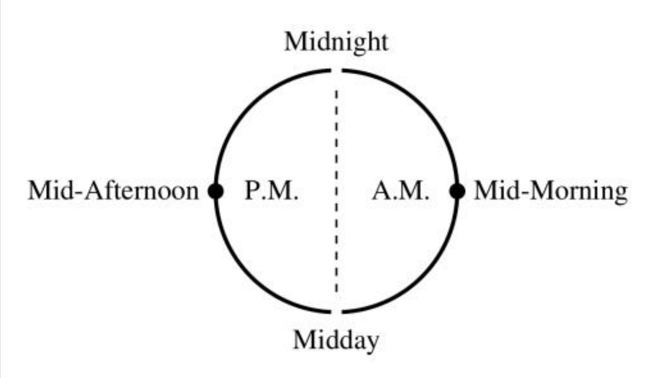

Fig. 2. The day divided into two parts.

Those who lived in the settlement identified landmarks on the horizon corresponding to the positions of the two dots (and the two gaps). These landmarks could be minor peaks or crags or water courses or other features which stand out. Such landmarks were known as 'daymarks'.

The diagram should not be interpreted as an ordinary map. The identified daymarks could be at greatly varying distances from the settlement at the centre of the figure, just as the heavenly bodies one sees on the celestial sphere are at varying distances from the Earth. The daymarks should all be a long way from the settlement.

Daymarks – Dividing the Day into Eight Parts

In practice, the ancient Scandinavians commonly identified eight daymarks which were as close as possible to the eight cardinal and sub-cardinal directions: N, NE, E, SE, S, SW, W, NW. Each daymark marked the centre of one-eighth part of the horizon. Each of these eight parts was given a name and these names would be used as times. This was time-keeping without numbers. Fig. 3 shows the horizon divided into eight parts and the daymarks at the centres of these parts have been given English names.

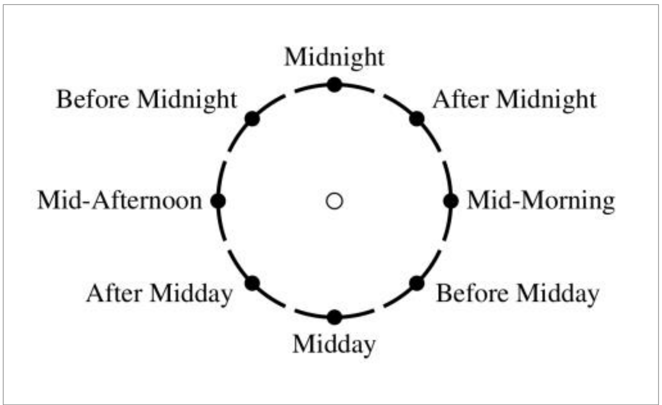

Fig. 3. The day divided into eight parts.

Moving to Old Norse, we note that the word for daymark is *dagmark* and the principal daymark was that associated with the sun at its highest point above the horizon. This had various names but the two most common are *middag* and *hádegi* or midday and high day. The midnight daymark lies on the horizon diametrically opposite *middag* and was called *miðnætti* where the '*ð*' character is pronounced 'th' and is sometimes known as a 'strike-through-d' or an 'eth'. The upper-case of '*ð*' is '*Đ.*'

Given that one-eighth part of the horizon is the basis for this time-keeping system, it is not surprising that there are several Old Norse terms to describe it. Two are *átt* and *ætt*, both of which Magnusen explains derive from the numeral *átta* which is common to several even older languages. Writing in the 1830s Magnusen further notes that *átt* "is still in use in Iceland" and adds that in Norway it is written *ætt*. Yet another word used is *eykt* (or *eikt*) which has an altogether different derivation. It relates to the English word yoke and originally referred to the length of time that one could yoke two oxen together when working in the fields. It later became a *de facto* unit of time, the (slightly variable) time it takes the sun to traverse an *átt.*

There is no widely accepted English term for one-eighth part of the horizon. The Harvard document suggests 'octant' or 'octet', neither of which gives the right implication. In the M'Caul translation of Magnusen, '*octava*', the Latin word for eighth, is suggested but there seems no good reason to resort to Latin. It makes most sense to stick with Old Norse and, in this article, the word *átt* and its plural *áttir* will generally be used.

The Old Norse Names of the Eight Daymarks and the Eight *Áttir*

The eight *áttir* took their names from the names of the daymarks at their centres and, to understand these names, it is useful to start with a short list of part-words:

- *dag* = day
- *-mál* = measure, related to the English word meal; think of measuring out portions!
- *mid-, mið-, miðr* = mid-, or middle
- *nátt* = night

Let us now give names to the eight daymarks going clockwise round the horizon starting at midnight:

- *miðnætti*, the middle of the night
- *ótta* signifies darkness; think "It's always darkest before the dawn!"
- *miðr morgun*, the middle of the morning
- *dagmál*, day-measure, the period before midday
- *middag* or *hádegi*, midday or high day (the sun at its highest)
- *undorn*, of unknown origin, perhaps relating to a meal time
- *miðr aptann*, mid-evening; *aptann* is related to the German *Abend*, evening
- *náttmál*, night-measure, the period before midnight.

This list is taken from the Harvard document which describes the names as being Old Norse. Magnusen gives equivalent, but different, names in Icelandic and Norwegian. Many variants were used in different countries and in different centuries and it is impossible to give a single definitive list.

As well as giving two names for midday, the Harvard document gives a second name *rismál* or rise-measure as an alternative for *miðr morgun*. Another name for *undorn* was *eykt* which, as noted above, is also used more generally to refer to *any átt*.

Additional confusion resulted from the arrival of Christianity. Prayer times were based on the unequal hours system, which was in use in most of the rest of Europe. The times had to be adapted for the Scandinavian use of *áttir*. For example, it was decided that the office of None should be observed during *undorn* so, eventually, *nón* (derived from the Latin *nona* for the ninth hour) became yet another name for *undorn*.

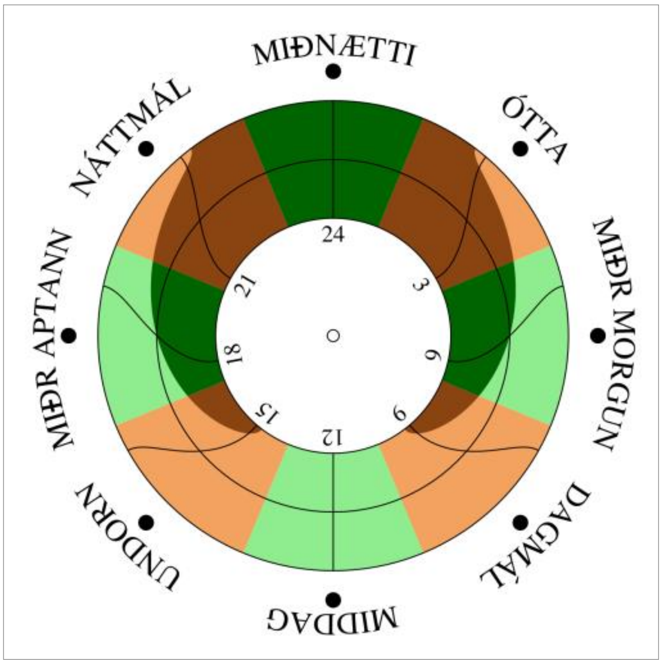

Fig. 4. A diagrammatic presentation of the names of the eight áttir *and, for 60° N, the coloured band shows, by shading, when it is light and when it is dark at different times of year.*

A Schematic Summary

Fig. 4 shows the eight daymarks as large dots that are spaced at 45° intervals. It would be too much to hope that there would be eight landmarks of note in precisely the right places, and, no doubt, the spacing might be somewhat irregular. Each daymark in Fig. 4 is labelled with the Harvard document's name of the associated *átt*. The names are formed into a circular ring representing the distant horizon. The small circle at the centre represents the settlement.

Between the ring of dots and the small circle is a multi-coloured band. This band is divided into eight regions in alternating brown and green colours; each region directly corresponds to an *átt*. The band is bounded by an internal circle and an external circle which serve as winter and summer solstice constant-declination lines. Another circle halfway between these two represents the equinoxes. Time of year runs approximately linearly from the internal circle to the external circle. [To be more precise, it is solar longitude which runs linearly from –90° to +90°.]

Other features in the diagram assume that the latitude is 60° N. The dark portions represent night. If you look round the internal winter solstice circle, you will see that over three-quarters of it is in darkness. By contrast, over three-quarters of the summer solstice circle is in daylight. At an equinox there is, as expected, equal day and night.

Eight regular hour-lines are shown at three common-hour intervals. The 12 h and 24 h hour lines run along the centrelines of the *middag átt* and the *miðnætti átt*. At the north pole, the other six hour lines would also be straight but, at 60° N, this is far from the case.

The Half-*Átt* Unit of Time

The ancient Scandinavians recognised when the sun was halfway between one daymark and the next and, in such a position, it was crossing the imaginary boundary separating one *átt* from the next. They had an expression, *jafn nærri báðum*, which means that the sun is at an 'equal distance from both' daymarks. Magnusen pays special attention to one boundary; this is *hirðis rismál* which marks the end of *ótta* and the beginning of *miðr morgun.* This was the shepherds' rising time when they set off to tend to their sheep. This time marked the start of the day and Magnusen deems *miðr morgun* to be the first *átt* of the eight.

Johan Wikander[2] gives an explicit name, *eyktarstad*, to the *end* of the *eykt* (*undorn*) *átt.* This was taken to be the end of the working day. He also notes *dagmálstad* as the *beginning* of the *dagmál átt*.

Note that -*stad* means place or position (compare with the German *Stadt* for city) but it is not used consistently; we have seen this suffix referring to the end of one *átt* and to the beginning of another *átt*. Moreover, in *middagsstad* it refers to the position of the sun at midday when it is in the *middle* of an *átt*!

The fact that the boundaries between *áttir* were as well-recognised as their mid-points suggests the use of a half-*átt* unit of time and also suggests the division of the horizon into 16 parts. Magnusen tells us that the name for the half-*átt* unit was the *stund* (compare with the German *Stunde* for hour) and he gives names for all 16 in both Icelandic and Norwegian.

Sundials

Some readers may be hesitant about classifying a settlement and its distant landmarks as a sundial but the arrangement certainly makes use of the sun to gauge the passage of time. A system which requires looking directly at the sun seems decidedly hazardous, but Scandinavia, like Britain, is often overcast and the use of landmarks means that one can tell the time even when the best one can hope for is the occasional glimpse of a watery sun. Using landmarks also provides a way of telling the time when all the regular local sundials are covered in deep snow!

Should the sun shine brightly, there is no need to look directly at it; simply stand with your back to the sun so that your shadow is directly in front of you, then do an about turn and then, holding your hands so as to shield your eyes from the direct sun, assess which daymark is closest to being straight ahead.

It is reasonable to ask why anyone would use an ordinary sundial when there is a nice big one all around. One reason is that a sundial can be marked out to higher precision than can be obtained by the chance positioning of selected peaks and other landmarks. Also, even in Scandinavia, there are places where there is a dearth of suitable landmarks. Additionally, a sundial provides a canvas for artistic creativity and, on a practical note, there may be occasions when the sun is quite high but the landmark below it is shrouded in cloud. A regular sundial would then be useful.

Johan Wikander has described many examples of surviving sundials in Norway. Some are very simple and have (or had) a vertical gnomon standing at the centre of what is geometrically equivalent to an eight-point compass, one point for each daymark. It is important to remember that the direction of the shadow will be 180° round from the relevant *átt* so you have to be very careful interpreting some of the figures in Johan Wikander's articles. If a symbol on the sundial indicates *middag*, does that represent where the sun is at *middag* or does it represent the direction in which the gnomon's *shadow* would point at *middag*?

With direct use of the sun, there is no scope for such confusion. Evidence abounds that *middag* daymarks were always to the south of settlements and, to this day, there are many minor peaks in Scandinavia which are named the equivalent of 'Mount Midday' or 'Midday Peak', and these are invariably to the south of ancient settlements.

Comparison with Ordinary Unequal Hours

During the centuries that *áttir* were used for time keeping, most of Europe was using the unequal hours system, which seems to have developed in the Middle East. Why was this system not taken up in Scandinavia?

The answer may simply be a practical one. The most common unequal hours system divided the daylight period into 12 hours. On the equator, these hours are identical to common hours, always 60 modern minutes. As you move away from the equator, the seasonal variation in the length of a daylight hour increases. If you need to plan some regular pattern of work, whether tending to livestock or observing Christian Offices, too great a variation can present intractable problems. A daily timetable which works well in summer may turn out to be impossibly overcrowded in winter.

