The British Sundial Society

BULLETIN

VOLUME 14 (ii) JUNE 2002

Front Cover: Sundial in Wandlebury Country Park, Cambridge. (Photo M.S.)

Back Cover: Sundial on wall of a Woolwich shop named "The Seventh Sun". (Dial designed by John Moir, made by Ray Ashley).

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BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

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EDITORIAL

Since our last issue, the Society has held its Annual Conference, which took place this year in Exeter, and was one of our most enjoyable occasions. Some of us had the chance of a visit to Buckfast Abbey, home of Sir Francis Drake. Others visited a small Observatory and Planetarium, now belonging to Devonshire County Council and run entirely by amateurs; it is much used by schools for introducing children to the stars and planets. A full account of the Conference, and also of the Annual General Meeting of the Society, will appear in the September issue of the Bulletin.

In this issue we have articles from the edges of Britain, the western fringes of Scotland and the Isle of Man; and items too from further afield: from Epidaurus in Greece, (with a Japanese connection), and from Israel in the Near East. But diallists' interests are not confined to our own planet: we have a report telling us about the sun's equation-of-time as viewed from Mars. This is not the only time that the Bulletin has invited its readers to another part of the solar system: in Bull.BSS 92.3, Mr. Oakley considered dialling on Uranus where the planet's rotation is in a different plane from its orbital movement. BSS members cannot be accused of being parochial in their outlook.

A DIAL AT THE NATIONAL MUSEUMS OF SCOTLAND, EDINBURGH

MARK LENNOX-BOYD

In the Summer of 2000 the Earl of Perth, our patron, asked me to design a sundial for the National Museums of Scotland. Lord Perth was likely to have the Trustees' approval for this proposal for he had been closely connected with the Museum's new wing since its conception.

The Architect of the Museum was Professor Gordon Benson and in the early stages of the project there was some uncertainty in his mind as to the suitability of a sundial on his building. However after much discussion and the consideration of various alternatives, he suggested engraving a sundial on one of the blocks of Clashach Stone that face the south-west wall of the building. The precise position is Lat.55° 56.75'N, Long.3° 11.30'W.

It is to be seen at the point where Forrest Road and Bristo Place meet. A photograph and line drawing are shown in Figures (1) and (2). The engraved block is 1200mm wide and the horizontal gnomon is 72.5mm deep. I do not know of a declining wall dial of this type in Western Europe but there are some fine examples in the Moslem World, notably in Cairo, on the Suleimaniyyeh Mosque in Istanbul and the famous horizontal dial with vertical gnomons at the Great Mosque of Damascus.

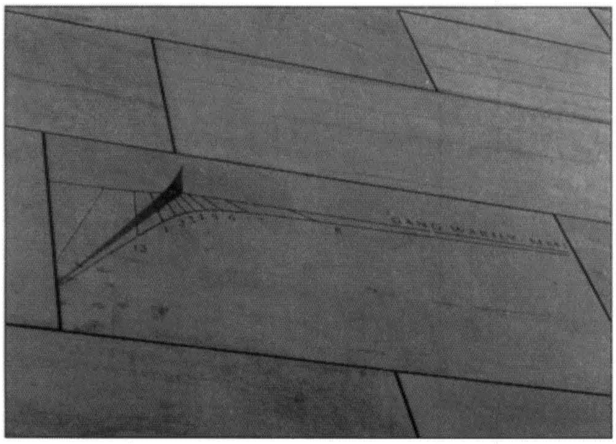

Fig.1.

To my great relief the calculation and engraving of the dial went smoothly. I had been informed that the wall declined 39.5 degrees West of North but I decided to check the figure. So the gnomon was inserted into the wall and before it was engraved, some 15 measurements were taken on sunny days by Mr Eric Quinn of the Museum staff. He measured x and y co-ordinates of the tip of the gnomon's shadow from its centre point. Armed with these and the

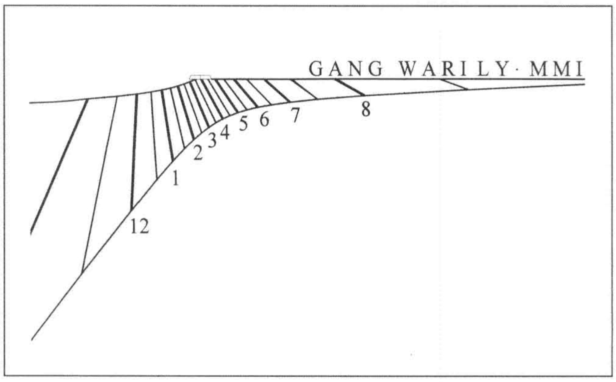

Fig.2.

times of his observations, I was able to calculate the wall's declination by inputting x values into a program based on the Mariners' azimuth formula. The observations had been well taken, for the resulting declinations of the wall were close and the average value was 42.5 degrees West of North. Declining in this direction, the dial only gives readings from about 11 a.m. to just before sunset. It is engraved for the hours and half hours and incorporates the displacement from the Greenwich meridian of 12.76 minutes of time.

Richard Kindersley, whose beautiful work is to be seen on many walls inside the Museum, engraved the dial. The motto GANG WARILY might be thought to be directed at those who come out of the pubs late at night. It is, in fact, the motto of the Drummonds, of which the Earl of Perth is chief. Among his many highly cultivated interests is a love of sundials; this one was inaugurated on his 94th birthday in May last year.

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SHADOWY SECRETS (PART 3) - THE PIGPEN MYSTERY SOLVED

JOHN MOIR

In part 1 of "Shadowy Secrets" (Bull. 98.3 p.3), I gave an example of a cryptic motto, taken from Mrs Gatty 'Book of Sundials', seen on a house in Valcrosia, Bordighera, Italy (see Fig.1. below). Her explanation of the motto was as follows:

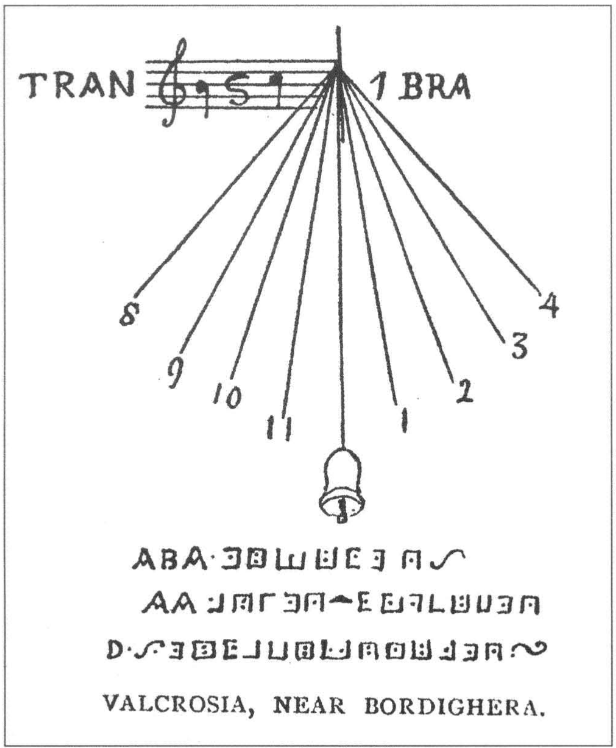

Fig.1. Valcrosia Dial: Mrs. Gatty explained the motto but was puzzled by the cipher below

The notes Te and Doh were at one time Si and Ut, and the 1 stands for UM (from UN). Thus: - TRAN SI S UT UM BRA- transis ut umbra -You pass like a shadow.

I also noted that the hour lines were wildly inaccurate for a vertical dial at Lat. 44° N°, (or indeed any other latitude), and that Mrs Gatty could throw no light on the peculiar cipher below the hour lines.

There the matter rested until a few months ago, when I chanced upon a form of cipher said to have been used by the Freemasons in the 1700s, and known as "Pigpen", due to its resemblance to animals in enclosures (Fig.2).(See Note 1)) The similarity between Pigpen and the sundial's cipher was striking, although there were some puzzling variations.

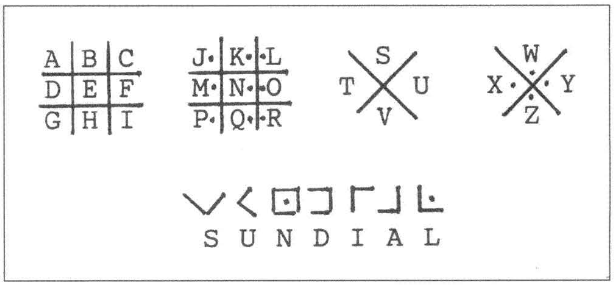

Fig.2. The PIGPEN cipher: 26-letter version

I immediately arranged a visit to the Freemason's library in London, to see if they could help me break the code, but apart from gaining insight into various weird Masonic rituals, I drew a total blank.

My next step was to contact a fellow member of the BSS, Mario Arnaldi, whom I knew to be interested in history as well as sundials. He kindly made widespread enquiries amongst the Italian dialling fraternity, but it was his friend Lucio Maria Morra who cracked the code in splendid style, and is the undisputed hero of this story.

Lucio Maria's breakthrough was to spot that the two final characters of each section repeat themselves. This suggested that the code represented four Latin verbs, ending in IT, preceded by groups of Capitals (ABA, AA, D.S.), in the manner of "So and so" fecit (Fig.3.).

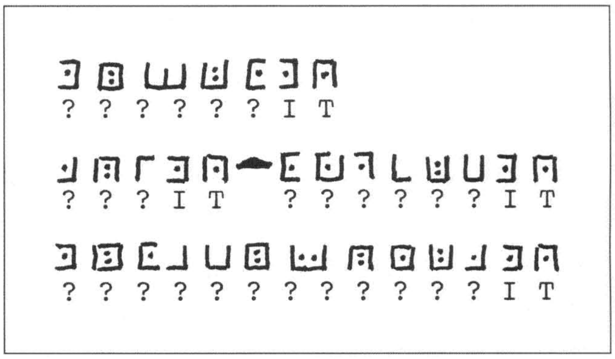

Fig.3. Repeated letters suggesting Latin verbs ending in IT

Next, his task was to find a "Pigpen" grid for the 21 letters of the Latin alphabet (note that the letters J, K, W, X and Y are not used - this explains why my own attempts using 26 letters were doomed from the start!). His grid would also have to be consistent with the conjectured symbols for I and T as matched in Fig.3. Lucio's solution is shown in Fig.4. (See note 2).

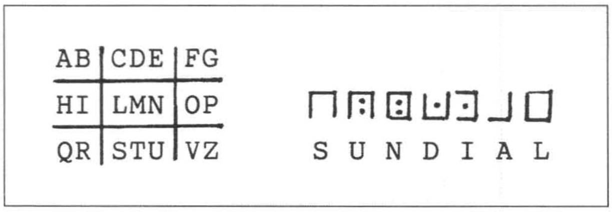

Fig.4. PIGPEN Cipher, 21 letter version
1st letter, no dot
2nd letter, one dot
3rd letter, two dots

He was now in a position to decipher the code, and the result can be seen in Fig.5. What an exciting moment this must have been, with the words all but revealing themselves after who knows how many years? It only remained to adjust for a few minor and quite plausible copying errors and the decoding was complete (Fig.6.).

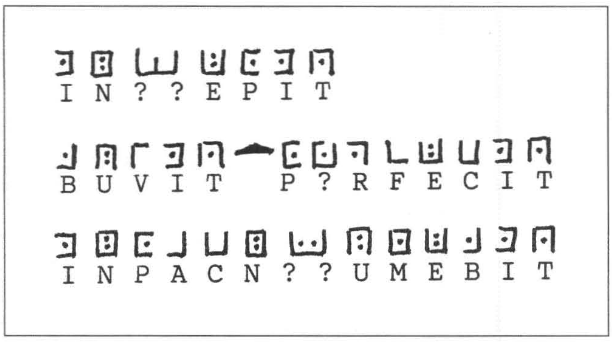

Fig.5. Almost there.....

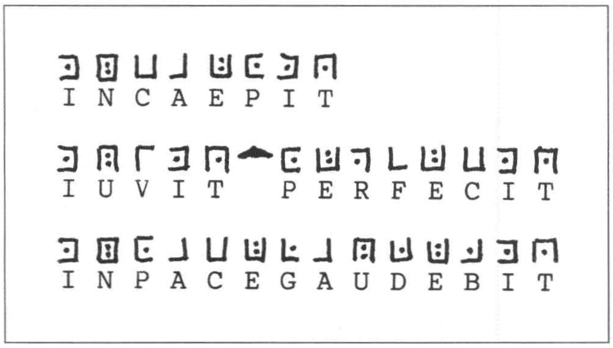

Fig.6. ....the Code broken!

Lucio Maria gives the following translations into Italian and English.

ABA ha iniziato

AA ha aiutato e compiuto

D.S. se la godrà in pace

ABA began it

AA helped and made it

D.S. will enjoy it in peace

I cannot thank Mario Arnaldi and his friend enough for finally bringing light to this shadowy secret. All we need to know now is this: who were ABA, AA, and D.S.? And does this sundial still exist? Over to you, dear readers!

NOTES:

1. Discussed in Simon Singh's excellent book "The Science of Secrecy".
2. There are various ways that 21 letters can be fitted, in a logical order, into the 9 compartment grid. However, only the configuration shown in Fig.4 gives the required symbols for I and T.

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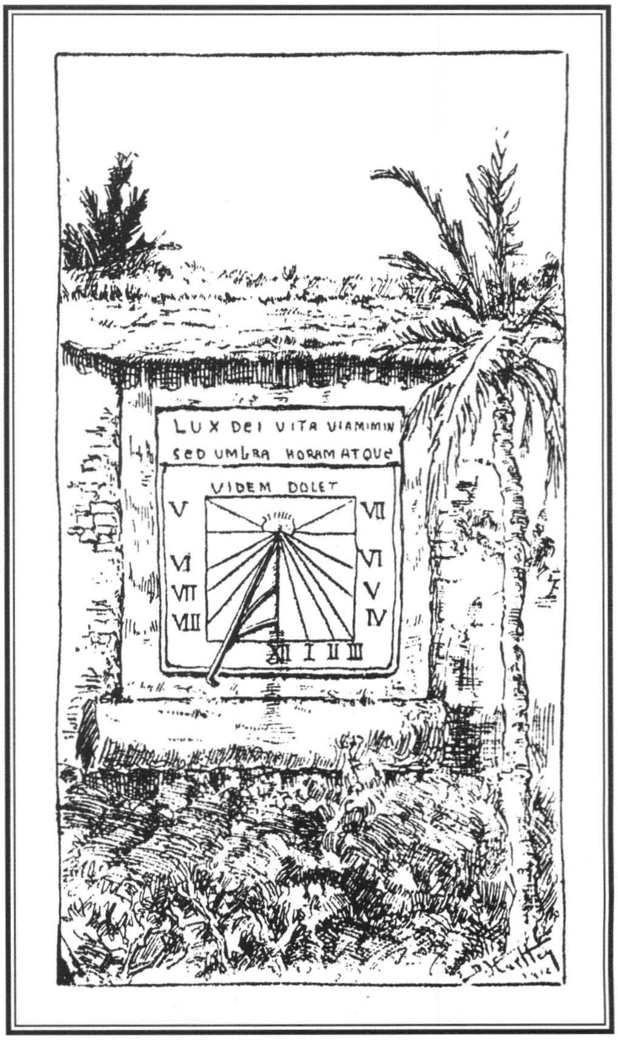


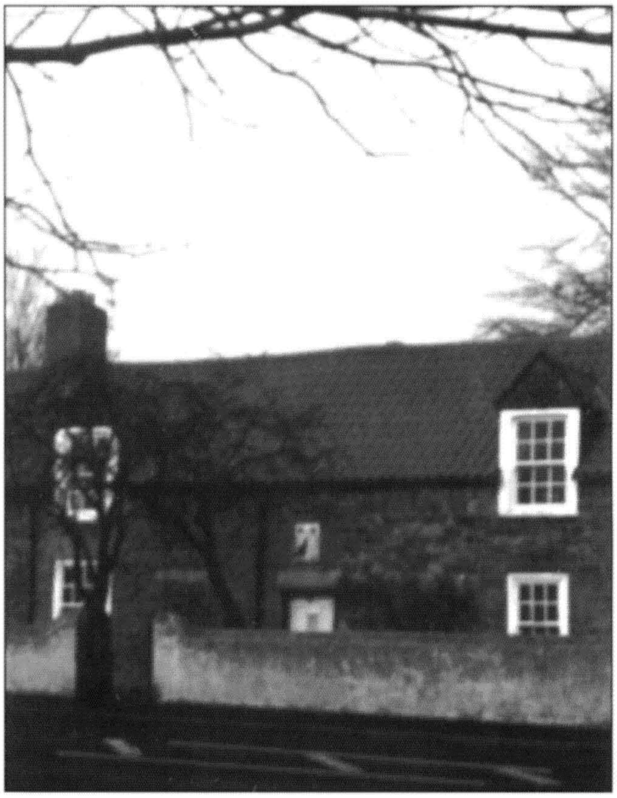
RAILWAY TIME (3)

J. WALL

When I described the sundial at Glion in Switzerland in the December 2001 Bulletin of the Society I lamented the fact that no reader had responded to my plea at the close of an earlier article[1] to send me details of other railway-related sundials known to them. I had quite overlooked the most celebrated of railway sundials in Britain, made by Robert Stephenson, and fixed to the front wall of the family home at West Moor near Newcastle-upon-Tyne, that was the subject of an article by Frank Evans in Bulletin No.97.3, July 1997[2]. I hope that Frank and our readers will forgive me if I seem to be going over old ground by adding some extra material derived from additional literary sources and a recent visit to the site.

Robert's father, George Stephenson, the 'Father of Railways' (1781 - 1848), was born on 9th June 1781 in a cottage by the side of the wagonway leading from Wylam Colliery near the River Tyne, ten miles upstream of Newcastle. Although George took on his first mining job at the tender age of 13, he graduated through a number of increasingly responsible posts at various collieries in the neighbourhood. Having married Fanny Henderson of Newburn on 28th October 1802, the young couple went to live in a cottage at Willington Quay nearby. It was here that George Stephenson's only son Robert (1803-1859) was born on 16th October 1803. In 1805 Stephenson moved to take up the post of brakesman at West Moor Colliery, Killingworth, four miles north of Newcastle. On the strength of that appointment he moved into a cottage at Killingworth by the side of the wagonway that led from the colliery down to coal-staithes on the River Tyne. He continued to live there when he was promoted to engine-wright at High Pit Colliery nearby, and put in charge of all the machinery in the collieries of his employers, the Grand Alliance.[3]

Although George Stephenson was almost entirely self-educated, and proud of it, he was fiercely determined that his only son Robert should have the best education that he could afford. Robert was duly enrolled at the prestigious Percy Street Academy in Newcastle run by one John Bruce. George Stephenson was a hard taskmaster and he would test Robert's knowledge by setting him exercises in the holidays. As Frank Evans noted, John Cordy Jeaffreson, author of the first biography of Robert Stephenson, wrote: "The earliest 'drawing' by Robert Stephenson's hand of which there is any record, was that of a sun-dial, copied from Ferguson's 'Astronomy', and presented by the lad to Mr. (William) Losh, in the year 1816, in token of his gratitude to him as his father's benefactor". I would dearly love to discover that first 'drawing', but I suspect that it has been lost long since. Jeaffreson contmues: "This drawing set the father and son on another work - the construction of a real sun-dial".[4]



Stephenson Cottage, Killingworth, Northumbria.

A much fuller account of this first railway-related sundial is given in Samuel Smiles' biography of the Stephensons, father and son. (Samuel Smiles, the eminent author of a series of books on self-help, was also a railwayman, in the employ of the Leeds Northern Railway). He writes: 'Whilst Robert was still at school, his father proposed to him during the holidays that he should construct a sun-dial, to be placed over their cottage-door at West Moor. "I expostulated with him at first", said Robert, "that I had not learnt sufficient astronomy and mathematics to enable me to make the necessary calculations. But he would have no denial. 'The thing is to be done', said he; 'so just set about it at once.' Well, we got a 'Ferguson's Astronomy', and studied the subject together. Many a sore head I had while making the necessary calculations to adapt the dial to the latitude of Killingworth. But at length it was fairly drawn out on paper; and then my father got a stone, and we hewed, and carved, and polished it until we made a very respectable dial of it; and there it is, you see," pointing to it over the cottage-door, "still quietly numbering the hours when the sun is shining. I assure you, not a little was thought of that piece of work by the pitmen when it was put up, and began to tell its tale of time." The date carved upon the dial is "August 11th, MDCCCXVI." Both father and son were in after life very proud of the joint production. Many years after, George took a party of savants, when attending the meeting of the British Association at Newcastle, over to Killingworth, to see the pits, and he did not fail to direct their attention to the sun-dial; and Robert, on the last visit which he made to the place, a short time before his death, took a friend into the cottage, and pointed out to him the very desk, still there, at which he sat while making his calculations of the latitude of Killingworth.'[15]

In Smiles' Biography this account is accompanied by three line drawings that depict, respectively, Bruce's School in Newcastle, Stephenson's Cottage at West Moor, and the Sundial.

Robert would be barely 13 years of age when he worked out the necessary calculations for the sundial to be jointly crafted by father and son. Remarkable! It is evident that he understood how latitude affected the calibration of a dial. The cottage lies on latitude 55° 02' and Robert has accordingly provided a gnomon with a co-latitude angle of 34° 58' (Unfortunately at the time of writing the gnomon is bent to the right and fails to record sun-time accurately). As Frank Evans has pointed out, Robert also understood that he would need to make allowance for the fact that the cottage at West Moor is not perfectly aligned east-west: it is what we term a south-west decliner. Accordingly, when I recently visited the site, I took with me an ingenious device that I call a 'declinometer' constructed by my friend and neighbour D. Scott-Kestin, with which I was able at noon to determine that the wall of the cottage does indeed decline by 11°. However, instead of doing the calculations necessary to create a west-declining dial whose gnomon is positioned at an appropriate angle to the meridian line, he cleverly solved the problem by building out the left hand side of the sundial so that it stands proud of the wall and enables the entire dial plate to face due south (By coincidence there is a sundial on the wall of a west-declining Old Peoples' Home in the village where I now live that adopts the same solution. Robert also must have had the knowledge and the means to determine the direction of true south at West Moor when his sundial was erected).

The visit of the 'savants' to which Smiles refers took place in 1838, that is 22 years after the making of the sundial, when George Stephenson was one of the Vice-Presidents of the British Association in the Mechanical Sciences section. The Conference of the British Association took place at the premises of the Literary and Philosophical Society of Newcastle-upon-Tyne, which was founded in 1793, and of which both George and Robert Stephenson were members. Robert borrowed the copy of 'Ferguson's Astronomy' from the Library of the Institute. Happily, the Society is still in existence and, miraculously, the very copy of '(James) Ferguson's Astronomy' that Robert Stephenson consulted survives in the Library there. The full title is 'Astronomy explained upon Sir Isaac Newton's Principles and made easy for those who have not studied Mathematics'. It is a Third Edition of 1764 and was published in London by A. Millar.

The Stephenson Sundial, Killingworth.

Towards the end of his biography (pages 336-7) Smiles gives another account of the visit of the men of science: 'During the sittings of the Association, Mr. Stephenson took the opportunity of paying a visit to Killingworth, accompanied by some of the distinguished savans (sic) whom he numbered amongst his friends. He there pointed out to them, with a degree of honest pride, the cottage in which he had lived for so many years, showed what parts of it had been his own handiwork, and told them the story of the sun-dial over the door, describing the study and the labour it had cost him and his son to calculate its dimensions, and fix it in its place. The dial had been serenely numbering the hours through the busy years that had elapsed since that humble dwelling had been his home; during which the Killingworth locomotive had become a great working power, and its contriver had established the railway system, which was now rapidly becoming extended in all parts of the world'.