In British latitudes, the daylight period in high summer is over 16 hours and in the depths of winter it is less than 8 hours. This variation is close to the limit of being usable. For example, Muslim prayer times use unequal hours and Muslims living in British latitudes must find the daily fast in Ramadan a considerable ordeal whenever Ramadan falls in high summer: the requirement is to fast every day from dawn until sunset.

In Scandinavia, another 10 or so degrees further north, the unequal hours system is unviable. The system of using *áttir* was adopted instead.

Although using *áttir* does not provide a precise equal hours system, such use, at 60° N, feels closer to using equal hours than does using the standard unequal hours system. Fig. 4 shows the variability in the time the sun takes to traverse different *áttir* over the course of a day and this variability itself varies with the time of year. At the north pole there is no such variability but it increases the further south you go…

In the Tropics, there are times of year when the entire diurnal path of the sun is in the north and at other times of year it is entirely in the south. There are days when the sun can be due south at *both* midday *and* midnight (albeit below the horizon).

In an extreme case, on the equator on the day of an equinox, the sun rises due east and stays due east all morning until midday when, directly overhead, it flips to being due west for the rest of the day. Solar azimuth does not remotely increase linearly with hour angle! Using *áttir* would not work at all!

Britain is closer to the north pole than to the equator and it is left as an open question whether using *áttir* would have been more appropriate in our latitudes than the unequal hours system that we used until the 17th century. Perhaps there are too few places in Britain where there are suitable landscapes?

An Exercise for the Reader

To gain a better understanding of the impracticality of using *áttir* too far from the poles, try sketching the three plots in Fig. 1 for latitude 20° N and on the equator. The results may come as a surprise!

Glossary

This glossary lists all the old Scandinavian words used in this article and in Johan Wikander's 2020 and 2021 *Bulletin* articles. It also lists most of the Old Norse words used in the Harvard document. Many more relevant words are noted in Magnusen.

ætt: an alternative word for *átt* (q.v.).

ætti: plural of *ætt.*

aptann: evening (c.f. *Abend* in German), see *miðr aptann*.

átt: a named eighth part of the horizon centred on a cardinal point (N, E, W, S) or on a sub-cardinal point (NE, SE, SW, NW).

áttir: plural of *átt.*

dag: day.

dagmál: (day-measure) the name of the *átt* immediately preceding the midday *átt.*

dagmálstad: the position of the sun at the *beginning* of the *dagmál átt.*

dagmark: daymark, a landmark on the horizon identifying the centre of an *átt.*

eykt: an alternative word for *átt*; it is derived from the word for yoke and once referred to a measure of time (how long it is reasonable to yoke two oxen together) but came to refer either to an arbitrary *átt* or, sometimes, specifically to the *undorn átt* (q.v.).

eyktarmark: an alternative word for daymark; it is commonly used in Iceland.

eyktarstad: the position of the sun at the *end* of the *undorn átt* which is sometimes referred to as the *eykt átt.*

hádegista: the position of the sun at its highest point.

hádegi: (high day) an alternative name for the *middag átt* (q.v.); it refers to the sun at its highest point.

hirðis rismál: shepherds' rising time.

jafn nærri báðum: means 'equal distance from both' and refers to the points on the horizon where the sun leaves one *átt* and enters the next *átt*.

leiða: means 'show the way' and is used in...

Leiðastjarna: Pole Star.

-mál: measure, possibly related to the word 'meal'.

mid-, mið-, miðr: mid- or middle.

middag: (midday) the name of the *átt* centred on midday.

middagsstad: the position of the sun at midday.

miðnætti: (midnight) the name of the *átt* centred on midnight.

miðr aptann: (mid-evening) the name of the *átt* halfway between midday and midnight.

miðr morgun: (mid-morning) the name of the *átt* halfway between midnight and midday.

morgun: (morning) an alternative name for the *miðr morgun átt* (used by Johan Wikander).

nátt: night.

náttmál: (night-measure) the name of the *átt* immediately preceding the *miðnætti átt.*

nón: an alternative name for the *undorn átt* (q.v.); it is from the Latin *nona*, ninth, and refers to the time of the mid-afternoon Christian Office, None.

ótta: the name of the *átt* immediately following the *miðnætti átt*; it comes from a word meaning the darkest part of the night before dawn.

rismál: rise-measure, an alternative name for the *miðr morgun átt.*

sol: sun.

sólarhringr: solar ring, the small circle followed by the sun each day.

sol i syd: sun in the south.

-stad: place or position.

stjarna: star.

stokk: stick or stock, see *timstokk.*

stund: one half of an *átt* or one-sixteenth of the horizon (c.f. *Stunde*, the German for hour).

syd: south.

tim: time.

timstokk: time stick, or gnomon.

undorn: the name of the *átt* immediately following the *middag átt*; it may originally have been the name of a meal.

ACKNOWLEDGEMENTS

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LIGHT SPOT SUNDIAL

EDUARD MASANA

A new sundial design is presented based on the daily movement of a light spot projected on a cylindrical surface. A combination of slits and small holes in two concentric rings creates a unique spot of light cast onto the central cylinder, on which hour and declination lines are drawn. The operation of the sundial imposes some constraints to its size and design which are discussed in detail. The sundial tells local apparent time. To tell standard time, the dial can be corrected by a shift in the hour lines to provide the longitude correction and a graph to correct for the equation of time. The concept of the light spot sundial has been successfully checked using Autocad.

Introduction

Most sundials tell the hour by tracking the shadow cast by a gnomon on a surface on which hour lines are drawn. The exact shape of these lines depends on the shape and orientation of the surface. Some sundials have a second set of lines, the declination lines, showing the time of year according to the length of the shadow, which is a function of the Sun's varying declination throughout the year.

The sundial presented here uses a light spot rather than a shadow to tell the time. This light spot moves on a cylindrical surface as the Sun crosses the sky, and it is used to tell the time in a similar way as the gnomon's shadow used by other sundials. The main design difficulty is to ensure that only one light spot is visible at a time. The cylindrical surface, on which hour lines are drawn, is surrounded by two concentric rings, one with a set of slits, the other with a set of small holes. The radii of the rings and the size of the slits must be accurately calculated using the formulae presented below.

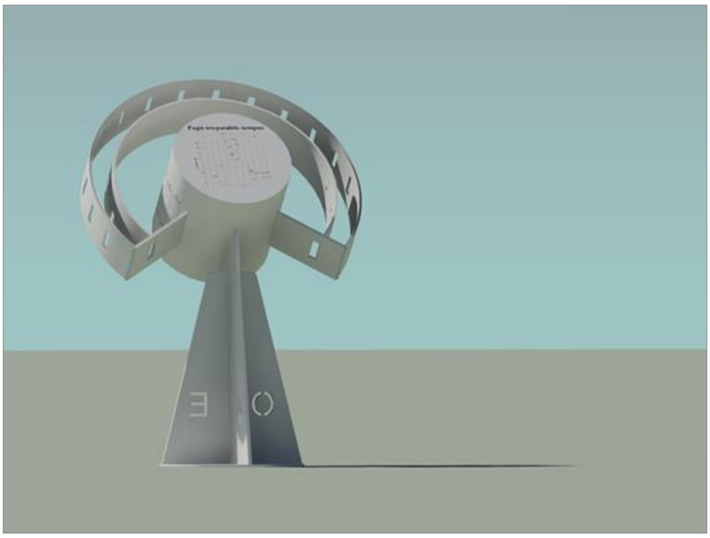

Fig. 1. An Autocad model of the light spot sundial.

Fig. 2. The light spot sundial. The holes in the inner ring are so small that they cannot be seen here.

The sundial tells local apparent time but can also be constructed to tell the civil time. In this case, the hour lines on the central cylinder are rotated to include the longitude correction between one's longitude and that of the time zone meridian. A graph or table, showing the equation of time and Daylight Saving Time, if applicable, may be added to the dial's time to provide civil time.

The large size of this sundial makes it particularly suitable for open spaces, such as gardens or parks, where the dial could be mounted on a column (Fig. 1).

Overview and Functioning

Fig. 2 shows the basic scheme of the light spot sundial. It is composed of a central cylinder with two concentric rings. The axis of the cylinder is parallel to the Earth's rotational axis, and the two rings are in the plane of the celestial equator. The function of the rings is to allow the projection of a light spot onto the central cylinder. For this, the outer ring has a series of slits every 15° and the inner ring has small holes also at 15° intervals. As the Sun moves in the sky, a given slit allows light to reach the area around the hole placed directly below it, projecting a light spot on the central cylinder. The distances between the rings and the size of the slits are computed in such a way that when a given hole moves into the shadow of the outer ring, the next hole begins to be illuminated. In this manner each hole

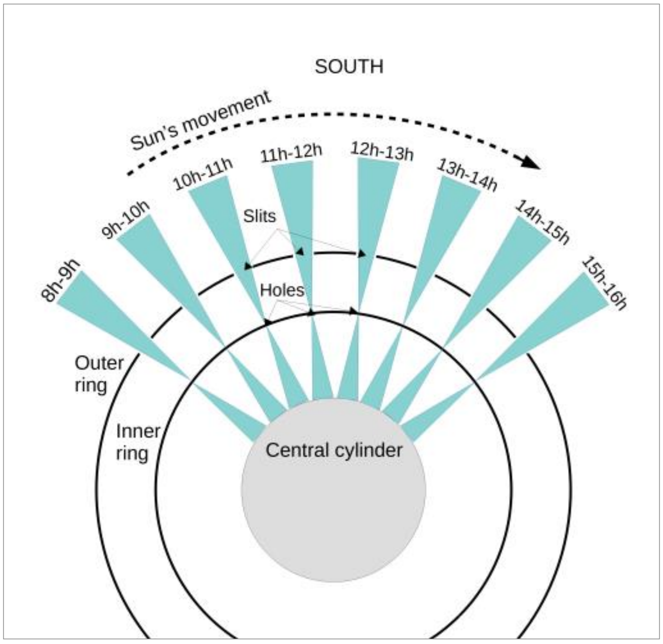

Fig. 3. Sundial schema. Each slit on the outer ring allows sunlight to fall on the hole below it for one hour. In this way only one light spot at a time is projected onto the central cylinder.

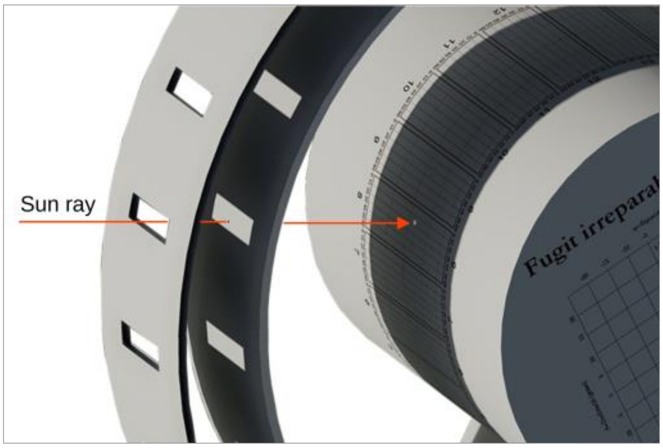

Fig. 4. Reading the time. The position of the light spot on the grid of hour lines and declination lines indicates the time and declination.

projects a light spot on the central cylinder for one hour (Fig. 3). The hour and declination lines are drawn on the surface of the central cylinder. The light spot on the hour lines allows the time to be read (Fig. 4).

Detailed Design

Hour and declination lines

The functioning of the sundial, in particular the need for only one hole in the inner ring to be illuminated at a time, imposes some conditions on the design. The first of these conditions concerns the ratio of the central cylinder radius R_c to the inner ring radius R_{inn}.