The sundial is still there, having 'serenely numbered the hours' through all the 186 years of its existence to date. Long may it continue to do so! Visitors may care to note that the cottage fronts the B 1318 road at West Moor on the north side, map reference NZ 275705. It is owned by North Tyneside District Council and administered by the Education Department. Whilst the bulk of the cottage, including the part behind the front door over which the dial is placed, is occupied by an employee who works at the local school, two rooms at the west end are being prepared to house a museum. It is hoped that this will be run by the nearby Stephenson Railway Museum, but a shortfall in funding means that it is not likely to be open to the public until 2003. The site is presently well signposted on all the approach roads, and there is an excellent Information panel in the front garden provided by North Tyneside Council.

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4. J.C. Jeaffreson: *The Life of Robert Stephenson, F.R.S,* Vol.1, Longmans Green, London, 1864, p.44.
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THE MARTIAN ANALEMMA

TONY MARSH

The figure shows the noon Martian analemma for a Dial on Mars. The Martian day is called a Sol by NASA and is 40 minutes longer than an Earth day. NASA divides the day into 24 Martian hours so Martian minutes are 1.0275 times longer than an Earth minute. However, there is no standard calendar for Mars. I have used Robert Zubrin's proposed calendar of 12 months named after the signs of the Zodiac starting at the Vernal Equinox with Gemini. Zubrin is the leader of the Mars Project, an attempt to undertake a privately funded manned mission to Mars. Zubrin's calendar uses 12 months that represent equal angles around the orbit. On earth a month is nominally 30 degrees of orbit. Zubrin uses 30 degrees to define the Martian months which keeps the same number of months as Earth. However, this means that the months are all different lengths and about double the length of an Earth month. Other proposals have used 24 months to give roughly 30 Sols each. The Martian year is 669 Sols. The Martian moons are small and orbit the planet too fast to give rise to a "monthly" cycle. Yet other proposals have been made using the same names as Earth months. However, should a colony arise on Mars one could anticipate endless trouble from say meeting in September - - do you mean Earth September or Mars September? Zubrin has used the signs of the Zodiac for the month in which that constellation is high in the night time sky - unlike the Earth system that is based on the Sun's position.

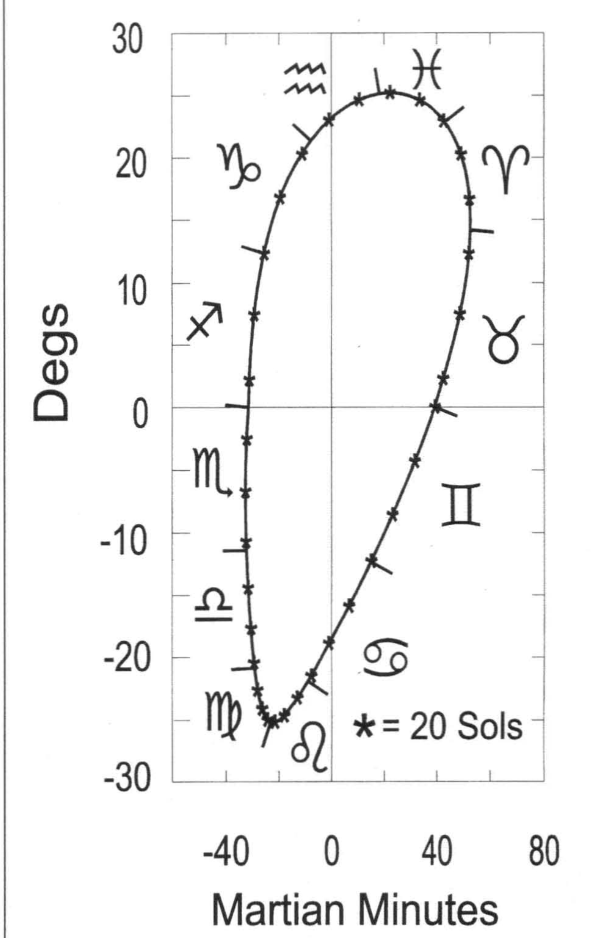

Fig. 1. Diagram of the Noon Martian Analemma for a Sundial on Mars

One consequence of a 669-sol long year is that leap years will be different on Mars. Some may have a birthday every 4 years on Earth if one is born on 29th February. The true Martian year is 668.6 Sols long. So every 5 years the year

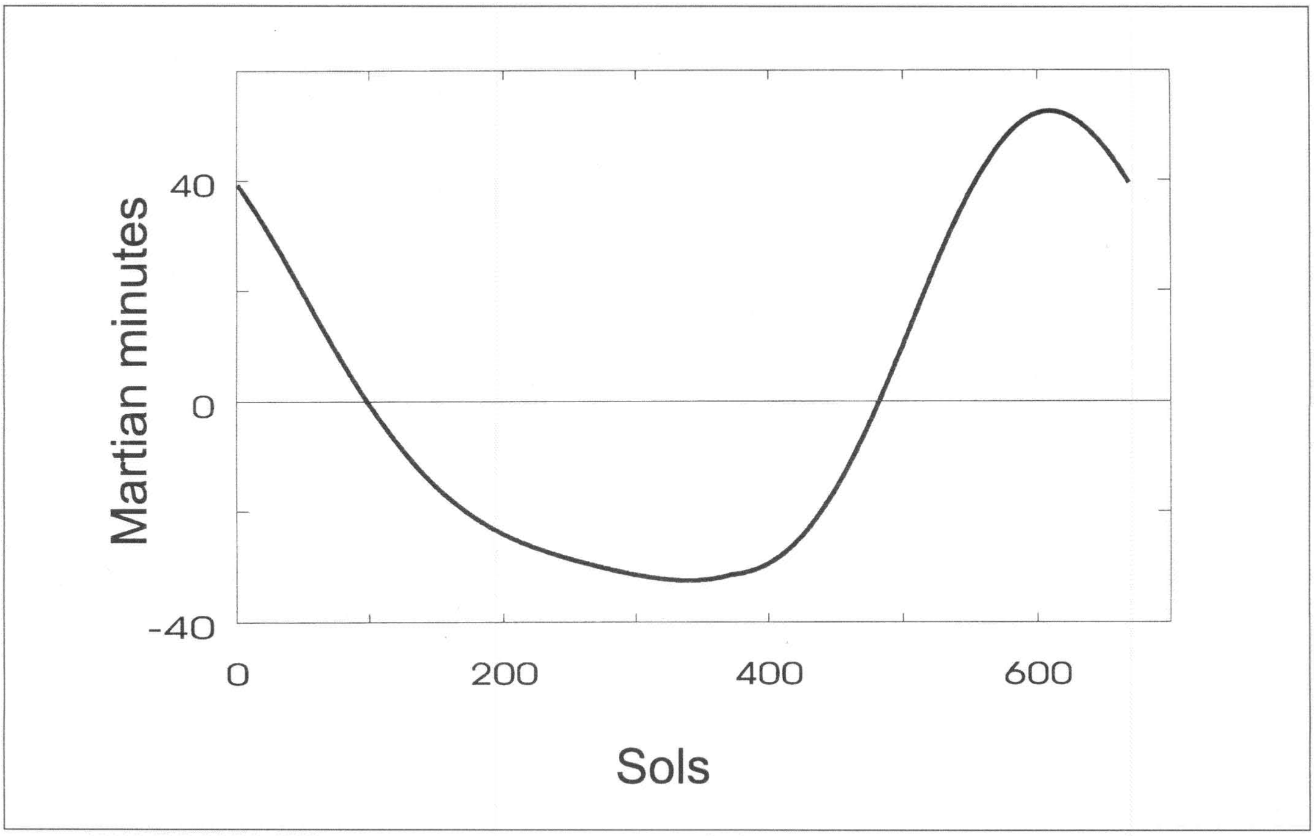

Fig. 2. Equation-of-Time graph for Mars

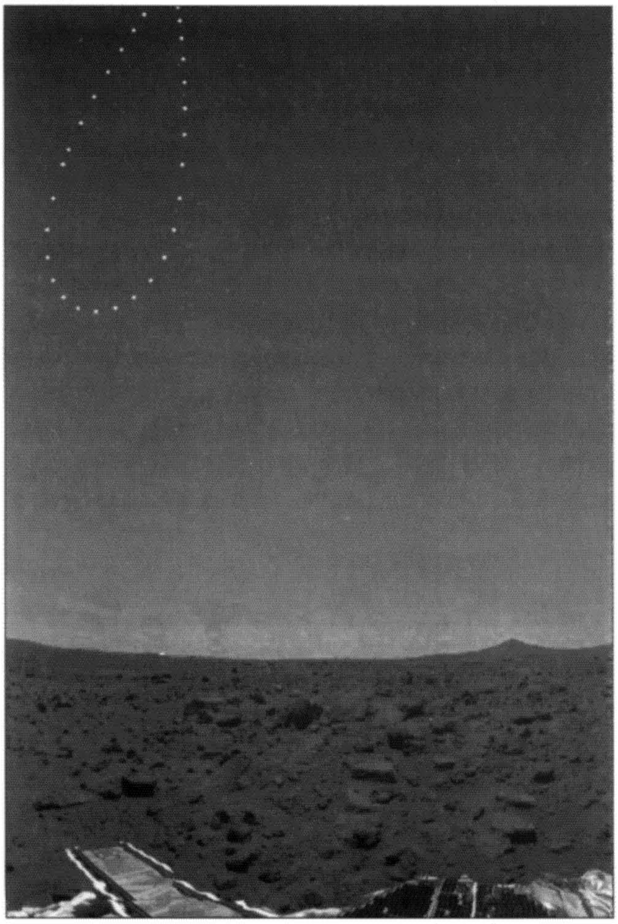

Fig. 2. Photo derived from 2 NASA pictures of Mars, with sun's noon analemma

would have to lose 2 Sols. In that case you might only have 4 birthdays every 5 years if you were born on the missing 2 days.

The prime difference from the Earth's analemma arises because on Earth the elliptical orbit correction and the tilt correction to mean sun time are of both about the same magnitude, so the interaction gives the complex equation of time. For Mars, however, the elliptical orbit totally dominates; the tilt of Mars is very similar to that of Earth but the orbit is more than 5 times as eccentric. The Arctic circle on Mars is at 64.848° latitude instead of 66.5° as on Earth. The diagram shows the Martian Equation of Time correction for a dial on Mars.

The picture is a modification of 2 NASA pictures to show what a picture of the noon analemma would look like when one is finally taken from the Mars Pathfinder site. The picture is based on the Mars presidential panorama and a dawn clouds picture 83624f both taken on the Mars Pathfinder mission.

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ANCIENT SUNDIALS OF ISRAEL
PART 1: SUNDIALS FOUND IN JERUSALEM

SHAUL ADAM

INTRODUCTION

Sundials have been produced and used in Israel since olden times. Various types of sundials that represent different cultures and eras have been found in Israel from the late 19th century till today, most of them during archaeological excavations, but some have been found coincidentally by ordinary citizens, in fields or ruined places.

Ancient records and speculations: Many diallists are familiar with the story of the miracle of the sundial of Akhaz, as told in the Bible (2 Kings 20:9-11, and Isaiah 38:7) when King Hezekiah of Judah saw *the shadow of the steps which is gone down ten degrees.... And the sun returned ten degrees by which it went down.* The sundial of Akhaz is said the belong to the 8th century BC, and there has been much speculation about the interpretation of the miracle, and about the translation of the words for 'steps' and 'degrees'.

Another Hebrew source, the 'Mishna', (2nd century AD) refers to a *stone, and there will be drawn on it straight lines, the names of the hours written on them, and a perpendicular nail on a perpendicular angle; and all will know from the shadow how many hours passed of the day.* This device was called the 'Hour Stone', and appears to be a horizontal or vertical scratch dial.

In 1954 a stone object on the form of a disc with 5 deeply cut concentric rings on one side was found at Qumran in the Judea desert near the northern shore of the Dead Sea.[1] Three of the five circles are marked with radial notches, and there is a central hole allowing for a vertical gnomon. The object has been interpreted as a sundial for seasonal hours, from the 1st century BC. The notches of the innermost ring would be for summer time-keeping and the outermost, winter; and the middle ring for spring and autumn. But the notches are not numbered or labelled, and there is no explanation of why the markings are in array all around, though the shadow of a vertical gnomon would never be cast on the southern part of the disc. So there are debates among archaeologists about the identification of this object as a sundial.

This is the place to recall a unique archeological site, a hilltop megalithic structure, *Rujem El Hirrl*, in the Golan Heights in northern Israel. When observed from the air it resembles the Qumran object. It consists of three concentric stone circles, the outermost 155m in diameter. It has two openings, to north-east and south-east. The theory held by most archaeologists is that it is a cult site used for some sort of astronomical observations. Perhaps the openings enabled the people who worshipped there to observe the first morning sunrays at the solstices.

ARTIFACTS FROM ANCIENT JERUSALEM

Most of the ancient sundials found in Israel are from the Roman and Byzantine eras and are of the Hemicyclium or the Conical types. The Hemicyclium sundial is considered the invention of the Babylonian astronomer Berossos who lived and worked on the island of Kos in Greece 356-326 BC and is named after him. Vitruvius attributes the Conical sundial to Dionysidoris. Vitruvius[2] notes in his book "About Architecture" that Berossos, who was "the pioneer of Chaldean Science" has brought with him from Babylon immense knowledge of astronomy (a paradigm developed and mastered by the Babylonians). Describing the inventors of sundials, Vitruvius says: *'some say that the type of sundial of the Hemicyclium shape, made of a square block in which a cavity is made, and cut at the bottom to match the polar latitude, has been invented by Berossos the Chaldean,- the hemispherium by Aristarchos of Samos... the Conical by Dionysidorus'*

Archeological Artifacts

During the excavations of the Hill of Ophel in Jerusalem in 1925-1926, led by Prof. R.A.S. Macalister[3] of the Palestine Exploration Fund, the excavators unearthed a complete conical portable sundial, made of limestone. Its dimensions are: 9cm high, 8cm wide, 5cm (maximum thickness). It was dated to the 1st century AD. There are 11 hour lines, dividing the concave to 12 equal sectors, and three parallel declination lines, for the solstices and equinoxes (Fig. 1). It

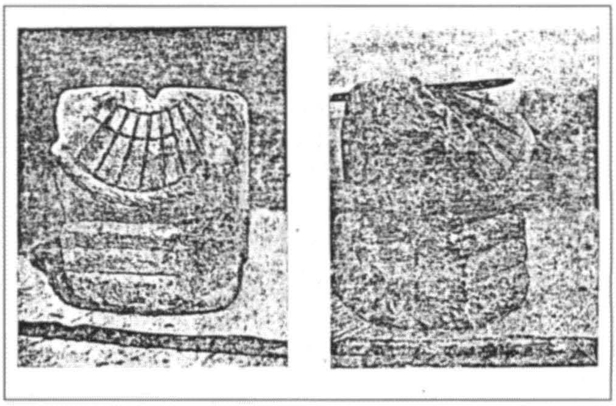

Fig. 1. Portable sundial from Hill of Ophel

bears no numerals or lettering, or any other symbols, or decoration This sundial is the first of several other portable hemicycliums and conical sundials that were excavated in Jerusalem in the years to come.

The excavations near the Temple Mount, in the Wailing Wall and in the Jewish Quarter of ancient Jerusalem revealed a number of sundials of various sizes; some of them are portable, of various levels of designs, quality and decoration, all made of limestone. Three fragments were also found, of three different larger sundials; all bear frontal edge decorations, typical to the Herodian epoch architectural features. The three fragments hint at special beautifully made sundials. Another fragment of a large hemicyclium was excavated in a site in the southern part of the city, about 5km south of the ancient town. All these artifacts will be described below.

The excavations of the Jewish Quarter

Four portable sundials, and another one, a bit larger, have been found in the Jewish Quarter excavations, led by Dr. Nakinan Avigad,[4] and later by Dr. Hillel Geva.

A beautifully decorated and constructed sundial was unearthed in the remains of a wealthy private house that was "nicknamed'" by the archeologists "the Grandiose House or the Luxurious House". It probably belonged to a family of high ranking priests of the temple (some evidence related to religious manners may confirm this possibility). It is a conical sundial, 12cm wide, 11 cm high, and 11cm thick, dated to the 1st century AD. It has parts of seven hour lines, with no numerals or inscriptions, or any lettering. The concave surface bears remains of red stucco, in which the hour lines are engraved (the other parts of the hour lines were lost when the stucco crumbled). Remains of the brass gnomon are still visible in its place on the concavity head. Above the concave edge and very close to it, there is engraved a peripheral outline, terminating the hour lines. If we assume that the gnomon length reached parallel to the cone base or close to it, then it is possible that this outline is the declination line of the summer solstice. It is quite low and close to the sundial edge. Due to the mortar crumbling and breakage in the concave surface at the centre and above, no remains of other declination lines and hour lines had been preserved from this area. This line may be simply be a part of the sundial's design and decoration. (I had no chance to check and measure the sundial more carefully and try to calculate the line's position from a hypothetical gnomon length). Whether it is the summer solstice line or a decoration remains to be investigated.

Three beautiful rosettes, typical of the Second Temple epoch, are engraved on the eastern face of the sundial. The engraving is deep, and of good quality. On the western face there is a beginning of engraving of another rosette. (Fig.2). The back of the sundial bears a simple scratched line of a square, and a vertical mid line. Two oblique lines descend from each upper corner of the square, meeting the vertical line at its bottom. The meaning of this scratching is not clear. Maybe these are initial geometric lines to establish the measures for a concave construction, used by the constructor, who later changed his mind and inverted the stone block to begin a new design (the finished one)? This sundial was certainly built by a professional and skilful person.

Fig. 2. Sundial with rosettes, from 'Grandiose House' Jewish Quarter

Another sundial made of limestone was unearthed in the Jewish quarter near the "Luxurious House", dated also to the 1st century AD. It is a conical sundial, slightly bigger than the previous one. It is 18cm wide, 18cm high, and 15cm thick. It was found broken in the meridian line (just half was found), and was reconstructed according to the existing half. It bears 11 hour lines, with no numerals, lettering or other signs. On its upper face, on either side of the concave and close to the sundial's back, there is a group of 7 round holes, about 34mm deep, arranged as circle of six holes with one hole in the centre (Fig.3) This sundial is also very well and professionally built. This sundial is on display at the Wahl Museum in the Jewish Quarter; (here also is a replica of the conical dial mentioned above, with rosettes on its sides.)

Both sundials bear three deep engraving of wide grooves (resembling "steps') on the lower front face, running left to right. This suggests that both sundials were made by the same artisan or workshop However, a similar design of groove engraving on the lower front face was found also in the conical sundial from the Hill of Ophel, and in another hemicyclium found in King Khilkaia's palace in Mount

Fig. 3. Sundial with 7-hole patterns on upper surface (left half reconstructed)

Hebron, and in a conical sundial from the 5th century AD that was found in 1985 in Abu Mina in Egypt, about 50km south west of Alexandria.[5] This sundial is a bit larger, 40cm x 25cm x 35cm. The similarity of the design of the sundials from Jerusalem and from Judea, and the sundial from Abu Mina is interesting. The gap of tens and hundreds of years between the different sundials precludes the possibility that all these sundials were made by the same workshop or family. It may hint of a mode of design that was fashionable during a long period of time in the eastern Mediterranean.

The excavations of the Jewish Quarter revealed three interesting little portable sundials, also from the 1st century AD. Two of them are engraved in cylindrical cores of lathe products, 6cm in diameter and 6cm high, probably scruff of lathe workshop. The scratches of the lathe are still visible on the cylinder's perimeter. The upper face of each cylinder was carved and deepened to form a "spherical concave". A notch was carved on the upper edge of the concavity to allow for a gnomon, and hour lines were scratched, freehand and primitively and with no accuracy, from the notch to the concave edge. In one of the sundials the lines are radiating from the gnomon notch (as it should be in a hemicyclium), but in the other sundial the lines are scratched vertically and parallel. This is strange, and there is no satisfactory explanation for it. It seems as if both sundials are experiments or initial exercise of a novice or unpractised sundial maker. (Fig.4).

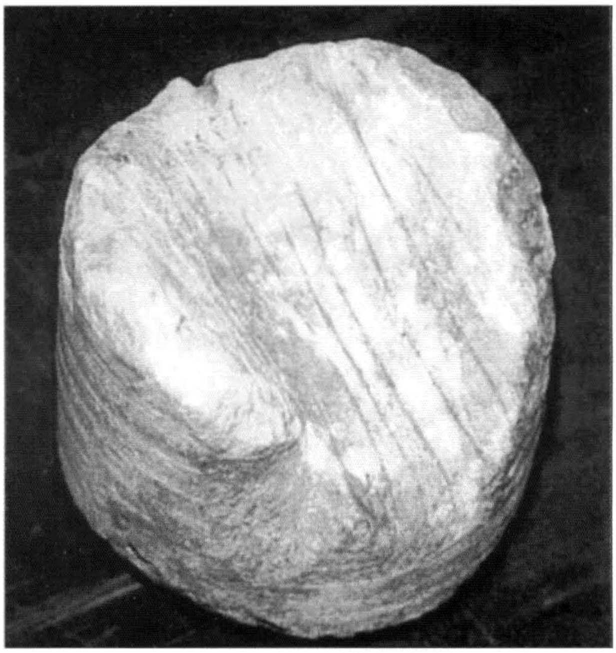

Fig. 4. Sundial of lathe-core (training exercise)

The third sundial made in the form of supposed "hemicyclium" from a hollow stone cube, 6cm wide, 5cm high, and 5cm thick, was probably used as another object prior to its sundial form. It was cut obliquely from one upper edge of the cube to the opposite lower edge, thus forming open hollow cube. A notch was carved in the upper rear edge for a gnomon, and hour lines were scratched freehand and not accurately, from the notch to the cube edges, radiating from the notch in a "hemicyclium" manner (Fig.5), thus forming a "pseudo-hemicyclium". This sundial also seems as training or experiment of unpractised person. From the close similarity of the way that all these three sundials were done, and the same place that all three were found, it can be assumed that they were done by the same person, maybe a "student" or trainee, and these were his

Fig. 5. Sketch of 'pseudo-hemicyclium', a training experiment

first exercises. They are no doubt meant to be sundials, as is apparent from their design and construction.

The excavations near the Temple Mount

A few interesting sundials were unearthed during the excavations near the Temple Mount led by Prof. Benjamin Mazar[6], from 1968-1978. (His grand-daughter Dr. Eilat Mazar is now continuing this work)

The first one is a very nice little portable sundial found at the Wailing Wall. It is a hemicyclium from the lst century AD, made of limestone, 8cm wide, 6cm high and 6 cm thick (estimation). It carries 11 hour lines dividing its curved surface into 12 equal sectors, and a single declination line.

To my estimation, according to the location of the line it is supposed to represent the equinox line; however it is not very accurately drawn, and not spherical all its way. It has no numerals, nor lettering nor any signs or symbols. On its back is a nice simple line carving of upside-down 'Menorah' (seven-branched candlestick) with very tall leg, (the traditional symbol of the Temple and Israelite Kingship, derived from the Menorah that lit the Temple, and was stolen by the emperor Titus). Two square sockets for precious stones or beads are carved one each side of the Menorah. The Menorah might be the clue that the sundial was used by a Jewish person, maybe a high priest in the Temple. Why the Menorah is upside down is not known. (Fig.6,6a)

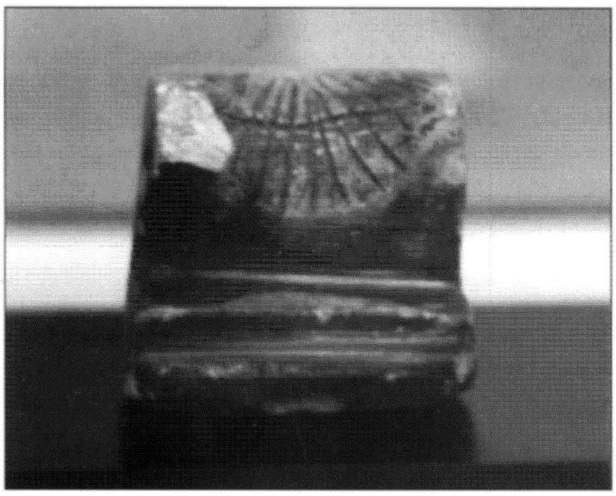

Fig. 6. Small portable sundial, (1st century AD) found near Wailing Wall

Three fragments of three different hemicycliums were found at the same place, at the foot of the south-western corner of the Temple complex. They were found in a layer that contained artifacts of the Second Temple era, the lst century AD. The three fragments are described below.