In the sundial, the hour lines are grouped in one-hour blocks, with lines every 10 minutes (Fig. 5). As each hour corresponds to 15 degrees, for a given hole, the incidence angle γ of the sun's beam varies uniformly with time between ±7.5° while the light illuminates the corresponding

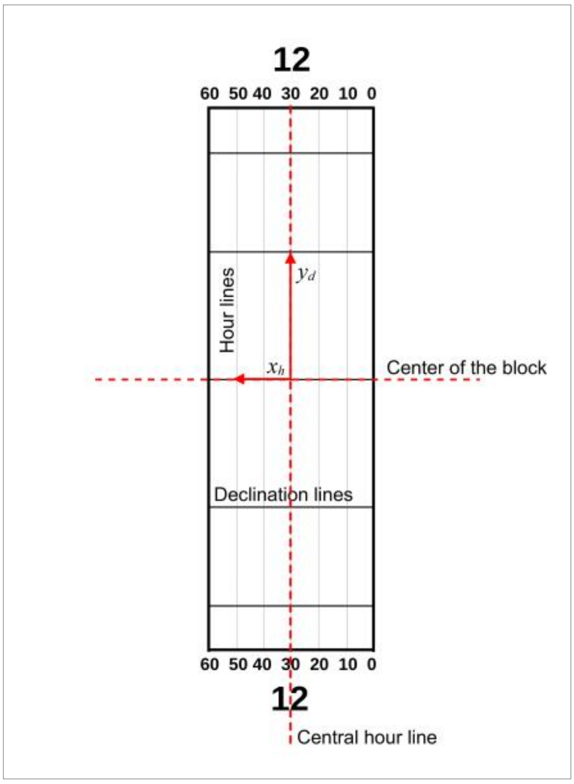

Fig. 5. Example of an hour block showing the hour and declination lines.

hour block. The *central hour line* of each block corresponds to 30 minutes after the start of the hour. The incident angle γ is then zero.

The angle β is the angular offset of the light spot from the central hour line viewed from O (see Fig. 6). Using the sine rule on the triangle shown in Fig. 6 we can express β in terms of γ.

$$\beta = \arcsin\left(\frac{R_{inn}}{R_c}\sin\gamma\right) - \gamma \tag{1}$$

From the angle β, it is easy to compute the positions x_h of the lines in the hour block with respect to the central line:

$$x_h = 2\,\pi\,R_c\,\beta/360° \tag{2}$$

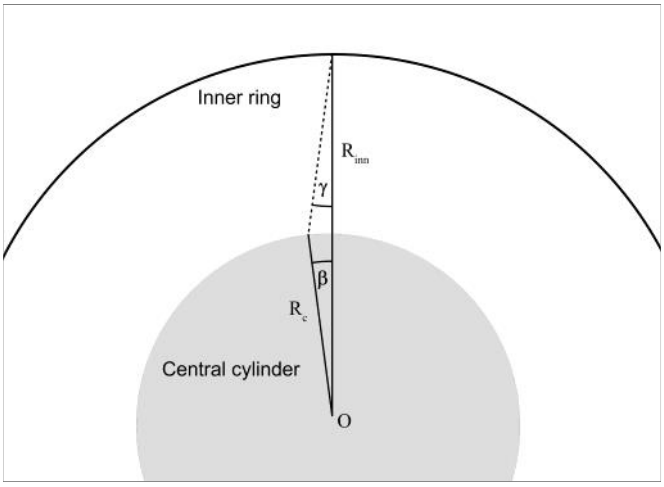

Fig. 6. The triangle used for the application of the sine rule (see text).

Minute	γ (°)	β (°)	x_h (mm)
0	−7.5	−6.86	−29.9
10	−5.0	−4.53	−19.8
20	−2.5	−2.25	−9.8
30	0.0	0.0	0.0
40	+2.5	+2.25	+9.8
50	+5.0	+4.53	+19.8
60	+7.5	+6.86	+29.9

Table 1. Position of the hour lines in a block for a cylinder of radius R_c = 250 mm and ratio R_{inn}/R_c = 1.9.

Note that x_h is the linear distance to the central hour line of the block measured on the cylinder surface, as shown in Fig. 5.

If β_h is the angle corresponding to γ = 7.5°, and the blocks may not overlap, we have:

$$\beta_h \leq 7.5° \tag{3}$$

And with a little algebra from equation (1):

$$\frac{R_{inn}}{R_c} \leq \frac{\sin(15°)}{\sin(7.5°)} = 1.983 \tag{4}$$

If the above condition is not satisfied, the hour blocks will overlap on the cylinder. Thus, to allow some distance between the blocks, a ratio of R_{inn}/R_c = 1.9 has been chosen.

The radius R_c of the cylinder determines the dial's legibility: the larger the value of R_c, the larger the size of the hour blocks and the greater the ease of reading. Table 1 shows the position of the hour lines inside the block derived from equation (2) for a central cylinder of radius R_c = 250 mm as an example. The width of the hour block is ≈ 60 mm, with a distance between 10-minute lines of ≈ 10 mm, enough for good legibility.

The declination lines follow the light spot on the dates when the Sun enters the different zodiac signs, thus marking the date of the year. In the light spot sundial, declination lines are straight lines on the cylinder surfaces, parallel to its base as shown in Fig. 5. As usual, the declination lines are drawn for the dates and Sun's declination given in Table 2. The position y_d of the declination lines with respect to the centre of the block is computed from:

$$y_d = (R_{inn} - R_c)\tan\delta_\odot \tag{5}$$

where $\delta_\odot$ is the declination of the Sun. The formula above can be deduced from Fig. 7.

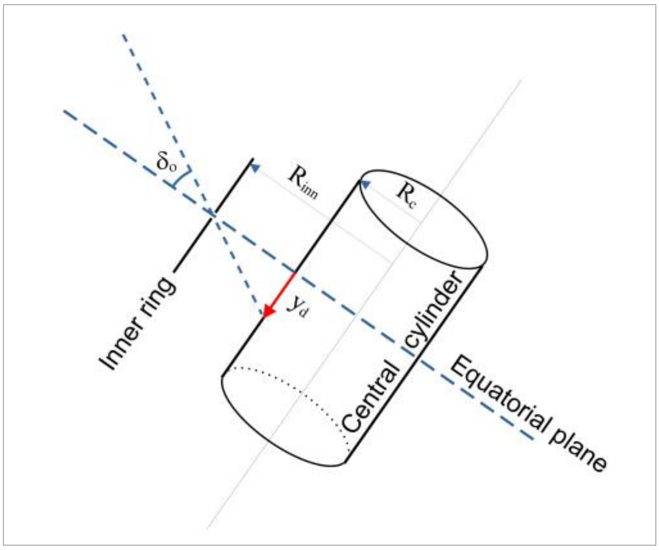

Fig. 7. Computation of y_d for a given Sun declination $\delta_\odot$ from the radii of the central cylinder and the inner ring.

Slit and hole sizes

In order to find the size of the slits and holes, two conditions must be met. Firstly, the light spot must be small enough to allow an accurate reading of the time, but big enough to be easily visible. Its size is approximately equal to the diameter D_h of the holes of the inner ring, due to the small viewing angle of the Sun. Once the diameter D_h has been set, the width W_s of the slits of the outer ring can be calculated by ensuring that the light passing through the slit *fully* illuminates the hole for 60 minutes or, in other words, for incident angles between +7.5° and −7.5°. From Fig. 8, the relation among D_h, W_s and the distance $L = R_{out} - R_{inn}$ between the inner and outer ring, can be calculated:

$$W_s' = 2L\tan(7.5°) + D_h \tag{6}$$

W_s' is the width of the slit in the tangential plane to the ring. If $W_s' << R_{out}$, W_s' is approximately equal to the width W_s

Date	Sun's declination (°)	y_d (mm)
22 December	−23.5	97.8
10 January / 22 November	−20.0	81.9
19 February / 23 October	−11.5	45.8
21 March / 23 September	0.0	0.0
20 April / 23 August	+11.5	−45.8
21 May / 23 July	+20.0	−81.9
21 June	+23.5	−97.8

Table 2. Position of the declination lines in a block for a cylinder of radius R_c = 250 mm and an inner ring of radius R_{inn} = 475 mm.

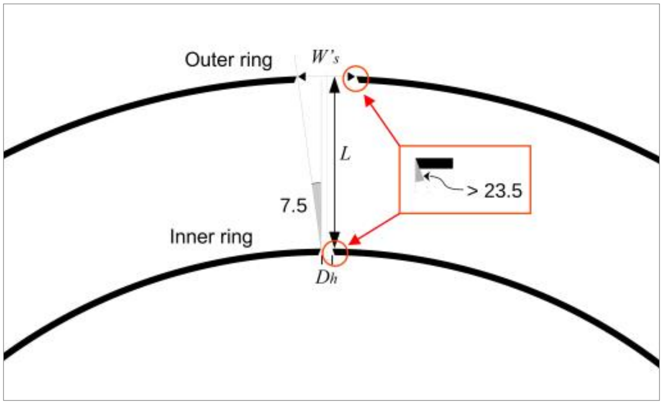

Fig. 8. Width of the slits. Note the bevel cut to account for the thickness of the rings.

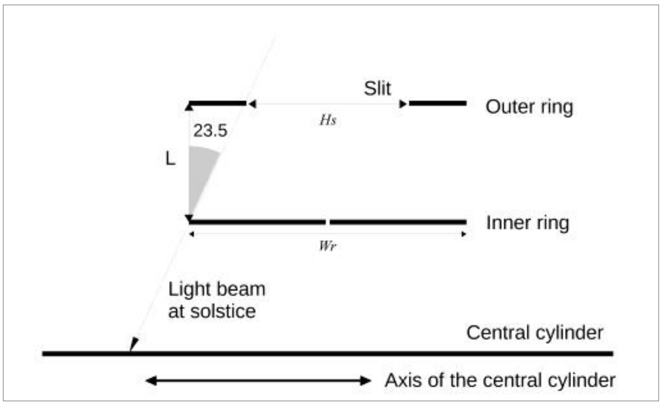

Fig. 9. Width of the rings. Note that a smaller W_r allows stray light on the central cylinder at the solstices.

measured on the ring surface. But for better accuracy, W_s must be computed from W_s':

$$W_s = 2\,\pi\,R_{out}\,\theta/360^\circ$$
$$\theta = 2\ \arctan\left(\frac{W_s'}{2\,R_{out}}\right) \qquad (7)$$

Additionally, as the hole has a diameter D_h, it is partially illuminated for incident angles slightly greater/smaller than ±7.5°. If α_{ini} is the incident angle when the hole begins/ends to be illuminated, is easy to show from Fig. 8 that:

$$\alpha_{ini} = \pm\arctan(\tan(7.5^\circ) + D_h/L) \qquad (8)$$

So, $L >> D_h$ must be chosen if $\alpha_{ini} \approx 7.5°$. For instance, if $D_h/L = 1/50$, $\alpha_{ini} = \pm 8.6°$. Thus the hole begins/ends to be partially illuminated around 5 minutes before/after the hour.

Since the hole must be fully illuminated for the solar declinations between ±23.5° the height of the slit H_s can be computed. This imposes a minimum value for H_s :

$$H_s \geq 2\ L\ \tan(23.5^\circ) + D_h \qquad (9)$$

Obviously, the width of the outer ring must be greater than H_S. So, the greater the distance L between the rings, the greater must be the width of the outer ring.

Both the slits and holes must be bevelled to account for the thickness of the rings. A bevel angle greater of 23.5° ensures that the light is never blocked by the ring walls. All the parameters in the equations above, including the radii, are given for the outer side of the rings.

Width of the rings

There is also a relation between the space L between the rings and their width W_r to ensure that all the light passing through the slits is blocked by the inner ring and always produces a shadow on the central cylinder (see Fig. 9). The condition must be computed for the solstices, when the Sun's declination reaches its extreme values ±23.5°:

$$W_r \geq 2\ L\ \tan(23.5^\circ) + H_s \qquad (10)$$

At smaller W_r the light passes to the central cylinder at the edges of the inner ring.

Although there are no restrictions to the width of the outer ring, provided that it does not cover the central cylinder (otherwise the hours could not be read), for aesthetic reasons we choose the same width as for the inner ring.

Positions of the slits and holes

The inner ring has a hole every 15 degrees. The highest point of the ring corresponds to the middle point between two holes, as shown in Fig. 3. Both the slits in the outer ring and the hour blocks in the central cylinder must be accurately aligned with the holes. This may be called the *reference configuration* of the sundial. It is valid for a sundial without longitude correction (see next section) telling the local apparent time.

Longitude Correction and the Equation of Time

This sundial, as designed above, will show the local apparent time at the location. Bear in mind that at noon (12 h) local apparent time the Sun is exactly at the local meridian and, therefore, culminates in the sky. The reference configuration described above ensures that, at noon, the light spot is on the line corresponding to 12 h.