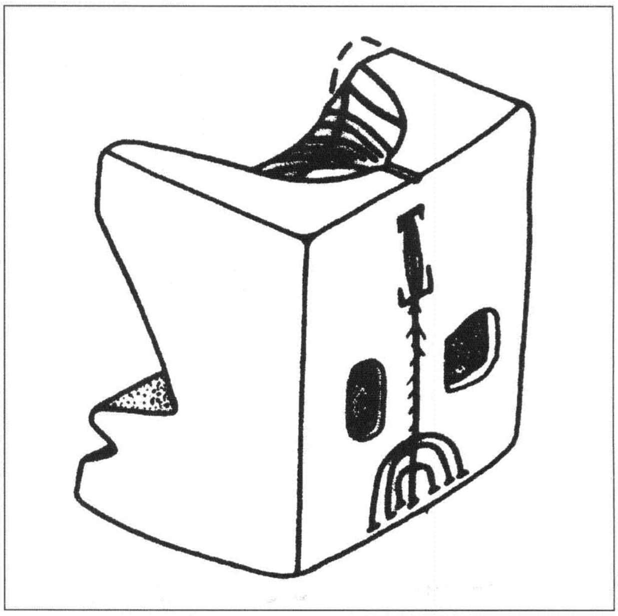

Fig. 6a. Sketch of back of sundial showing upside-down 'menorah' (seven-branched candlestick)

1. A triangular fragment 12 x 27 x 30cm. The dial is carved in red limestone and decorated on the front face of its concave edge with symmetrical decorations resembling "waves" or "curls"; the fragment sector bears 4 hour lines. There are remains of red stucco in the carvings. The length of each hour sector on the perimeter line is 7.5cm. This means that the perimeter line for 12 hours was 90cm long for the half circle. These facts enable computation and reconstruction of the full size dial:
Half a circle is 57.2cm in diameter, and together with the ornaments - 60cm.

2. The second fragment is of a somewhat smaller sundial, carved in a simple gray limestone. The fragment is of the left (western) portion of the concave and it carries two hour lines, meaning the lines for the first and second hours of the morning. The dimensions of this fragment are 21 x 1 9 x 15cm. Each hour sector is 6cm on the perimeter, meaning the length of the perimeter of half circle (for 12 hours) is 72cm, and the diameter is 45cm. On its front edge there are symmetrical decorations of similar symmetric carvings to those of the first fragment, in the form of "waves", just in a little different styling and the carvings are cruder (Fig.7).

3. The third fragment is of a hemicyclium made of gray marble; the stone cutting work and the finish is of very high quality. This fragment also carries on its front edge decorations of the same basic design as in the two previous sundials, yet in somewhat different styling. The basic design and motive of the front edge decoration is the same in all three fragments and is typical of the Herodian architecture. The length of the fragment is 25 cm, and the edge thickness is 7cm. It is apparent that the thickness of

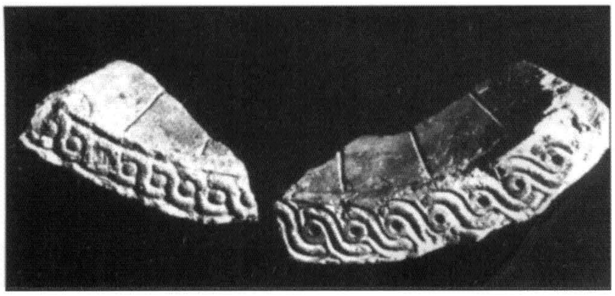

Fig. 7. Fragments of Sundials from SW Temple area, showing 'waves and curls' decoration

the concave is increasing from the edge inward. The fragment is of the very outer portion of the concavity and has no remains of hour lines, which leads me to speculate that the hour lines ended in a line (may be the summer solstice line) a bit further up the concave. Its curvature is quite flush, a portion of a large sphere. The spherical shape and the unique edge decorations - I suggest - leaves no doubt that it is a large sundial. These fragments, and also the complete dial with menorah carving, are now on display at Hecht Museum, Haifa University, Mount Carmel.

The three fragments are of unique interest, and deserve special attention.

According to the similar dimensions, and especially according to the identical motive and similar styling of the front edge decorations, I speculate that all three sundials either were done by the same workshop or expert, or designed by the same artisan, or maybe they were commissioned by the same entity (was it the Temple's general management? Or was it the highest priest of the Temple?) They were ordered from one producer, to serve in different locations in the Temple complex.

All three sundials are large dials intended to stand on a pedestal in a public place. The differences in size, materials and construction quality may point to the importance of their location in the Temple complex; and from the other side, the similarity in design and decoration may point to a desire for some sort of unification.

Very close to the place where the three fragments were found, the excavators unearthed a stone carrying a Hebrew inscription saying: "To the house of blowing to declare..". Dr. Eilat Mazar[7] who now leads the excavation of the Temple Mount surroundings, speculates that it might have been in this place, in the highest corner of the Temple court (the southwestern corner, not far from the large main staircase that climbed from the temple yard) that the highest priest stood to declare the coming and going of the "Shabbat" (the Jewish rest day, Friday~Saturday), using a ram's-horn trumpet. For this duty he would have needed a sundial, to blow the horn at the right time. It might be possible that these sundials were standing in this part of the Temple yard, serving the priests and the coming public (the main staircase leading to the temple came from south), and it was the most imposing sundial of them all, the largest one made of marble, which served particularly the needs of the declaration of Shabbat.

Finding the fragments of the sundials and the Hebrew inscription of the "Shabbat" declaration site, which must all have fallen from that corner of the temple yard, all in the same point below the southwestern corner, may testifv to this possibility.

It is interesting to note the relatively large number of sundials including few a portable sundials that were unearthed in a small area around the Temple and in the Jewish quarter.

It is possible that the Temple priests who worked in shifts, and were obliged to keep to a tight timetable of prayer, ceremonies and shift changes, used to keep sundials at their homes. Some of them were probably portable, to allow them more convenience. The finding of two sundials in the "Luxurious House" in the Jewish quarter may confirm such theory.

However, we have no certain proof that sundials belonged just to the priests and other temple workers. They might have been used by ordinary people as well, at least the wealthier.

So many sundials of various types and sizes, of different designs, accuracy and production quality, may point to a strong and well-established community with advanced knowledge, that may put energy and personal and economic effort into the making of such items as sundials, either for public or for private use.

As was the manner in the 18th to 20th century with pocket clocks, maybe people of some higher status used to keep sundials, and portable sundials as well, as a status symbol

A MEDIEVAL WALL SUNDIAL

In order to complete this survey of ancient sundials of Jerusalem, it is necessary to include here a short description of a sundial on the south wall of the Armenian Church of Jerusalem. It belongs to the medieval period and is therefore of much more recent date than the archeological artifacts so far described. The Armenian Church Sundial has already been described in Bull BSS,[8] so only short account will be given here.

Daniel Rubinstein described, in the Hebrew daily newspaper Ha'aretz (The Land)[9], a newly discovered scratched medieval sundial from the Armenian Church in the Old City of Jerusalem. It was unknown previously, except to a few Armenians related with the church, and even they did not give much attention to it.

The sundial is scratched on the southern wall of the ancient structure of the church (first built in the 5th century AD, and rebuilt in the 12th century AD), about 4-5 meters above the ground. It is half a circle, about 35cm in diameter, divided into 12 equal hour sectors, and there are divisions to halves of hours, marked by short lines on the circular peripheral line, in the middle of each hour sector.

The hour's numerals are Armenian letters, scratched in the end of each hour sector. The gnomon is missing and there is a great breakage around the gnomon's hole. The lines, marks and letters are very well preserved and visible.

Another sundial of this type, of the same size, is scratched on another stone - just right to the stone of the main sundial. However, this second sundial is much simpler, and has only the lines dividing it to 11 sectors, with no numerals or lettering or any further division. It scratched very simply and is quite shallow.

It is not clear why this simple sundial was scratched so, and why it carries only 11 hours.

It is possible that this sundial showed different time-divisions of the day for a different religious community or for different religious needs and rites. Similar medieval 'Twin sundials" are known from other places in Europe and Armenia as well, where one sundial is "regular" with 12 sectors, and the other one is with different division of 11, or 10, or 13 sectors.

We may assume that the sundials were scratched on the church wall during the rebuilding or shortly later, after the building was completed in the 12th century AD. Comparison with a similar sundial from the 12th century AD from Bjni in Armenia reveals the similarity to the "main" sundial, and it may be assumed that the sundials from Jerusalem are also from the 12th century.

CONCLUSION

Many centuries separate the date of the sundials derived from archeological studies of the Old City and Temple Mount in Jerusalem and the date of the Armenian Church scratch dials. Although no sundials in Jerusalem have yet been found to fill this gap in time, there are a number of sundials from this period from elsewhere in Israel. Some of these dials will described in Part 2 of this article.

THANKS

I wish to thank Karlheinz Schaldach and Herbert Rau, whose interest and assistance induced me to begin the research for this article; and to Mario Arnaldi whose knowledge and translations helped me with this article.

I give special thanks to Eilat Mazar, Hillel Geva and Baruch Brandel for advice and criticism, and for permission to survey and photograph sundials; also to George Hintelian for information about Armenian sources, and for permission for photography.

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TWO HORIZONTAL SCRATCH DIALS IN SCOTLAND (AND ONE IN ENGLAND)

R. BOWLING & A. O. WOOD

The vast majority of mass dials are scratched or carved onto the walls of our medieval churches. They are therefore 'vertical' dials and the shadow of the gnomon gave some indication, however roughly, of the time of day; more importantly perhaps, the times of the services held.

The simplicity of using the sun's shadow to indicate events is well known and has been used possibly for all historical time. Certainly Egyptian culture included sundials[1]; possibly obelisks, so well known, constituted early gnomons and Eratosthenes effectively used a couple of dials or noon marks to obtain a good estimate of the earth's circumference in the 3rd century B.C.

Consequently it is surprising to find that all our mass dials are vertical - why not horizontal? After all their accuracy is the same and the essential simplicity of 'a stick in the ground' is compelling. The answer probably lies in the phrase 'stick in the ground'. In terms of permanence a stick will not last very long and 'in the ground' implies an openness to accident or theft. A more permanent column requires markers and some area of ground; the whole project becomes much less 'cost effective' than a rod knocked into the mortar between a couple of stones.

Window sill dials use a shadow from a vertical edge of either a buttress, if external, or a window frame if internal. Nicholls and Lowne[2a,2b] have described such dials in Dorset and Sussex and a good internal example is at Sandhurst in Gloucestershire[3]. There may well be others, window sills behind the choir occasionally have marks 'in the right place' to indicate a 9 o'clock mass but are difficult to establish as definite indicators.

At the time of writing neither of the authors has seen any of the three horizontal dials to be described, and seek no credit for their discovery, only for bringing them into the corpus of mass dials and to the attention of the British Sundial Society. Both Scottish dials are documented by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS).

The ‘discovery’ by Roger Bowling of a horizontal dial at Craignish, Argyll, Scotland was of interest to the Mass Dial Group. In early 2001 whilst on holiday in Scotland Roger saw a photograph of the Craignish (Kilmarie) dial in the Kilmartin House Museum Guide[4]. This excellent museum displays the rich archaeology of the surrounding area and provides details of tours to see the larger artefacts in the landscape, stone circles, burial mounds, forts, standing stones, rock carvings, carved stones and much else. One of these tours is to Kilmarie Church on the eastern side of the Ardfern peninsula overlooking the sea loch, Loch Craignish. The medieval church is ruinous but the churchyard contains a collection of carved stones.

The dial there is scratched onto the surface of the large stone base of a cross. The cross is missing but a large socket hole is in the centre of the stone. Following a letter from Roger about this dial Tony Wood contacted the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) and obtained further details of the dial from their records[5].

Shortly afterwards Johan Wikander, one of our members from Norway, contacted the Society about scratch dials and was passed on to RCAHMS for the documentation about the Craignish (Kilmarie) dial. They duly sent him their records and pointed out a second very similar dial at Kilberry, also in Argyll. From Norway, the Kilberry dial information winged its way back to Tony in England.