However, a sundial telling civil time would be much more interesting and useful. There are three reasons why the Sun is not at the local meridian at noon civil time: (a) the equation of time; (b) the distance to the standard meridian of the time zone; and (c) the Daylight Saving Time. Thus:

$$T_{Civil} = T_{LAT} - \mathrm{ET} - \Delta\lambda + \mathrm{DST} \qquad (11)$$

where:

- T_{Civil} is the civil time. This is the time indicated by clocks and the time desirable for the sundial to tell.
- T_{LAT} is the local apparent time. It is the time indicated by a sundial if no corrections are made.
- ET is the equation of time. It is the difference between the time shown by true sun (local apparent time) and a fictitious mean sun which moves

uniformly around the equator (local mean time). The difference derives from two separate phenomena. Firstly, the earth does not move uniformly in its elliptical path around the sun. This gives rise to an annual more-or-less sinusoidal difference of amplitude ca. 7.5 minutes with origin at perihelion (earth closest to the sun). Secondly, the sun appears to move around the ecliptic rather than the equator. This gives rise to a biannual more-or-less sinusoidal difference of ca. 10 min with origin at the equinoxes.

- $\Delta\lambda$ is the angular difference between the longitude of the observer and that of the standard meridian of the time zone.
- DST is the Daylight Saving Time. DST cannot be corrected by sundials. One hour must be added during spring–summer, if necessary, to the hour shown by the sundial to get the civil time.

The equation of time (and DST) difference can be corrected with the aid of a table or graph as shown in Fig. 2. The longitude difference can be simply managed by rotating the dial's hour lines around the central cylinder by 4 minutes per degree of longitudinal difference. Viewed from above, the rotation is clockwise if east and counter clockwise if west of the standard meridian.

Limiting Hour Lines

The hour lines must cover all the time that the Sun is above the horizon at any of the year, or, in other words, from the earliest sunrise to the latest sunset of the year.

For a place in the northern hemisphere, the earliest sunrise and latest sunset happen around the summer solstice, when the solar declination is ≈ +23.5°. If the sundial is at latitude θ, the approximate time of earliest sunrise $T_{Sunrise}$ and latest sunset T_{Sunset} can be computed from:

$$\cos H = -\tan(23.5°)\tan\theta$$

$$T_{Sunrise} = 12 - \frac{H + \Delta\lambda}{15} + 0.0286$$

$$T_{Sunset} = 12 + \frac{H - \Delta\lambda}{15} + 0.0286 \qquad (12)$$

Where H, the hour angle, and $\Delta\lambda$ are expressed in degrees. The term 0.0286 corresponds to the value of the equation of time on 21 June (summer solstice) expressed in hours (equal to −1 m 43 s).

The limiting hours determine the angle ϕ_{ring} of the rings arc. Each hour block occupies 15 degrees. Furthermore, we must consider the rotation for the longitude correction and an extra angle (chosen equal to 10°) to allow the attachment of the rings to the cylinder:

$$\phi_{ring} = N_{HB}\ 15° + 2|\Delta\lambda| + 10° \qquad (13)$$

where N_{HB} is the number of hour blocks. ϕ_{ring} could be rounded up to the nearest multiple of 5.

Example

The above formulae allow computation of all the parameters needed to make an actual light spot sundial. As an example, Table 3 summarizes those parameters for a sundial at Barcelona ($\lambda = 2.175°$ E, $\theta = 41.4°$ N). The radius of the central cylinder is set to 250 mm. The size of the holes and the distance L between rings are arbitrary (within certain limits), but, as explained before, must follow the recommendations. For instance, the diameter of the holes should be around 3–4 mm for an accurate reading and good visibility.

For the ring arcs, using equation (13), $H = \pm 112.54°$ and $\Delta\lambda = -12.825°$ (Barcelona is at GMT+1 time zone, so the standard meridian is at $\lambda_0 = 15°$ E), and therefore $T_{sunrise}$ = 5h 23m and T_{sunset} = 5h 23m. In this case the sundial must have 16 hour blocks from 5 am to 9 pm; thus for Barcelona, $\phi_{ring} = 255°$.

Figs 10 and 11 show an early prototype made of plywood to indicate the general scale. Note the time-telling spot of light in Fig. 11.

Cylinder radius (R_c)	250 mm
Inner ring radius ($R_{inn} \approx 1.9\ R_c$)	475 mm
Outer ring radius (R_{out})	575 mm
Hole diameter (D_h)	3 mm
Slit width (W_s)	29.2 mm
Slit height (H_s)	> 90 mm
Ring width (W_r)	> 177 mm
Hour blocks (N_{HB})	from 5 h to 21 h
Ring arc angle (ϕ_{ring})	255°

Table 3. Example of parameters for a sundial at Barcelona ($\lambda = 2.175°$ E, $\theta = 41.4°$ N).

Conclusions

A new sundial design has been presented. Its main characteristic is that the time is marked by the position of a spot of light projected on a cylindrical surface, instead of the usual gnomon's shadow. The functioning of the sundial imposes several restrictions to the design, in particular the sizes and positions of its components.

The concept has been successfully tested using Autocad. We constructed a full model of the sundial and rendered dozens of images with the Autocad's solar position simulation capability. The renderings show that it is possible to get an accurate reading of the time for the light spot dial constructed as described above. With the dimensions used in our model (radius of the central cylinder equals 250 mm), the estimated accuracy achieved would be some 2 minutes.

Fig. 10. An early version of the dial, made of plywood, showing the general size and shape of the dial. The author (right) and Cesc Gelpí, who made the plywood model.

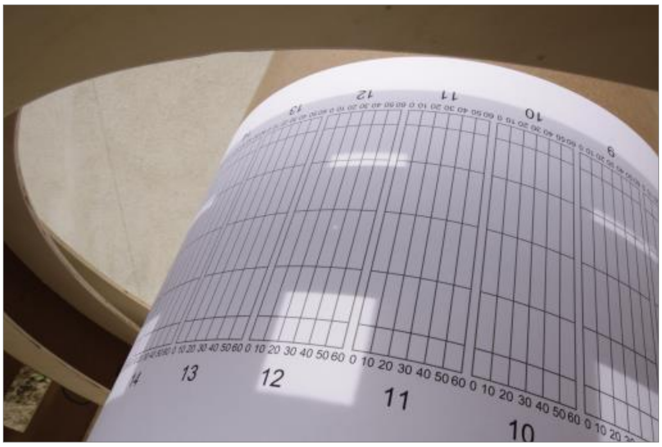

Fig. 11. As Fig. 10, showing the tiny spot of light. The brightness and contrast of the photograph has been changed to make the spot more visible.

Because of its large size, the sundial is most suitable for gardens or parks. Very precise work would be required to make such a dial. The rings, slits and holes must be accurately cut to the right sizes and positions and the whole structure assembled very carefully. The most suitable material would be a metal such as stainless steel. Probably it would need a precise laser cutting for the slits and holes. No actual dial has been made yet. An alternative for smaller sundials is to use a 3D printer.

ACKNOWLEDGEMENTS

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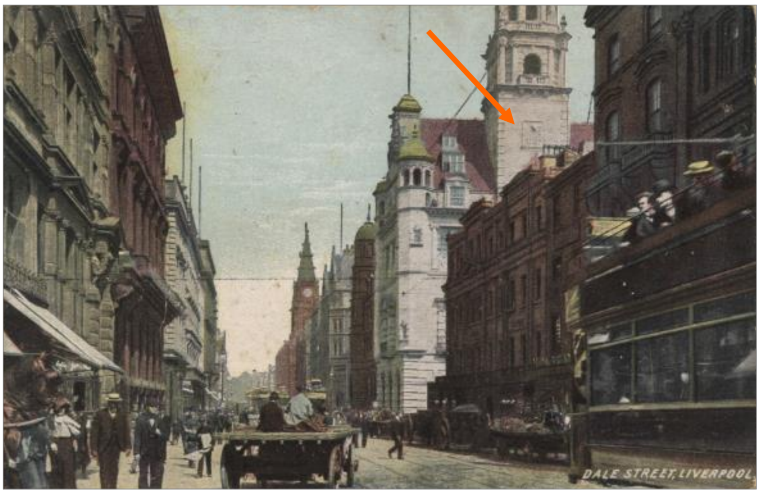
Eduard Masana (Barcelona, 1969) studied physics at the University of Barcelona, and currently works at the Cosmos Science Institute, belonging to the same University. His professional work is currently linked to the European Space Agency's Gaia mission, designed for measuring the positions, distances and motions of stars with unprecedented precision. He enjoys any activity related to astronomy, from sundials to astrophotography. He has travelled around the world to see several solar eclipses, another of his passions. He can be contacted at *emasana@fqa.ub.edu*

Postcard Potpourri 56 – Liverpool

Peter Ransom

This is dial SRN 5665 in the Fixed-Dial Register, where it is listed as being in North John Street (it is, in fact, 1 North John Street). The dial is an impressive vertical one, a great decliner, just strides away from the pedestrianised shopping streets of Liverpool city centre. Its condition is good (as recorded in 2003) and the declination of 67 degrees to the west adds to its visual interest. It is on the old Royal Insurance building which is now the Aloft hotel.



The card is postally unused and on the reverse it has Lewis's Series in a circle. I have not been able to find out much about this, but a 'Lewis's Series' search on ebay came up with about a dozen cards, all of which feature pictures of or around Liverpool. Those that can be dated from postmarks have late Edwardian dates and the people and transport featured on the card would support that era. I suspect that that these were produced by the department store Lewis's that first opened in Liverpool city centre in 1856 and which in 1879 opened one of the first Christmas grottoes. This brought back memories for me as I grew up in Liverpool in the 1950s and 1960s and was often taken to Lewis's grotto at Christmas. Lewis's became a Liverpool institution and more details about it can be found at *https://en.wikipedia.org/wiki/Lewis%27s*

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WELSH LANGUAGE INSCRIPTIONS ON SUNDIALS

IRENE BRIGHTMER

Reporting sundials with Welsh language inscriptions is not a major task because there are so few known examples. Those described below include verticals and horizontals, old and new, broken and lost, and two of unknown provenance.

There is an interesting remark on their rarity in a Welsh newspaper from a century ago. The 1921 cutting is inserted in a manuscript in the National Library of Wales. The small notebook has hand-written comments and drawings by the Revd David Harris Williams (1870–1927).[1] The notebook is a record of the sundials seen during Harris Williams's travels throughout Wales over several years during the 1920s. The correspondent in the news cutting expresses surprise at the scarcity of Welsh mottoes on dials. He asks

"*Were our forebears in Wales so imbued with the classic spirit that they would have nothing but Greek or Latin on their sundials, or is the Welsh language not suitable for gentle moralisings on the flight of time?*"

The present writer has seen many dials in Wales with Latin or English mottoes, none with Greek inscriptions, and only a few in Welsh. Searching the BSS Fixed Dial Register produced four at the beginning of my project, and findings elsewhere have produced a grand total of nine.

Painted Slate Vertical Dial

One of the finest is the painted vertical dial on St Cybi's Church, Holyhead (SRN 2736; Fig. 1) which has recently been restored. Mrs Gatty[2] included the motto in her collection and had been informed that it was written by a 6th century Welsh bard:

YR HOEDL ER HYD EI HAROS
ADDERFYDD YNNYDD AC YN NOS

(*Man's life, though prolonged it may*
Draws to its close by night and day)

Horizontal Dial

In the quadrangle of Bangor University is a horizontal brass sundial by Silas Higgon with a Welsh inscription around the stone pedestal (SRN 4351; Fig. 2):

HED AMSER
MEDDI NA!
ERYS AMSER
DYN A

(*Time goes*
You say – no!
Time stays
Man goes)

Fig. 1. A painted vertical dial on the church of St Cybi at Holyhead.

Fig. 2. Horizontal dial at Bangor University.

Harris Williams saw a dial here in 1923 and described it as a "bronze crescent sundial," but this is not the one in place now. The replacement dial plate, apparently on the original pedestal, is octagonal, and while not incorporating a motto as such, does include some text in Welsh: the graph for the Equation of Time has "add" and "subtract" in English as well as Welsh ("adio" and "tynnu") and the initials of the months are also in English and Welsh.

Slate Vertical Dial

The third of the Welsh language dials in the BSS Fixed Dial Register is also in Gwynedd (SRN 2205; Figs 3 and 4) and dates from 1816. It is a vertical dial in slate with an iron gnomon, high up on the south wall of St Beuno's Church, Penmorfa, Porthmadog. It includes the Rector's name, Jefferey Holland; was he also the maker and/or the writer of the motto?

Fig. 3. Vertical church dial at Porthmadoc.