This dial is also scratched onto the large stone base of a cross; in this case the cross, or at least the lower part, remains. The church is on the western side of the Knapdale peninsula overlooking the Sound of Jura.

Initially recognition of the Craignish and Kilberry dials as mass dials was met with some doubt. So far north is well out of the English mass dial regions and mass dials are rare in Scotland. Roger has suggested that rather than seek an English relationship an Irish one was more likely given the long cultural connections of Ireland and Scotland. The two dials were very similar in their design and other features. They were like nothing we had seen before in the British Isles, but the large stones of epidorite, local to Argyll, shows that the dials remained where created. Indeed their size precludes transport and proves that they were not fallen vertical dials. Only these two dials were known by the RCAHMS and as the crow flies over land and sea they are only 37 km apart on the same peninsula adjoining the Sound of Jura. They are both in churchyards near the sea.

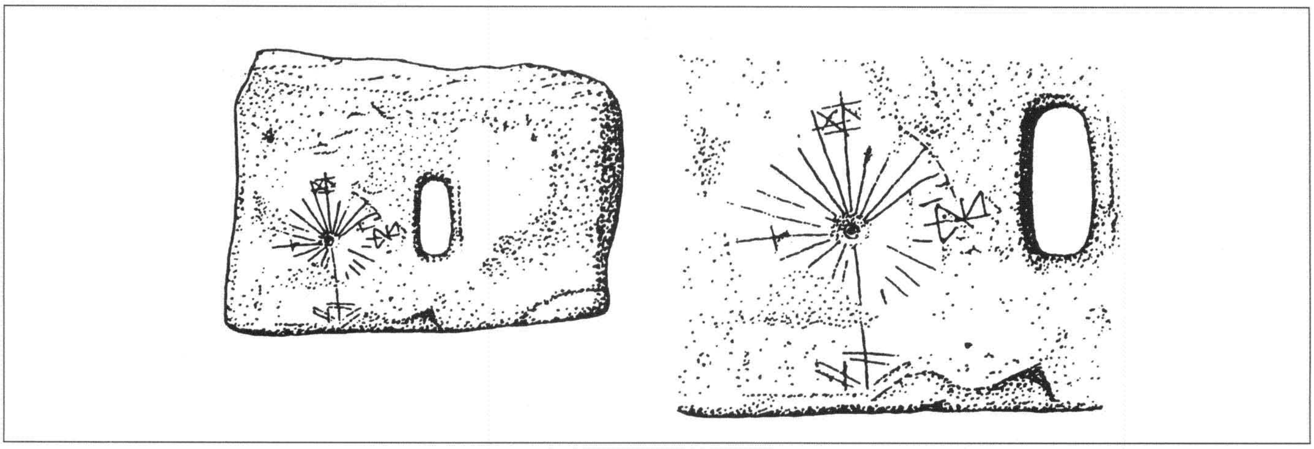

Fig. 1. Horizontal Scratch Dial, Old Parish Church of Craignish, Kilmarie, Argyll

Two features of these dials distinguished them from other dials in the British Isles: they were horizontal and Scottish. Other features link them so strongly that it is fair to ask if they could be by the same hand. They are equiangular with 24 rays, one dial has a crosslet on one of the rays and they are both situated on large stone bases of medieval crosses in churchyards. There can be no doubt that they are mass dials.

Other features are more puzzling. The one dial with cardinal points marked could also be a direction finder, similar to a modern marking at viewpoints. Their location near the coast adjoining the Sound of Jura could suggest a nautical connection. This may not be so surprising given that in ancient times the sea was not a barrier but the road. There is no reason why a mass dial should not be horizontal, and it is well understood that a horizontal dial in higher latitudes works better than a vertical one.

Now comes a twist to the tale. Since the original article was drafted, Val and Mike Cowham have produced a Cambridgeshire Sundial Trail[6] which features a horizontal mass dial similar to the Scottish ones.

This dial is at All Saints' Church, Lolworth, again incised on the base of a churchyard cross. The cross base is now inside the church by the font. The date given is 15th century, which matches the dials in Scotland, both quoted as 14th to early 16th century. The radial lines however are at 30° intervals with a 120° sector not marked except for two small marker holes in mid-region.

Our conclusion is that horizontal mass dials were certainly made, their presence in Scotland is an unusual addition to the mass dial record; and Lolworth remains (so far) the sole English example with a central gnomon. Churchyard Cross bases must be added to the list of 'places to look' when searching for mass dials.

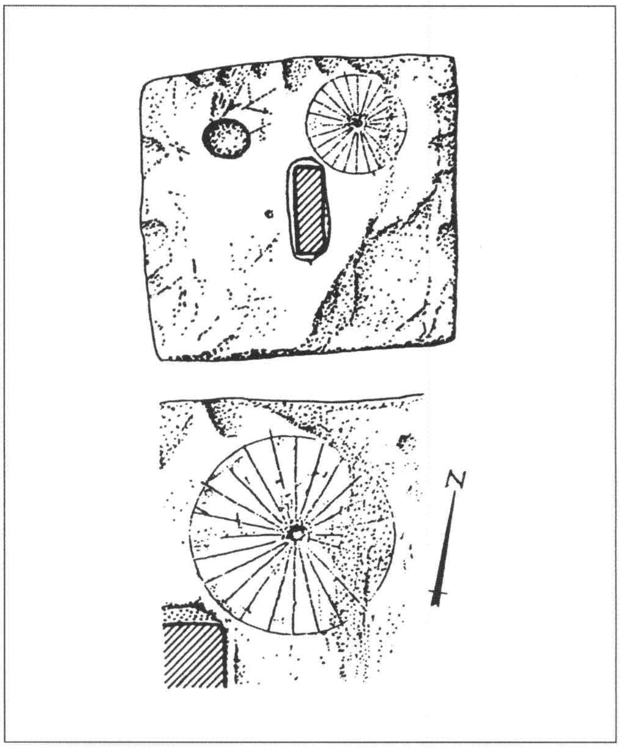

Fig. 2. Horizontal Scratch Dial, Old Parish Church of Kilberry, South Knapdale, Argyll

The dials are shown in Figures 1, 2 and 3 and are all full circles. Their details are as follows:

1. Old Parish Church of Craignish, Kilmarie, Kirton, Argyll Dedicated to St. Maelrubha of Applecross. O.S. reference NM 778014 RCAHMS CK15

Dial is about 375mm diameter with originally 24 radial lines and 4 cardinal points marked. A small arc remains of a (bounding?) circle. The orientation of the dial is not known with any certainty but appears to have been carefully aligned as it is at a small angle to the cross shaft (hole). The cardinal points are indicated by various characters, none decipherable. In the centre is a gnomon hole.

Fig. 3. Horizontal Scratch Dial, All Saints' Church. Lolworth, Cambridgeshire

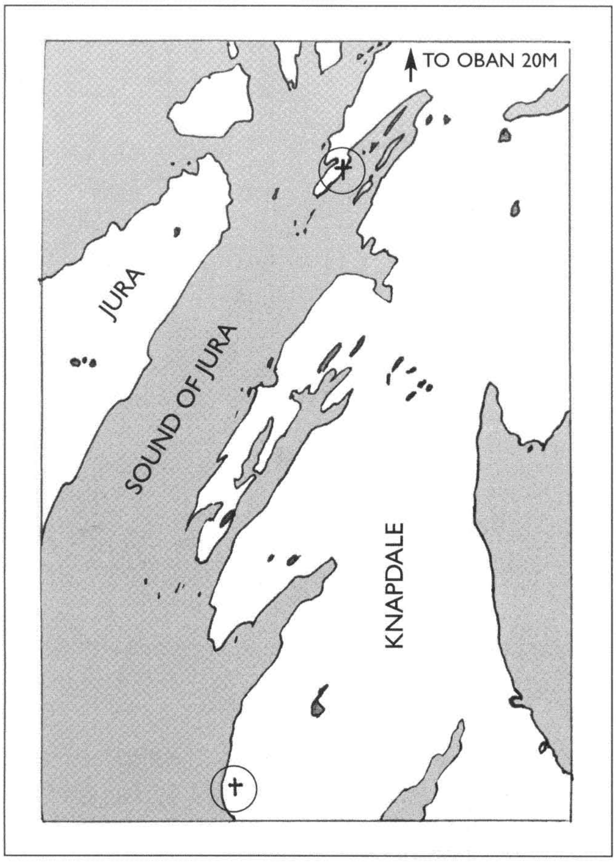

Fig. 4. Sketch map of west coast of Scotland, north of Glasgow, south of Oban, showing location of dials.

2. Old Parish Church of Kilberry, South Knapdale, Argyll. O.S. reference NR709642 RCAHMS BC 10

Dial is 360mm diameter with a full circle and originally 24 radial lines. There is a possible mass marker on the line nearest the shaft indicating that the dial is incised to the south-east of the cross as might be expected. Otherwise there is no indication of any orientation. In the centre is a gnomon hole.

3. All Saints' Church, Lolworth, Cambridgeshire. O.S. reference TL369642 West Cambridgeshire Sundial Trail

Dial is 130mm diameter and has 9 radial lines at 30° intervals with a tenth line bisecting one of the sectors. There is a central gnomon hole.

The Scottish dials are in remote areas, even today, lying south of Oban on the Mull of Kintyre peninsula. A map of their location is given in Fig.4.

ACKNOWLEDGEMENTS:

The authors express their thanks to Veronica Steele of RCAHMS and to Mike Cowham and Margaret Stanier for their assistance in providing information for this article.

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BOOK REVIEW

'Sundials from Cardboard' Kits by SunWatch Verlag
Haedenkampstrasse 5, 45143 ESSEN, Tel.0201/63497—0
www.sunwatch.de

SunWatch Verlag is currently producing., in stiff cut-out cardboard form, a variety of scientific instruments. These instruments are clearly very instructive, although not necessarily entirely durable.

At present on offer are: a 'Universal-Ring Sundial'; a 'Digital Sundial'; a combined 'Nocturnal-cum-Astrolabe'; a 'Desk Planetarium'; a 'Star Chart'; a 'Sextant;' an Artificial Horizon'; a 'Magnetic Compass'; a 'Telescope'; a 'Microscope'; a 'Periscope'; and a 'Kaleidoscope'.

Meticulous instructions (in most instances in German) are included for the assembly of the instruments, (although in some instances translations in English are available).

Essential equipment not included with the kits are a sharp knife, and a tube of suitable glue.

Also clearly necessary are a certain degree of patience, diligence dexterity and persistence, for the satisfactory assembly of most of these instruments.

The 'Digital Sundial' is particularly novel. It is equatorial in form, and arranged so that the sun transmits, or projects, the time from the upstream section of a semi-translucent equatorial ring on to an analemma, rotated about the polar axis and sited in place of the traditional gnomon. Accordingly, both sun time and watch time can be observed.

The prices of these instructional kits, as quoted, are in the range from 10 to 35 DM, with 1.50 DM equal to 0.77 Euro, in Autumn 2001.

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NOTES FROM THE EDITOR

Pembroke College Sundial: Readers may recall an article (Bull. BSS 13,16, 2001) describing the building of a large sundial on the wall of a building at Pembroke College Cambridge. This award-winning dial, notable for its heavy stainless-steel gnomon fixed without external support, is under continuous scrutiny by a camera in the window of a nearby building, the research laboratory of A.T. & T. The camera records onto ATT's web-site, so you can read the sundial by logging-on to www.uk.research.att.com then clicking on 'interactive', then 'online sundial'. On cloudy days, you are offered a recent view of the sundial taken when it was sunny.

Duplicated article: Although we do not publish articles which have already appeared (in English) elsewhere, it is sometimes difficult to avoid duplication. Such duplication unfortunately occurred with the article on p.32 of our March issue. This, owing to a misunderstanding between the author and the editor of 'Compendium', was also published in the March issue of 'Compendium' the Journal of NASS. No doubt the dozen or so BSS members who also belong to NASS, and the similar number of NASS members who belong to the BSS, may have felt short-changed when their second journal arrived. Authors of articles coming from USA will be questioned carefully in future.