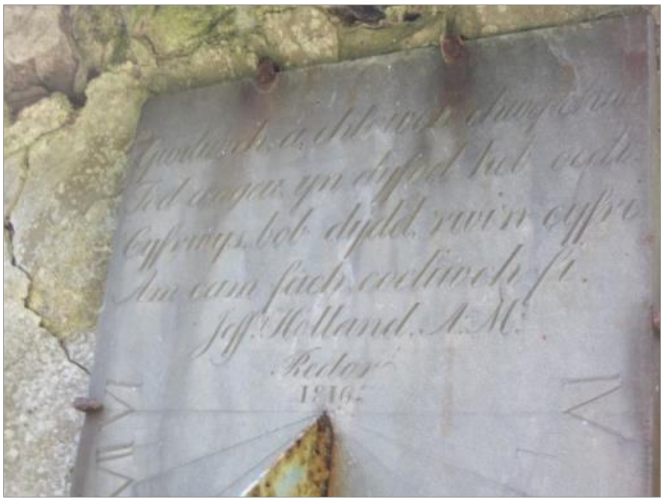

Fig. 4. Close-up of the Porthmadoc dial.

The dial is so high up that it is difficult to read, and even photograph. It was originally transcribed by non-Welsh speakers of the BSS, but has now been looked at by a native Welsh speaker who transcribes and translates it here:

GWILIWCH A CHLEWCH DRWY DRAI,
FOD ANGAU YN DYFOD HEB OEDI
CYFRWYS BOB DYDD, RWI'N CYFRI
AM CAM FACH COELIWCH FI

(*We must be aware that death waits for no one,*
and one must wisely watch one's step)

Modern Welsh Commemorative Dial

A modern Welsh sundial was installed in 1984 in Whitland, Carmarthenshire (SRN 6817; Figs 5 and 6) and commemorates Hywel Dda (Hywel the Good). He was a notable king in southwest Wales, and in the 10th century united most of the country under his rule. He is especially associated with developing the Welsh Laws into a written code.

The sundial is horizontal, constructed wholly of Welsh slate, and richly embellished with colourful enamels and elaborate engravings celebrating Hywel as the lawgiver. The text is in Welsh, with copious extracts from the Laws.

Fig. 5. Commemorative garden dial at Whitland, Carmarthenshire.

Fig. 6. The Whitland commemorative dial.

The dial is at the centre of a small commemorative garden at the museum in Whitland (Fig. 6). It was designed and made by the Welsh artist Peter Lord of Aberystwyth. Very sadly the gnomon was detached and thrown into the adjacent pond not long after the installation, and there has been no attempt to replace it.

Vertical Stone Dial

There is another dial mentioned in Gatty and also by Harris Williams. It is a sandstone vertical dial, and when it was seen by Harris Williams in 1922 he reported that it was already broken and was kept inside the church at Whitford in Flintshire (Fig. 7). He made a drawing and quoted the Welsh motto and gave a translation:

GWEL DDYN MEWN GWIW LAN DDEUNYDD
MAE FFO HEB DARIO MAE YR DYDD

(*Behold oh man, the day*
It flieth without tarrying)

Happily it is still there and I have seen and photographed it, thanks to the churchwarden who provided appropriate lighting. It is inside the 15th century church of St Mary and

Fig. 7. Seventeenth century stone dial inside Whitford Church, Flintshire.

St Beuno, sitting among a collection of stone fragments, not necessarily from the parish, some of them older than the present church building itself. These include an early churchyard cross, various incised stones, a sarcophagus, fragments of medieval sepulchral slabs and a 17th century font. The various fragments are said to have been collected by Thomas Pennant (1726–98), Flintshire's antiquary, naturalist, traveller and writer who lived at Downing Hall in Whitford parish.

The sundial, however, is generally believed to belong to the church, and a note in the church claims that it is 17th century, which is consistent with its style. Eighteenth century illustrations of the church by Pennant's own illustrator, Moses Griffiths, do not show any vertical sundial in place, although this is not necessarily significant. But it would be interesting to know exactly where it was originally placed. The church walls have been rendered since that time, so potential fixings are not visible.

Although the dial was described as 'broken' in 1922 when it was seen by Harris Williams, it is not seriously so: it has merely lost its corners and its gnomon. The inscribed Welsh motto is complete and is as recorded by both Gatty and Harris Williams. It has inscribed on it the latitude of Whitford, 53° 15′ N and also the declination of the wall as 9 degrees east of south: impressive detail for a stone dial of this date for a rural church.

It has been suggested that it is likely that the dial was originally painted. The engraved lines are very fine, but deep, and would have served as guides for repaintings.

This dial deserves a place in the sun. It needs only a new gnomon and new brackets to hold it safely on the wall of the church for which it was made centuries ago. Even better, since the stone is beginning to 'spall' (peel), an exact reproduction could be made.

Welsh Slate Vertical Dial 1812 (unknown provenance)

Since beginning to search out dials with Welsh inscriptions I have acquired a Welsh slate vertical dial dated 1812. Mysteriously it had been languishing in the barn of an Oxfordshire farm and was offered to BSS member and former Secretary, Doug Bateman.

When Doug read of my interest in Welsh language sundials he offered it to me, and it now awaits the fitting of a new gnomon and fixing on to a suitable SSE-facing wall, preferably in Wales! It has the Welsh motto inscribed along the top in a large script, but below that is a Latin motto in smaller script. The original owner/commissioner must have been a scholar (or an aspiring one!) as the Latin text is from Ovid, according to the late Margaret Stanier of Newnham College, Cambridge and a former Editor of the *Bulletin*. The inscriptions are as follows:

DYDDYDDIAU YDYNT FEL CYSGOD
(*The days are like a shadow*)

NON QUA PRAETERII HORA REDIRE POTEST
(*The hour which has passed cannot return*)

Fig. 8. Welsh slate declining vertical dial, of unknown provenance.

In the bottom corners are engraved GRYFFITH and DAFYDD. These may be the name(s) either of the maker, or of the churchwarden(s) if this had been a church dial.

Fake (?) Horizontal Dial (unknown provenance)

A curious brass circular horizontal dial plate was offered for sale on the Internet a few years ago. It was described as an 'early' dial, but some of the features suggest that it is not as old as it appears, but made to deliberately suggest antiquity, in other words it is a 'fake'. What is of interest is that it has two mottoes, one in Welsh, the other in Latin from Horace's odes. The latter happens to be the same motto as seen recently by this writer on a very fine early 18th century dial by a famous maker and still in its original location in a North Wales garden. (Is this a coincidence, or did the modern maker of the fake know the genuine old dial?)

The simple Welsh motto is:

DIM CYSGOD
DIM HAUL
(*No shadow, no sun*)

Horizontal Dial with Family Motto

In 2015 I came across my first dial with a Welsh inscription which is part of a family motto. The one and only! The dial was made by 'Bate, London' and is dated 1826 (SRN 7723; Figs 9 and 10). It is in a secluded part of the garden of a country house in North Wales. The family of the current occupants bought the house in 1829, and must have brought the dial with them from their previous house which was nearby and at a similar latitude.

It is a horizontal dial with a circular dial plate containing a wealth of information including the Equation of Time. It also has the latitude of the location for which it was originally made.

In the south of the dial plate is a coat of arms which is now very indistinct. The inscription is:

HEB NEFOL NERTH NID SICR SAETH
(*Without heavenly aid no arrow is sure*)

Lost Horizontal Church Dial

Sadly, the last one on my list has been stolen from its pedestal, which still remains in place in Llysfaen churchyard near Colwyn Bay. I knew of this dial from an official listing of 1997, although the inscription was already reported to be illegible. When I went to search it out I found only the empty pedestal. According to the listing the dial was a brass/bronze horizontal and was dated 1731. Its rare Welsh motto was, fortunately, recorded by Harris Williams:

MAE'R HAUL AC AMSER AR EU HYNT
YN MYNED RHAGDDYNT CEUNYDD
GWNA DDYN DY ORCHWYL HEB YMDROI
MAE RHAIN YN RHOI I TI RYBYDD
NI BYDDI YN HIR YN RHODIO'R LLAWR
DY OES FEL AWR A DDERFYDD

(*Sun and time on their course*
Between them move for ever
Man, see to your task without delay
For those two give you warning
That you will not be long on earth
Like an hour you will end)

Postscript

Are there really so few sundial inscriptions in Welsh? And is North Wales alone in possessing historical ones? It is doubtful. Knowing that over the centuries there have been many sundial makers throughout Wales, often combining sundials with clockmaking, I am optimistic that continued searching may discover more!

Meanwhile, perhaps the 1984 commemorative dial in South Wales will provide the inspiration for some new 21st century dials celebrating Welsh culture in the Welsh language.

Fig. 9. Horizontal garden dial by Bate, London.

Fig. 10. Detail of the Bate dial.

ACKNOWLEDGEMENTS

I am especially grateful to friends in England and Wales, without whose help I could never have even begun the above short study: the owners of the dial by Bate for allowing me access; Doug Bateman of the BSS who offered me the opportunity to own a dial with a Welsh motto; John Davis, Editor of the *BSS Bulletin*, for his help and advice in understanding some of these dials, and for drawing my attention to the fake dial offered for sale on the Internet; Jim Maxwell of the Pennant Society for arranging for me to see and photograph the Whitford dial; Sara Owen of Bangor for the transcription and translation of the motto on the Penmorfa dial; Tony Wood of the BSS for originally drawing my attention to the important Harris Williams manuscript in the National Library of Wales.

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2. Mrs Alfred Gatty, H.J.F. Eden and Eleanor Lloyd: *The Book of Sun-Dials* (4th ed., 1900), London, George Bell and Sons.

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FROM MADELEY COURT TO THE HALFWAY HOUSE

GRAHAM STAPLETON

As an inveterate dial-hunter (though for the time being, constrained to Internet discoveries), I am well aware that they may well be found when you are not expecting to see any. I had not, however, anticipated this extending to watching films. While viewing a DVD of *The Halfway House,* a 1944 Ealing Studios film directed by Basil Dearden,[1] I was astonished to see what resembled the Madeley Court sundial (Fig. 1) in the background, and again in later scenes fleetingly but more clearly.

Fig. 1. A glass plate slide, showing the position of the dial relative to Madeley Court house. Image courtesy of John Foad.

The Madeley Court sundial is most distinctive; a stone cube with sides of some four feet (1.2 metres) with a domed top and numerous scaphe dials, some of quite intricate shape, it is a remarkable example of this form of sundial. In this film, it seemed to have been relocated and to have acquired a thick coat of whitewash in the process (Fig. 2).

Multiple thoughts came to mind: Could there be a twin to Madeley? Had the Madeley dial been moved? Was this a 'prop' made for the film and did it still exist, reposing in somebody's garden? The first question was fairly easily answered; although the eponymous 'Halfway House' was supposedly in Wales, the actual filming was done at the remaining part of Barlynch Priory, outside Brompton Regis in Somerset.[2] Google StreetView allowed me to 'drive' past the building and confirm with reasonable certainty that the dial was not still there.

It seemed quite improbable, but could the Madeley dial have been transported the 180 miles from Shropshire? Certainly in 1880, Madeley Court was described as "fast going to decay" and "a scene of utter desolation"[3] and there could have been an estate sale. However, this possibility is disproved by the dial's description in Pevsner's 1958 Architectural Guide for Shropshire.[4]

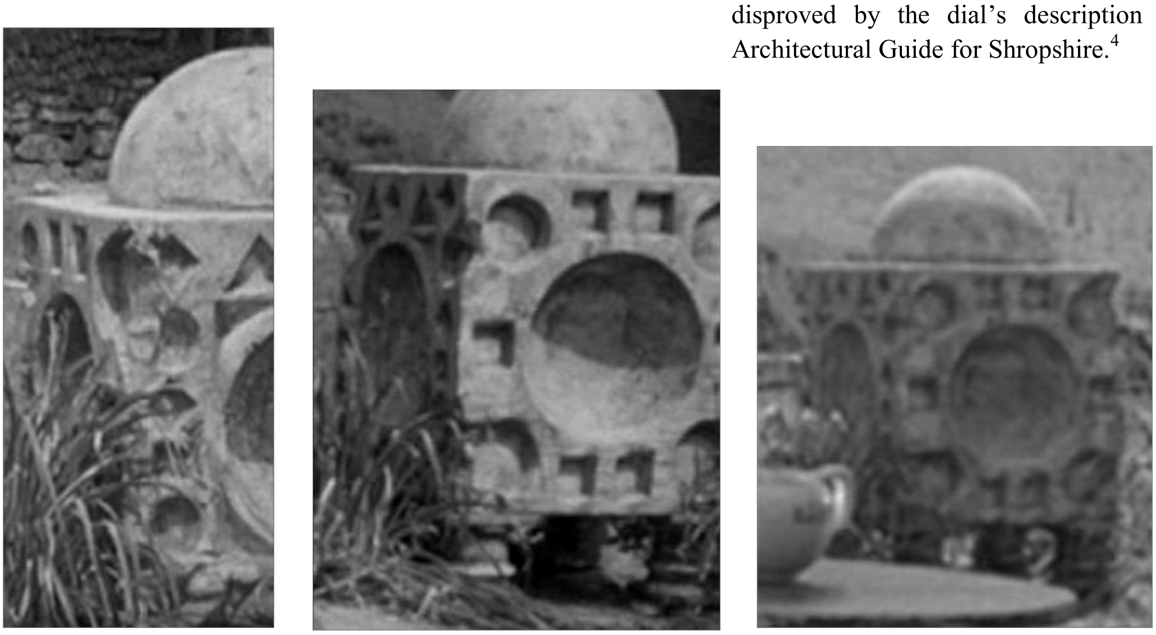
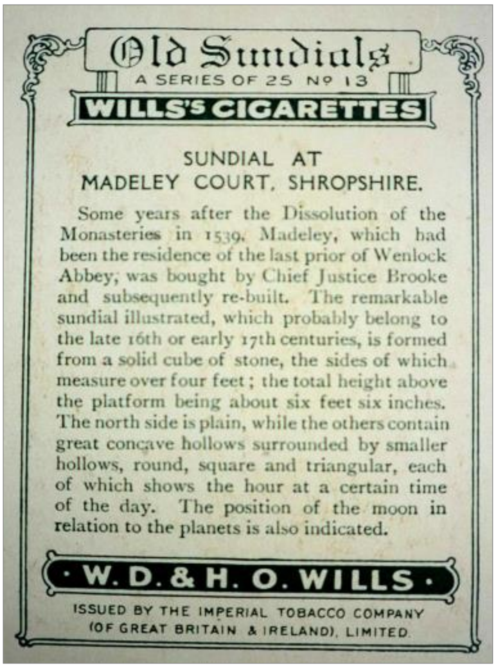


Fig. 2. Extracts from stills of 'The Halfway House' showing the prop 'sundial'. Copyright Ealing Studios.