RECEPTION AT THE ROYAL ASTRONOMICAL SOCIETY

The President's Reception of the Royal Astronomical Society took place at Burlington House, Piccadilly, on 8th February 2002. Some members of the British Sundial Society were invited, and were asked to present a small display illustrating the Society's interests and activities. On these occasions several amateur and professional organisations are asked to present exhibitions, and there were also displays by British Astronomical Association, the Rutherford-Appleton Laboratory, the Society for Astronomy in Education and others. John Moir and Doug Bateman are seen here with Dr. Helen Walker of the Royal Astronomical Society, with a part of the Sundial Exhibit in the background. The display excited considerable interest, as the guests enjoyed handling and 'working' various items on view. In the photograph below, John Moir is explaining the art of dialling to one of the guests.

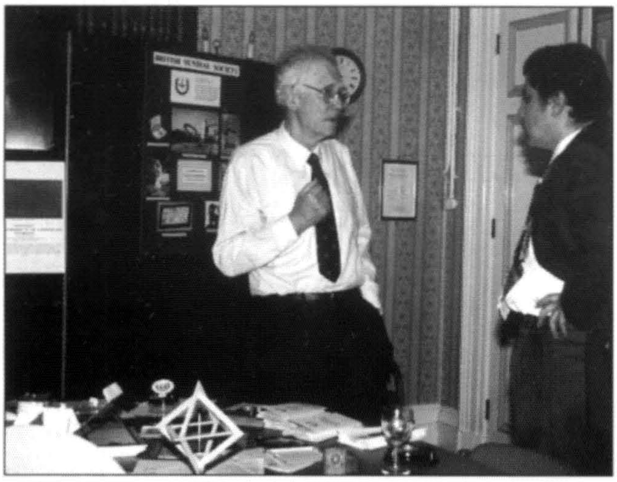


Photo by Douglas Bateman

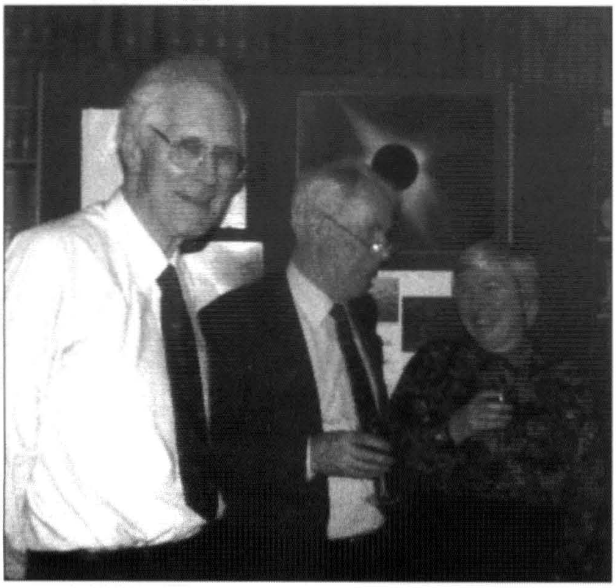


Photo by Quentin Stanley

SUNDIAL AFTER DUSK

Now that my day's work has finished
The dew has settled on my face.
My position here in this garden
Allows me to rest in this space

The aroma of the plants swirl round me,
Lilies, lilac, hyacinths and roses
Make my hours of quiet
The easiest of poses.

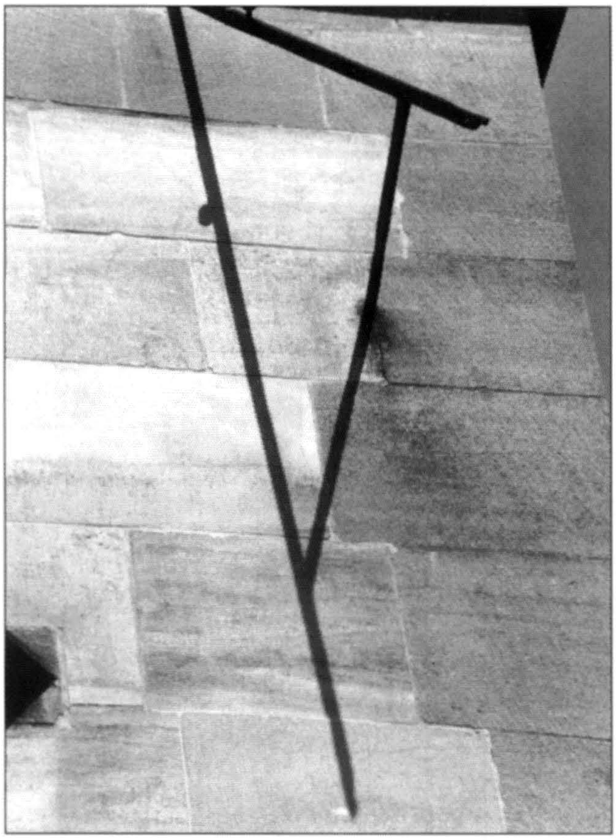
After dawn I'll renew my efforts
Shading the lines of the sun.
Visitors who come to read the hour
Won't know my labour has just begun

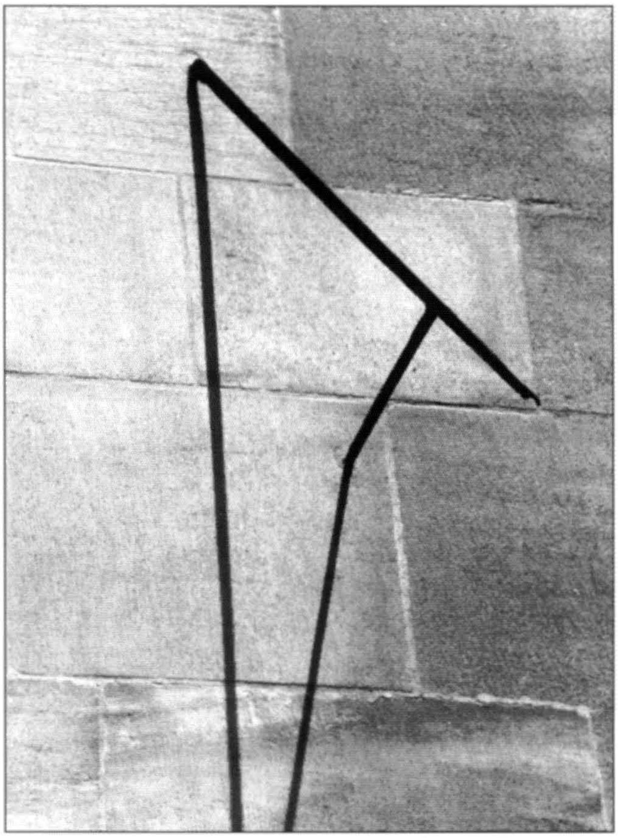
My long service on this beautiful site
Makes me grateful for an evening's rest
Gazing at stars on a clear night
Having performed to my absolute best

Jackie Holland

THE SUNDIALS AT WADHAM COLLEGE, OXFORD

HARRIET JAMES

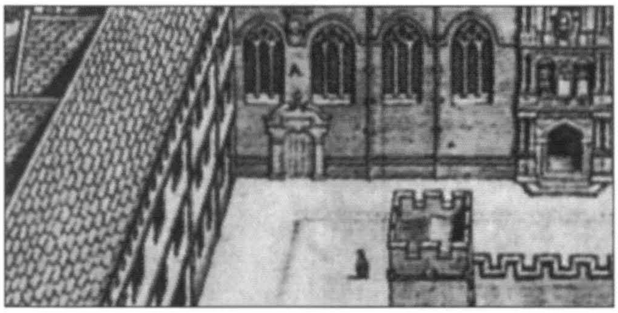




The authorities at Wadham College are keen to restore the two sundials on the chapel there. This article is the result of my search for evidence of the original date and appearance of the dials. My investigations have revealed a wealth of dialling activity at Wadham College in the seventeenth and eighteenth centuries.

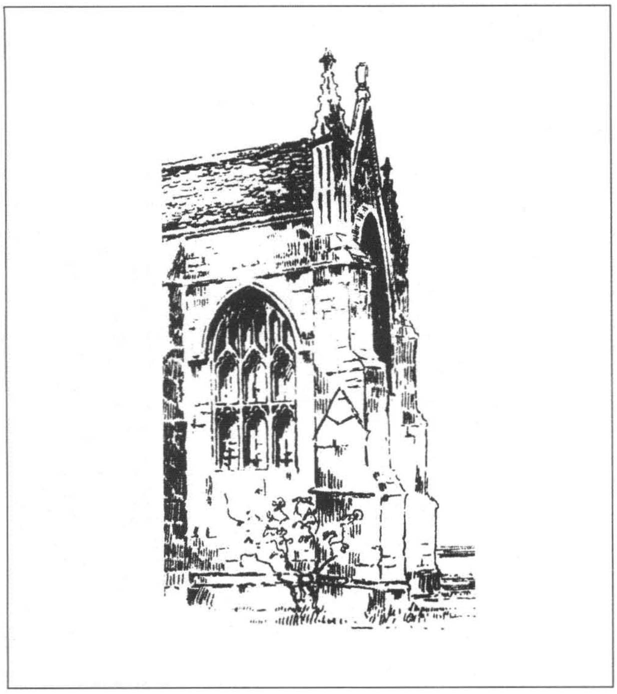
For pictorial evidence I looked at David Loggan's *Oxonia Illustrata* (1675). Several of his plates of Oxford colleges show sundials. The detail of the Wadham plate is very fine and one can imagine that the chapel gnomons are shown in miniature. R. T. Gunther in his *Early Science in Oxford* ii (1923) has no doubts: 'Loggan is celebrated for the accuracy of his plates and for his remarkable powers of observation. In the case of one of these dials he has surpassed himself, for though the dial would not be visible from the point of view from which his drawing was made, yet he has indicated its position by showing the gnomon by the faintest possible scratch that might pass for a slip of the graver was it not more likely to escape observation altogether; as indeed it has been by the College historian and architect, Mr. T.G. Jackson, in his history of the College.'

One cannot detect the gnomons in the engraving of the college by William Williams of 1732, but it is possible that a small mark in the view by Vertue for the University Almanack of 1738 does show a gnomon.



Gnomon possibly visible on the chapel buttress from Vertue's University Almanack, 1738.

A search of the Wadham archives produced a sketch by Edwin Glasgow of 1900 which shows the lower gnomon in position. There is no sign of the upper gnomon or of any markings on the stone of the chapel.



Part of Edwin Glasgow's sketch of the Chapel from Sketches of Wadham College (1900)

Early pictorial evidence of the gnomons may be scarce because their corner of the college grounds was originally a graveyard. It was converted into a garden for the Warden and Fellows in 1777 (T.G.Jackson *History of Wadham College* (1893)). There was an entrance to the college through the nearby garden wall shown in the seventeenth and eighteenth century prints mentioned above, but it seems to have been very much the back door of the college. Views of the college were usually drawn from the front.

Written evidence for the sundials is also scarce. Mrs Gatty in her *Book of Sundials* (Ed. Eden & Lloyd) (1900)) writes "When Loggan took his views of Oxford, published 1688, there were several dials on the colleges, but most of these are gone. He shows them at Exeter, St. John's, Trinity, Wadham, Brasenose, Christchurch, All Souls, Magdalen, and St. Mary Hall, besides pedestal dials at Queen's, Balliol, and Pembroke, and a tall pillar in New College gardens. Of these there remains the great dial at All Souls, and one in Brasenose quadrangle: a [sic] gnomon on the south-east buttress of Wadham Chapel, possibly placed there by Dr. Wilkins....'

R.T.Gunther also thinks that the dials were put there by Wilkins : 'The gnomons of the two south dials are *in situ* on the south side of the south-eastern buttress of the Chapel, but the faces of the dials have perished. The lower and probably older one may be contemporaneous with the Chapel (1612): the other, possibly a more accurate time-indicator, may have been added in the scientific days of Warden Wilkins (1648-59).'