Fig. 3. Obverse and reverse of the Wills's cigarette card illustrating the Madeley Court dial.



Old Sundials
A SERIES OF 25 Nº 13
WILLS'S CIGARETTES

SUNDIAL AT
MADELEY COURT, SHROPSHIRE.

Some years after the Dissolution of the Monasteries in 1539, Madeley, which had been the residence of the last prior of Wenlock Abbey, was bought by Chief Justice Brooke and subsequently re-built. The remarkable sundial illustrated, which probably belong to the late 16th or early 17th centuries, is formed from a solid cube of stone, the sides of which measure over four feet; the total height above the platform being about six feet six inches. The north side is plain, while the others contain great concave hollows surrounded by smaller hollows, round, square and triangular, each of which shows the hour at a certain time of the day. The position of the moon in relation to the planets is also indicated.

· W. D. & H. O. WILLS ·
ISSUED BY THE IMPERIAL TOBACCO COMPANY
(OF GREAT BRITAIN & IRELAND), LIMITED.

Whilst waiting for replies from the local museum, Exmoor National Park, a local paper and a number of parish magazines, I sought what information was available about this dial. There are a good number of similarly complex multiple dials in Scotland, but they are rare in England, so I would have expected examples to be commented on. There are, however, fewer references to it than I might have hoped. The Madeley Court dial is mentioned in Gatty[5] and has appeared in the *Bulletin*,[6] but the best description is by Andrew Somerville in a Madeley Court themed issue of *Shropshire History and Archaeology*.[7,8]

As the film-prop dial was probably made from timber, chicken-wire and plaster, it was unsurprising that the replies to my enquiries all returned negative results for a present-day sighting, or even a recollection. All of this very strongly suggests that the 'dial' was broken up shortly after filming was completed.

I then corresponded with John Davis who had visited the original dial and has a number of photographs, especially ones showing the faces of the cube not usually portrayed. He observed that the distribution and shape of the hollows seen in the film stills did not match those of the Madeley dial and – most tellingly – none of the circular hollows had a hole at its centre. (These holes can be seen in Fig. 1.)

Now that I had stopped looking at the question of where the dial might be and had started studying the images, the differences were quite apparent to me. On one face the shield shapes were not replicated, but most of the damage to the circles was. Again, the side with triangles was copied closely, but an edge was chipped off the copy that was intact on the original. All of this places the origin of the 'Halfway House' copy untraceably in the Ealing Studios Art Department.

The final question left is what source the prop-makers took as their reference. In 1943 there would have only been the venerable dialling texts that we know now, and given the studio's general attention to detail, to research an image and then make a pastiche seems inconsistent.

It was only by accident during the process of going through the possible books that the answer arrived: the Wills's cigarette card set 'Old Sundials' printed in 1928 (Fig. 3). Whether the studio happened to have them already, or whether they were the quickest reference available under wartime conditions, cannot be known. I can say that this prop was not designed on the back of a cigarette packet, but from the inside of one.

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6. Andrew R. Somerville: 'The Sundial at Madeley Court, Shropshire', *BSS Bull.*, 89(i), 9-11 (July 1989).
7. Andrew Somerville: 'The Sundial', in *Transactions of the Shropshire Archaeological and Historical Society*, vol. LXXXI 2006, pp. 61-5 *https://shropshirearchaeologyhistory.files.wordpress.com/2019/09/shropshire-transactions-vol.-81_sm.pdf*
8. There is very little specific information, but very good drawings of the dial in: Paul Belford: *Industrialisation and Identity in Shropshire: the Brookes of Madeley, 1544-1646*, PhD University of York Archaeology, September 2015, pp.141-3 *http://etheses.whiterose.ac.uk/12011/1/Belford_PhD.pdf*

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SYMBOLS FOUND ON SCANDINAVIAN SUNDIALS FROM THE MIDDLE AGES

JOHAN A. WIKANDER

In the September 2020 issue of the *BSS Bulletin* I described some Norwegian mass dials and their symbols.[1] However, sundials were also used by the laity. Secular symbols were then used, and these symbols are the subject of this article.

The Pole Star Symbol

In Fig. 1 we see the only sundial so far found with a Pole Star symbol. It is a horizontal sundial carved on a piece of soapstone, and the Pole Star is the only symbol carved. The sundial shows the middle of each of the eight octaval hours.

In addition, a small hole is carved at the end of the octaval hour called *Undorn* or *Eykt*. This was an important time, as that was when the working day usually ended. The Sun was then WSW, and this point on the horizon was called *Eyktarstad*.

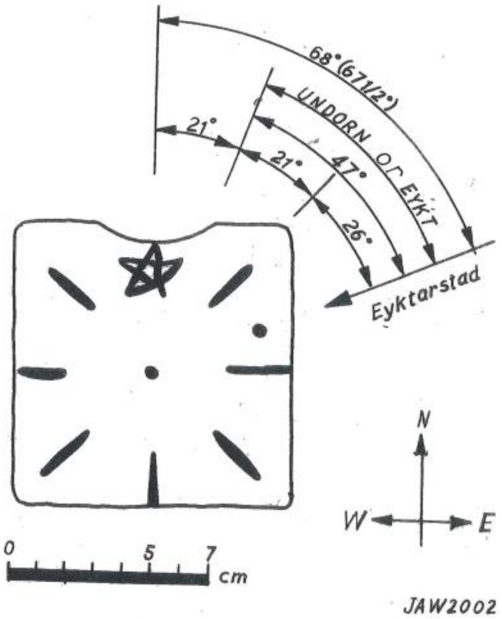

Fig. 1. Sundial carved on soapstone, octaval hours, with a carved symbol representing the Pole Star. Holder: Norsk Folkemuseum, Oslo.

We should note that *Dagmálstad* in those early days was another important point on the horizon. The Sun was then ESE and the octaval hour *Morgun* ended. However, there is no small carved hole for *Dagmálstad* on the sundial in Fig. 1.

We should also note that the definition of *Eyktarstad* was changed when Christianity came to Scandinavia very early in the 2nd millennium, so that the Sun was then said to be in the *Eyktarstad* position when the Sun had gone ⅔ of the sector SSW–WSW, and there was ⅓ left. This time of the day was the end of the 9th unequal hour, and was the time from which a holy day should be observed. This was according to the Christian way of thinking.[2]

The sector SSW–WSW, 45 degrees, was an *ætt.* The whole horizon, 360 degrees, was divided into eight *ættir.* The octaval hours were linked directly to the *ættir.*[3]

We do not know exactly how old this sundial is. However, the Pole Star was important in navigation before the mariner's compass was introduced in the late Middle Ages. The Pole Star was called *Leiðastjarna*, and "*Leiða-*" means "show the way". The old Norwegian word "*-stjarna*" means "star".[4]

Both octaval hours and the unequal hours brought to Scandinavia by the Church were used throughout the late Middle Ages and also after the Reformation in the 16th century.[5] I will write a separate article about that, with details about a sundial which has lines engraved for both octaval hours and unequal hours: two separate sundials on the same piece of ivory.

The octaval hours system was also used by the Anglo-Saxons, but in part they used different names from the Scandinavians.[6]

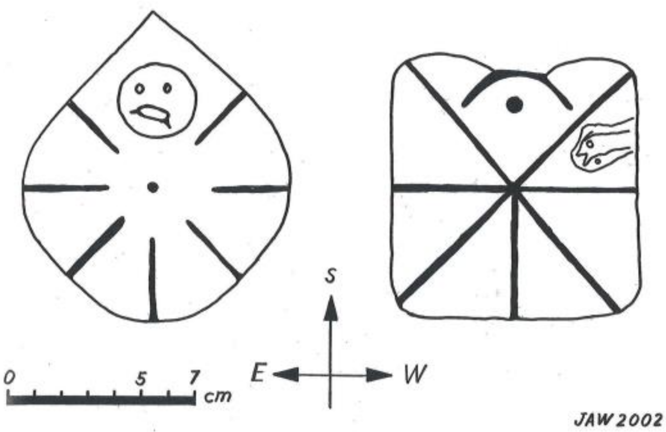

Fig. 2. Sundials carved on soapstone, octaval hours. The Sun is shown as a symbol, and a cock is a symbol for the very early morning. Holder: Norsk Folkemuseum, Oslo.

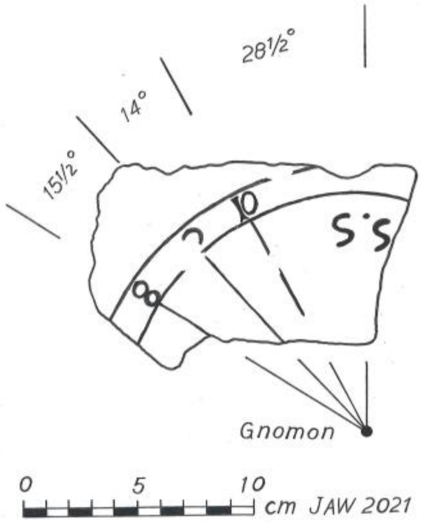

Fig. 3. Sundial carved on limestone, unequal hours. It was found during excavations in the village of Lilla Ullevi, Bro parish, 59° 31′ N, 17° 34′ E.

The Sun Symbol

Fig. 2 shows two horizontal sundials, both made of soapstone, and each with a symbol for the Sun. The sundial to the left has a primitive Sun symbol carving, and its arrow shape indicating south is itself a symbol.

The sundial to the right has a small carved hole, which is really a symbol for the Sun, and on its right-hand side there is a carved head and neck of a cock: the cock crows in the early morning, and he is thus a symbol for this very early time of the day. Both sundials are carved according to the octaval hours system, and the carved radial lines show the middle of each octaval hour.

Fig. 3 shows a piece of a horizontal sundial carved on limestone. The sundial was found during archaeological excavations in the small village of Lilla Ullevi, Uppland, Sweden, northwest of Stockholm, and has been dated back to the late Middle Ages.

The letters "*S S*" stand for "*Sol i Syd*", meaning "Sun in South". A small hole carved between the two 'S'-es indicates the noon line. The sundial shows unequal hours, although the angles between the hour-lines are not exactly 15 degrees. We often see such very small inaccuracies when we study old sundials.[7]

The Farmer's Sundial AD 1500

This particular horizontal sundial is made of soapstone and is shaped like an old small weight. It comes from a valley south of Trondheim, Norway. Fig. 4 shows the underside of the weight, on which is carved the date AD 1500. However, we see that the Roman numeral *U/V* is used instead of the corresponding Arabic numeral.

The hour-lines show the beginning and the end of each octaval hour, and the corresponding symbols are carved on the edge of the weight (Fig. 5). We start with the very early morning, the octaval hour Ó*tta*. The farmer is then still in his bed with his nightcap on his head.

Fig. 4. The year AD 1500, carved on soapstone, partly with Arabic numerals and partly with a Roman numeral, U/V. This is the date on the sundial in Fig. 5.
Holder: NTNU Vitenskapsmuseet, Trondheim.

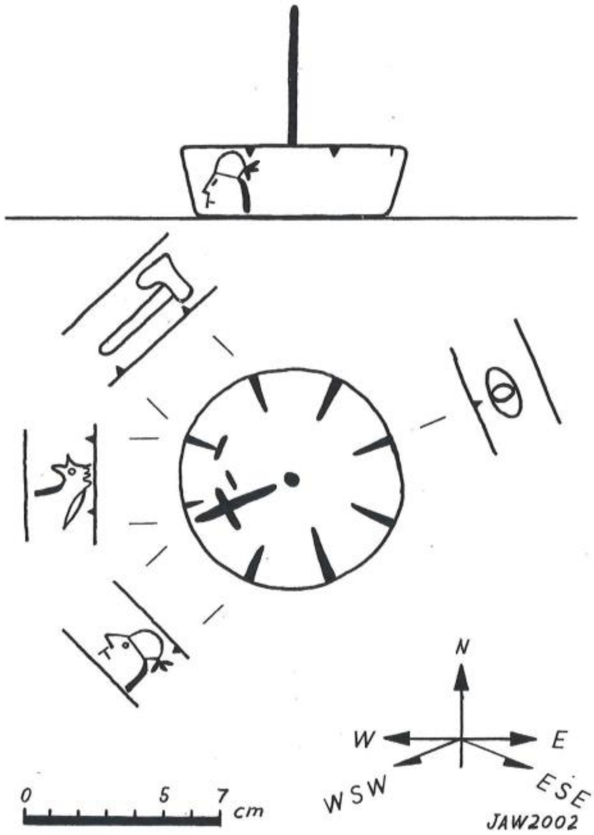

Fig. 5. The farmer's sundial AD 1500 carved on soapstone, octaval hours. The symbols are typical for his life. Notice that one symbol, the Latin cross, is picked up from a mass dial – the farmer was a good Christian.
Holder: NTNU Vitenskapsmuseet, Trondheim.

The next octaval hour, *Morgun*, has a cock symbol. We know from the Bible and Christ's Passion that the cock crows in the early morning. The next octaval hour, *Dagmál*, has an axe symbol. The Sun is then in the ESE–SSE sector, and it is time for the farmer to work in the wood or in the field.

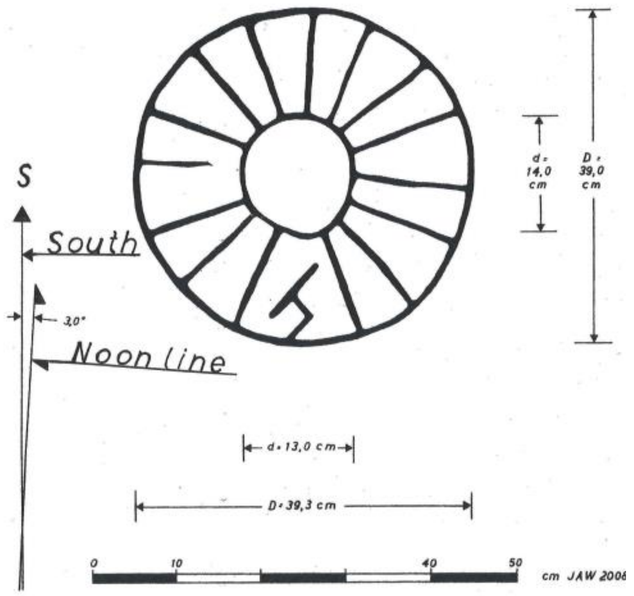

Fig. 6. The Mandal horizontal sundial carved on rock, octaval hours. The runic letter 'K', which is the 6th letter in the runic alphabet, and which is used as a golden number, is carved as a noon mark. 58° 2' N, 7° 39' E.

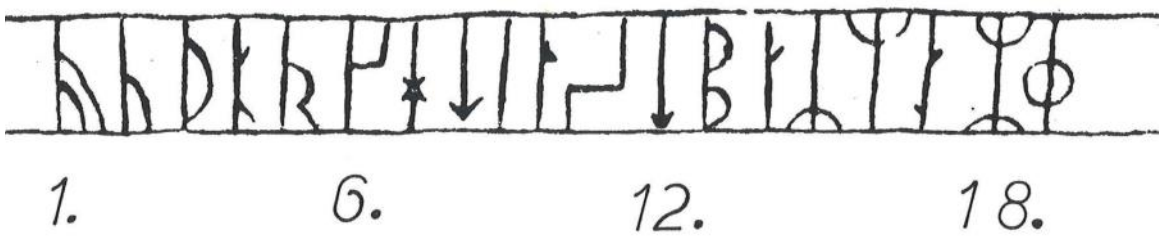

Fig. 7. The 19 golden numbers carved with runic letters. The 6th letter is used as a symbol in Fig. 6, but upside down. The carving is made on a Swedish calendar staff in the collections of Harrow School, Middlesex. Runic letters were used as golden numbers from ca. AD 1150. From: Proceedings of the Society of Antiquaries of Scotland, Vol. XXV, Edinburgh 1891.[11]

An eye is the symbol at the end of the octaval hour *Eykt*. The sun is then at the point on the horizon called *Eyktarstad*, WSW. It is then time for the farmer to relax and do easier work at home.

It is very interesting to notice that the beginning of the octaval hour *Morgun* and the end of the hour *Ótta* has a Latin cross as its symbol. The farmer would have been very familiar with the mass dials used by the Church, their symbols and unequal hours.[8] However, he preferred to have octaval hours carved on his own sundial and to follow these hours at work and at home.

Runic Letters Used as Symbols

In Fig. 6 we see a horizontal sundial with a runic letter symbol. The sundial is carved on the rock, very hard gneiss, on a local lookout by the bank of Mandal River. Nearby there was a small village and a harbour called *Casperboden*, named after a man called Casper, who was most probably a local merchant. From the lookout only the river and the surrounding hills can be seen.[9]

The sundial is carved according to the octaval hours system and shows every half hour. The sundial is very close to the true geographical directions; we do not know for certain whether the Pole Star or a mariner's compass was used to determine the direction of the noon line. This discussion is rather complicated and is not considered here, as our task is to study the symbol.

The symbol on this dial is the K-rune, which is the 6th rune in the Younger Futhark runic alphabet. The K-rune in this sundial is upside down compared with the way it is ordinarily written. Runes were from time to time carved inverted in this way.[10]

We have to explain this in more detail. From about the middle of the 12th century, the Younger Futhark, containing 16 runic letters, was used to represent the numerals for the *golden numbers*, and it was necessary to add three 'new' special runes to make a total of 19 numerals. These 19 runes/numerals were often carved continuously, just as the ordinary writing of the alphabet, for instance on calendar staffs or prime staffs. We see an example of this in Fig. 7.[11]

This particular symbol indicates the end of the 6th unequal hour, even though the sundial itself is carved according to the octaval hours system. We have already seen that the citizens in the late Middle Ages were familiar with both systems. We also find other such 'mixed sundials' in

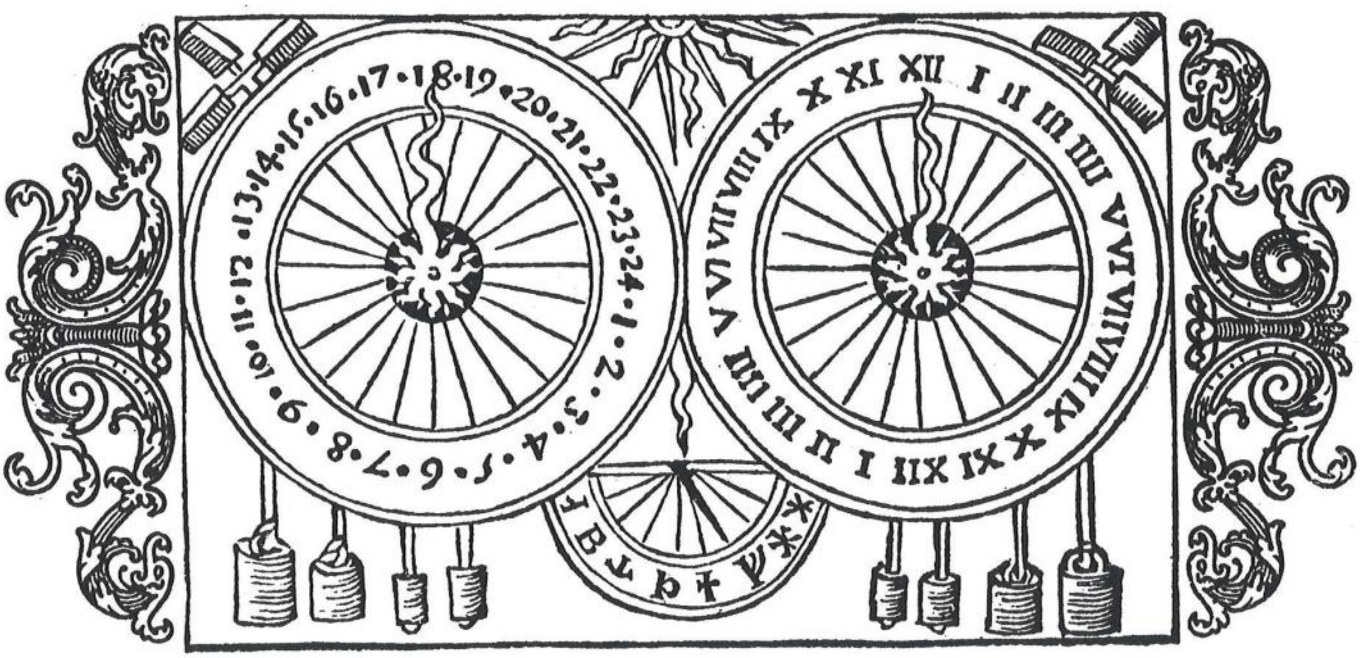

Fig. 8. Woodcut in "The History of the Northern People", issued Rome 1555 by Archbishop Olaus Magnus. The vertical sundial below the two mechanical dials is shown with the numerals represented by runic letters in the Greek order.

Scandinavia, in particular a horizontal sundial at an outport on the coast just west of Trondheim, Norway.[12]

The golden numbers and Sunday letters (dominical letters) written as runes were most common in Sweden. The sundial shown in Fig. 6 is linked directly to this Swedish custom. The dimensions of the two carved circles are approximate subdivisions of the *ell* of Gotland (in the Baltic Sea); this unit of measure was about 52.2 cm.

In those days there was an important sea route just off the southern and southeastern coast of Norway, linked directly to the trade between central Europe and the Baltic waters. The vessels then preferred to sail along the coast of Norway. When a contrary wind happened, the vessels put into our very good out-harbours for safety.[13]

Olaus Magnus (1490–1557) was the last Catholic Archbishop of Uppsala, Sweden. Because of the Reformation, he left Sweden and never returned, and he settled in Rome. In 1555 he issued a book, very detailed with many woodcuts and written in Latin, whose title translated is "*The History of the Northern People*". He gives interesting information about the life of people in Scandinavia.[14]

We see in Fig. 8 one of his woodcuts. Below the two large mechanical dials, a vertical sundial is shown. The numerals are runes according to the Greek order, Alpha, Beta, Gamma and so on. Nothing is written in the 1555 text about sundials and their numerals. However, it is understood that runes were used as such numerals from time to time. So far, the sundial in Fig. 6 is the only one found in Scandinavia with a rune representing a numeral.

Symbol for South and the South–North Direction

Fig. 9 shows a portable horizontal sundial made of soapstone. In the centre there is a hole for a vertical gnomon which has been kept separately. Hour-lines are not

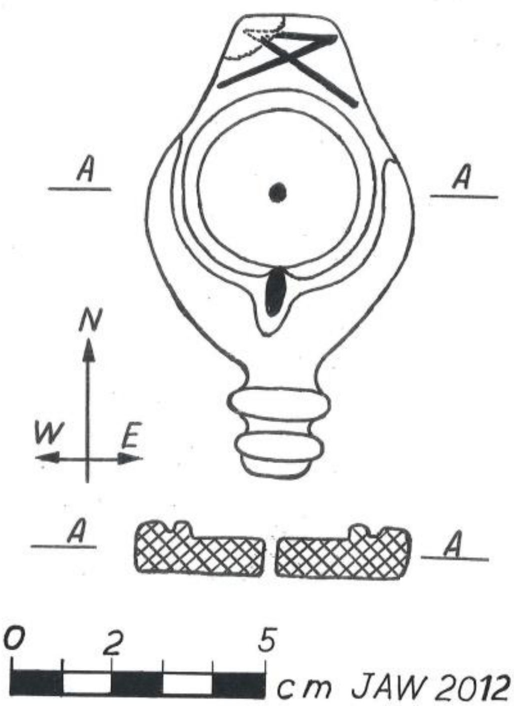

Fig. 9. Portable horizontal sundial made of soapstone and found in Trondheim. The hour-lines or sectors would have originally been painted; however, the painting is gone. The carved symbol is a symbol for south or the south–north direction, 63° 26′ N, 10° 26′ E. Holder: NTNU Vitenskapsmuseet, Trondheim.

Fig. 10. Horizontal sundial made of limestone, unequal hours, found during excavations at Glimmingehus, a castle in Sweden. The sundial was made for IESPER MORT (ENSSØN). He was not the owner of the castle, but was most likely an office-holder, civil or official. The symbol represents south or the south–north direction.
55° 30′ N, 14° 14′ E.
Holder: Lund Historiska Museum. Photo: Anders Ohlsson.

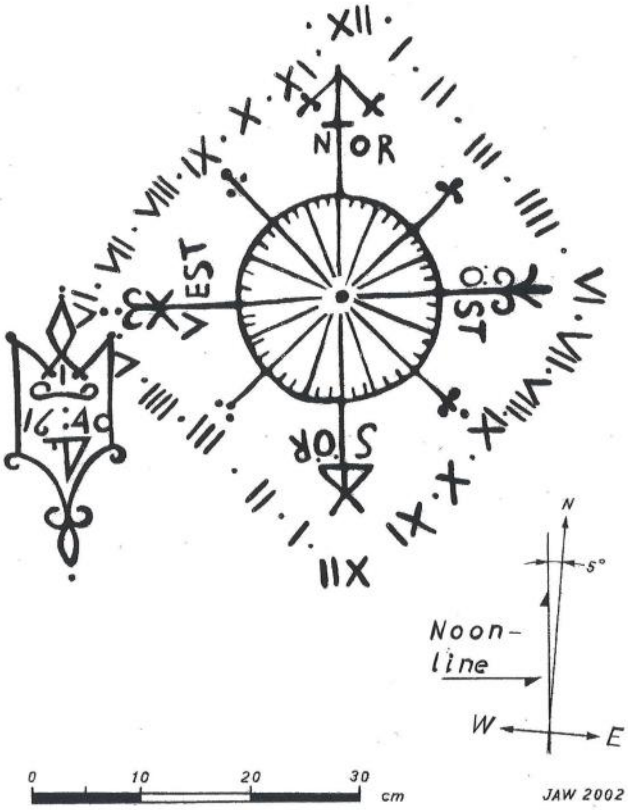

Fig. 11. Horizontal sundial with compass rose in the middle, unequal hours, carved on rock. This very detailed carving was made by military guards in 1640. The symbol towards south is the same symbol as we see in Figs 9 and 10.
59° 25′ N, 19° 12′ E.

carved. As the sundial is quite small, it is likely that sectors showing the different hours would have been painted. We do not know whether these painted sectors showed octaval hours or unequal hours. Between the grip and the dial, quite a large hole has been carved in the soapstone. This hole was originally for a chain or a rope. The sundial was found in Trondheim, Norway, during an excavation. The sundial has most probably been lost.

A symbol is very distinctly carved opposite the grip. This symbol looks very much like a runic letter. However, it is a symbol of its own for south or the south–north geographical direction, and shows how the sundial was intended to be held.

We see in Fig. 10 a very nice horizontal sundial carved on limestone. The sundial is Swedish and comes from *Glimmingehus*, a castle built very early in the 16th century on the extreme southeast coast of Sweden. Very early in the 17th century several things from the castle were thrown into the moat which surrounded the castle. We do not exactly know why, but there must have been some kind of a rebellion. The sundial was rediscovered by excavation. The sundial has exactly the same symbol for south as the sundial in Fig. 9, but turned around.

A third horizontal sundial with exactly the same symbol for south is shown in Fig. 11. There is a compass rose carved in the middle of the sundial. In the Baltic Sea, east of Stockholm, Sweden, there is a group of small islands called *Lille Nassa Skjärgård.* In the middle there is a lagoon and a very good harbour for small boats. On the biggest island, to the east, this compass rose and the sundial with Roman numerals were carved in 1640 on the rock. I had to be careful when I identified the carving and made the drawing exactly to the scale of 1 : 1 because, I was told, there were many poisonous snakes, vipers, on this particular island![14]

Sweden was at that time heavily involved in the European Thirty Years' War between 1618 and 1648. There was then a military sentinel, and the very detailed carving was done by the guards.

This symbol for south and the south–north direction has so far been found in three different places in Scandinavia. The symbol is obviously very old and goes back to the Middle Ages and the Viking Period. The symbol is not a rune but is closely related to runic writing and has survived through the centuries. Octaval hours were linked directly to the geographical directions. The sea route was the main route and knowledge about navigation was important for the Scandinavians.

ACKNOWLEDGEMENTS

I got very good photographs of the sundial in Fig. 3 from Helena Rosengren, Statens Historiska Museer, Stockholm. I could not visit Stockholm because of Covid-19. I also got the Fig. 10 photograph from Anders Ohlsson, Lund Historiska Museum, Lund, Sweden. I thank them very much for this help.

REFERENCES and NOTES

In 1844 Finn Magnusen (1781–1847), professor, published in Copenhagen a monograph: *Om de gamle Skandinavers Inddeling af Dagens Tider,* 119 pages and two plates. The subject is the history of the hours through the day and night in Scandinavia, especially the octaval hours.

Kulturhistorisk Leksikon for Nordisk Middelalder (KLNM), published in Copenhagen 1956–78, 22 volumes. This encyclopedia contains articles dealing with culture and daily life in Scandinavia in the Middle Ages; it is very detailed and has many references to older literature.

The sundials discussed are not on display in museums etc, apart from the one in Fig. 10, the Glimmingehus sundial.

1. Johan A. Wikander: 'The horizontal mass dial at Munkeby Abbey, Norway, *BSS Bulletin*, 32(iii), 42–46 (September 2020).
2. Sam Owen Jansson: 'Dygn (och dess indelning)', *KLNM*, vol. 3, Copenhagen (1958), columns 389–395. The subject is timekeeping.
3. Magnús Már Lárusson: 'Horisont', *KLNM*, vol. 6, Copenhagen (1961), columns 669–671. The subject is the division of the horizon, 360°.
4. Anne Holtsmark: 'Stjernekundskab', *KLNM*, vol. 17, Copenhagen (1972), columns 190–194. The subject is astronomy.
5. Sven Helander, Knud Ottosen and Einar Molland: 'Tidegärd', *KLNM*, vol. 18, Copenhagen (1974), columns 255–268. The subject is the canonical hours.
6. John Davis: *BSS Sundial Glossary*, British Sundial Society (2000), Appendix II. Anglo-Saxon Tides.
7. Mathias Bäck, Ann-Mari Hållans Stenholm and Jan-Åke Ljung: *Lilla Ullevi. Historien om det fridlysta rummet*, Riksantikvarieämbetet, Stockholm (2008). The subject is the excavations.
8. Wikander, n. 1.
9. Johan Anton Wikander: 'Solur eller Kompassrose på Høybakken ved Mandal?', *Agder Historielag*, Annual publication, Kristiansand, No. 85 (2009), pp. 43–54. The subject is a discussion about the carving and its site.
10. Sam Owen Jansson: 'Gyllental', *KLNM* , vol. 5, Copenhagen (1960), columns 615–618. The subject is golden numbers. Runic letters are used as numerals only in Scandinavia.
11. H.F. Morland: 'The Southesk and other rune prime-staves or Scandinavian wooden calendars', *Proceedings of the Society of Antiquaries of Scotland*, vol. XXV, Edinburgh (1891), pp. 256–332. Drawing of the Harrow School prime-staff, from Sweden and made ca. 1600, is shown, pp. 296–297.
12. Johan Anton Wikander: 'Solur eller kompassrose ved uthavnen Kråkvåg?', *Fosen Historielag*, Annual publication, Trondheim (2005), pp. 23-48. The discussion concludes that the carving is a sundial, most probably made ca. 1650 at this outport, not a compass rose which was the common opinion.
13. Johan Anton Wikander: *Gamle havner ved Grimstad*, Grimstad (1985 and 1989), pp. 1–191, folio. The subject is the outports and the navigation along the south and south-east coast of Norway.
14. Olaus Magnus: *Historia om de Nordiska Folken,* vol. 1, Stockholm (1976), Swedish translation of the Latin edition Roma 1555, Book 1 and Chapter 32, pp. 70 – 71. Remarks on this chapter are given on pp. 312–313 by John Granlund.
15. Johan Anton Wikander: 'Solurene ved Øyestad Kirke', *Agder Historielag*, Annual publication, Kristiansand, No. 80 (2004), pp. 9–60. I have also written about this sundial on pp. 29–30. The focus is then mainly on the compass rose, the geographical directions and the magnetic variation in 1640.

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READER'S LETTER

Holme Pierrepont Hall

It was interesting to see the 17th century print of Holme Pierrepont Hall (*BSS Bulletin*, 33(ii), p.31), as it does not look like that today, although the interior retains much of its Tudor structure. And the ancient parish church, also shown on the print, is still there immediately next door. I first visited the church, hall and gardens in 2014 and recorded and photographed the fine horizontal dial in the courtyard garden (Fig. 1), which can be seen just over the wall from the church. I was surprised not to find my report in the BSS Fixed Dial Register (*mea culpa*), and I cannot find any notes in my field notebook.

Fig. 1. The sundial in the courtyard garden.

However, my photographs show that the dial is in good condition, although it has green patination, and the latitude on the dial plate, 52° 58′, confirms that it was made for Holme Pierrepont (Fig. 2). The circular dial plate is signed "Cary, Strand, London", but by which member of the Cary family is hard to know as it is not dated. It has the equation of time, a solid gnomon (Fig. 3), and shows the time from 4 am to 8 pm.

The courtyard garden is believed to have been laid out in 1875 by Nesfield, and if confirmed this may help to date the dial. (However, I understand that there is a research project to ascertain Nesfield's involvement, which may confirm this, or otherwise.) Other clues to dating could include an examination of the style of the stone pillar or a comparison of the signature here with the signature of a Cary dial of known date. Digging into the extensive archive of the Pierrepont family held by the University of Nottingham may also provide a definitive date, but I regret that I am not sure that I have either the time or patience to attempt this. (Perhaps we have to leave challenges for the next generation!)

Irene Brightmer

Fig. 2. Dial detail, showing the latitude, and Cary signature.

Fig. 3. Close-up of the gnomon.

NEW BOOKS (2)

Le Gnomon du Méridien Cassini: La méridienne à chambre obscure du Sanctuaire de N.D. de la Visitation à Perinaldo, by Giancarlo Bonini (translated into French from the Italian by Jean-François Consigli), Perinaldo, 2021, paperback, 84 pp., colour illustrated throughout. ISBN 978-2-322-22957-4. Price 12€.

Originally published in Italian as **Uno Gnomone sul Meridiano Cassini**: La meridiana a camera oscura del Santuario di N.S. della Visitazione in Perinaldo. Published by youcanprint, 2019, paperback. ISBN 978-8-831-63539-4. Available from Amazon at £12.98.

The meridian line in the cathedral of San Petronio in Bologna was constructed to the design of Giovanni Domenico Cassini between 1655 and 1657. Cassini (1625-1712) was born in Perinaldo in western Liguria, close to Ventimiglia and San Remo. In this hilltop village, the *Associazione Stellaria* and the commune have developed striking activity in astronomy, creating a museum devoted to Cassini, a public observatory, and a programme of popular education in the subject. To crown all this, in a small church just south of the village, a group of astronomical enthusiasts have designed and realised a meridian line, overcoming in the process a multitude of logistic, administrative, financial and technical problems.

The present booklet, attractively produced if a little tightly trimmed, written by one of the driving group, describes the conception and construction of the meridian, placing it in historical and gnomonic context. The location is historically appropriate and the church is not inconveniently oriented for this project, which was first mooted in 1994. It was not however until 2004 that the project was officially approved. Work started in 2005 and was completed at the end of 2007. The first part of this work is devoted to the history and theory of gnomons, meridians and the *camera obscura*, meridians being seen as gigantic instruments of this type. The second part gives a step by step description of the calculation and construction of the meridian that now traverses the church of Our Lady of the Visitation at Perinaldo, longitude 7° 40′ East.

Anthony Turner