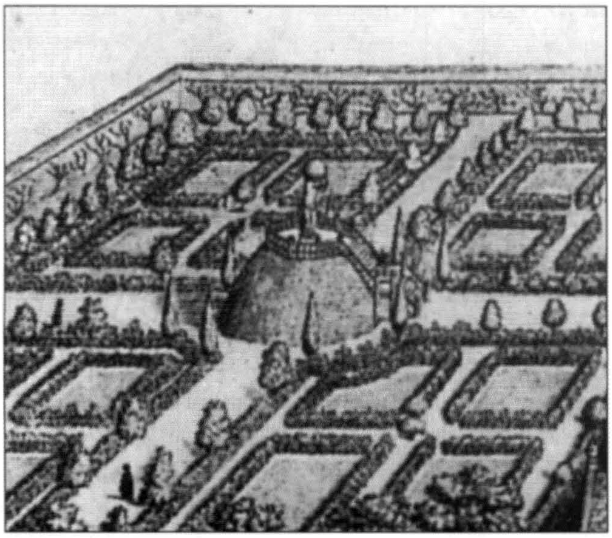
Dr. Wilkins became Warden of Wadham after the Civil War. A shrewd politician, he married Cromwell's sister, yet became a bishop in later life. During his time at Wadham the college became a focus of scientific experiment.

Neither Mrs Gatty nor Gunther says what evidence they have for thinking the dials may have been erected by Wilkins. As Mrs Gatty and Glasgow record only a single gnomon in 1900, whereas Gunther records two in 1923, it is possible that the upper gnomon fell off before 1900 and was replaced between 1900 and 1923. *Oxford Stone Restored: The Work of the Oxford Historic Buildings Fund 1957-1974* (Ed. W. Oakeshott) says of Wadham 'Very few alterations had been made in the buildings which were substantially in Headington stone, nearly 350 years old....Between 1920 and 1930 a programme of piecemeal repairs had been undertaken'. In 1935 'the stone work of the east and south faces of the chapel was repaired', in the 1950's the buttresses of the chapel were restored. In the 1980's the gnomons were removed, the rustier parts replaced with stainless steel, repainted and reset. So it seems that the gnomons and surrounding stonework have been disturbed several times in the twentieth century.

Although there is no direct evidence, it is likely that at least one of the dials dates from the heyday of sundialling or *gnomonics* in the 17th century. The early members of the Royal Society met at Wadham and certainly had an interest in dialling and clocks. When one of them, the young Christopher Wren, went to Wadham in 1650, he was already interested in gnomonics. At the age of fifteen he wrote a treatise on dialling entitled *Sciotercion Catholicum* and a year later translated William Oughtred's Latin treatise *The Art of Dialling (Parentalia* (1741)). As a boy he made 'curious dialls' at Bletchingdon where his sister and her husband lived, and when he arrived at Wadham he made a reflecting dial on the ceiling of his room. I know of two dials still in existence which have been attributed to Wren: the vertical decliner at All Souls, Oxford and a horizontal dial at Amen Court, St. Paul's Cathedral, London.

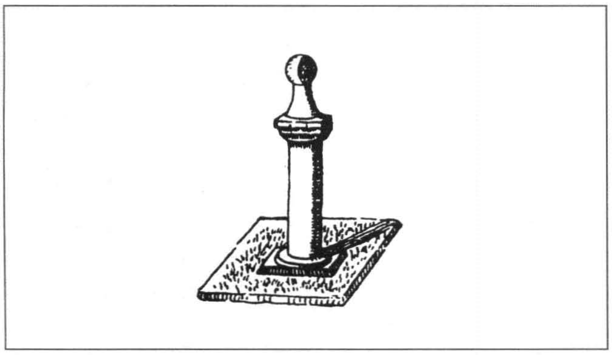
In 1654 Evelyn visited Warden Wilkins's lodgings and recorded in his diary: 'Wilkins showed me transparent aparies...these were adorned with a variety of dials, little statues, vanes.... (*Diary*, i. p.271)

Wilkins was responsible for setting up a statue of Atlas at Wadham which was also a sundial. This is shown in the Loggan and Williams engravings of 1675 and 1732 respectively. Pointer describes the statue in his *History of Oxford* ((1749), p.106): 'In the Gardens, is a Mount, with a Summer-House under it, and the statue of Atlas upon it, upholding the World curiously gilded. A Poetical Emblem, to express the vast Comprehension he [Dr Wilkins] had in inventing Astronomy. The Globe is an entire Dial without a Gnomon."



The statue of Atlas shown in Loggan's Oxonia Illustrata of 1675

Gunther says that Williams' *Oxonia depicta* engraving of 1733 shows a horizontal dial on a column near the north wall of the Fellows' Garden but 'as it is not shown by Loggan we conclude that it was erected after 1688 – perhaps just before 1730 when "causeless and expensive alteracons in ye Garden" were made (Wadham College, Convention Book 1730)'



Gunther's copy of a detail from Loggan's plate showing a horizontal dial at Wadham in the late 17th century

Vertue's 1738 engraving of the college shows Seth Ward holding a horizontal sundial.

Of course, Wadham was not the only college in the seventeenth and eighteenth centuries with sundials - as Williams' and Loggan's engravings show. One senses a rivalry between colleges. Certainly the question of accuracy in time-keeping had become much more critical with the advances in clock- and watch-making. Challenges such as the search for an accurate method of measuring longitude at sea interested Wren and others from the early days of the Royal Society.

Left to right: Sprat, Ward and Wren from Vertue's engraving of 1738

After Wren had left Wadham for All Souls in 1653, he designed a grand sundial for the All Souls chapel. He contrived it 'so that one may see to a minute what it is a clock, the minutes being depicted on the sides of the rays, viz., 15 on each side, and divided into fives by a different character from the rest' (R. Plot *Natural History of Oxfordshire* (1677)).

Wren also presented Wadham with a pendulum clock c. 1670. This clock had an early 'seconds' pendulum. The clock face is still in its original position over the west door of the chapel at Wadham. The original mechanism is now kept in the Museum of the History of Science in Oxford. It may be that one or both of the sundials on Wadham's chapel were used to regulate Wren's clock. The clock mechanism was inside the chapel, through two doors and round a corner from the sundials. Some sort of signal may have been used to let the keeper of the clock know the time. Alternatively it is possible that the dials were used to set a watch which was then taken to the clock. Thomas Sprat's *History of the Royal Society* (1667) mentions Fellows' experiments with 'several new kinds of Pendulum watches for the Pocket, wherein the motion is regulated, by Springs, or Weights, or Loadstones, or Flies moving very exactly regular.'

Another possibility is that Wren's clock at Wadham was set to sidereal time using direct star observations. An observatory was set up at Wadham over the entrance tower by Seth Ward. This observatory was regularly used by Wren during the mid-1650s, and was equipped with telescopes of 6, 12 and 22 feet. (A. Tinniswood *His Invention so Fertile* (2001)).

The upper gnomon on the chapel has an ellipsoid mounted on a stalk which holds it above the style. This means that the ellipsoid sits on a second, virtual gnomon parallel to the style. The shadow of the ellipsoid would not have related to the hour lines which would have been read with the shadow of the style. Sometimes part of the ellipsoid's shadow is obscured by the shadow of the style suggesting that the ellipsoid, as a mathematical conceit, might have been designed to show a circular shadow when the sun is in a particular point in the sky, or it may have been used to determine the date with a set of declination lines.

It is easier for the eye to determine the centre of an elliptical shadow than to gauge the edge of a shadow made by a straight style. The early members of the Royal Society were well aware of the problems of a shadow's fuzzy penumbra. Thomas Sprat says that the Fellows invented 'An Instrument for finding a second of Time by the Sun: - A new kind of Back-staff for taking the Sun's altitude by the Shadow, and Horizon which is so contrived, that though the shadow be at three foot distance, or as much as is desired, yet there shall not be the least Penumbra: and the shadow may be easily distinguished to the fourth part of a minute.'

It is also possible that the shadow of the ellipsoid was used to track an analemma – a 'figure-of-eight' shaped plot of the Equation of Time on one axis and the sun's declination on the other, though I have not been able to determine when this device first appeared on sundials. Flamsteed published his Equation of Time tables in 1675, and Christian Huygens published his in the Netherlands a few years earlier; so from then on the difference between mean time and solar time became more significant. Before Flamsteed's publication of the tables, clocks would have been set to local solar time with errors of as much as fifteen minutes creeping in.

In their present position the gnomons are set at different angles. This may be because they have been disturbed, or it may be that one was meant to correct the other. The latter seems to be the case for two old vertical dials at the church of St. Mary the Virgin at Broughton Gifford Church, Wiltshire. Set one above the other, the upper dial's motto reads 'Hodie Vive' [Live this day] and the lower one's reads 'Umbra Nuget Umbram' [This shadow makes the other foolish].

There was no fixed Prime Meridian until 1884. The Greenwich Meridian was not established at its current position until 1850 and before that it was sited further west. The angles of the Wadham gnomons should have been been the same whether the dials were designed to tell local solar or the time of the Prime Meridian, but the hour lines would have been differently spaced.

In April this year a close examination of the gnomons from a scaffolding showed that the stone on the buttress around the gnomons has been replaced leaving no trace of the original dials. The roots of both gnomons have been repaired with stainless steel bar and reset at angles incorrect for the declination of the buttress. The lower gnomon seems to be older, made of thin and pitted iron bar. The upper gnomon is sturdier and wedge-shaped in section, 10mm wide on the upper edge of the bar, tapering to 7mm. The axes of the ellipsoid nodus measure 27.2 x 21.5mm, its centre lying 27.5 mm above the top edge of the style. The tips of both gnomons end in an ornamental 'finger' shape.

If one or both the dials were made in the seventeenth century, it is possible they were executed by a mason called William Byrd (sometimes spelled 'Bird') who became Wadham's mason in or before 1656. The dials may have been painted onto the stone, or carved into it. Byrd was a letter-cutter and was also skilled at paint effects such as marbling. He had his yard between Wadham and All Souls. His name appears in the All Souls *Acta in Capitulis* recording a payment of £32.11.6d on 23rd November 1658 to be made to 'Mr Bird for the diall in the Quadrangle lately erected' (J.S.G.Simmons *Wren's dial remov'd* (2000)), ' the 'diall' being Wren's vertical dial mentioned above, moved from its original position in 1877 and mounted on the Codrington library. Byrd's name appears in the Wadham accounts in 1656, 1657, 1661-4 and 1669-75 but there is no specific reference to a dial. He appears again in the New College accounts in the Bursar's long book of 1676 'Sol. to Mr Bird for mending ye diall ut per billam £1/2/0.'

Byrd later worked with Wren at Winchester. Mrs J.C. Cole reported that his lettering can be seen on the Fettiplace monument at Swinbrook Church, Oxfordshire, and in the churches at Lydiard Tregoze, and Pusey in Wiltshire amongst others. (Mrs. J.C Cole 'William Byrd, stone-cutter and mason', *Oxoniensia* xiv. (1949)). The monuments at Pusey and Lydiard Tregoze are still there. I have not checked the others.

I am now at the stage of producing designs for two replacement sundials. I hope to copy William Byrd's style for the numerals and lettering on the dial, and perhaps to imitate the colour schemes of extant seventeenth and eighteenth century dials (e.g. the dial at All Souls, Oxford or at Queens' College Cambridge). Seventeenth century sundials with a nodus (including one at Merton College, Oxford) would provide clues as to the range of declination lines that might be used. A declination line for the saint's days of St. Nicholas (6th December) and St. Dorothy (6th

February) might be included as the college was founded by Dorothy Wadham and her husband Nicholas. The chapel is dedicated to St. Nicholas.

Decorative features on the new dials might include symbols taken from the arms of the college or of the Royal Society. A motto could be included. The one on Wren's dial at All Souls reads 'Pereunt et imputantur'('They [our good days] slip away, and [are] put to our account'). The British Sundial Society's Register of sundials includes many 17th and 18th century mottoes, as does Mrs Gatty's book.

Perhaps one dial could be restored to tell local solar time, and the other Greenwich time.

There are many decisions to make and planning permission to seek, so I expect it to be a long but enjoyable process.

ACKNOWLEDGEMENTS
My thanks to Dr. A. Chapman of Wadham College, Dr. J. Davis and other fellow members of the British Sundial Society, Dr. J.S.G. Simmons of All Souls College, Professor L. Jardine of Queen Mary and Westfield College for discussion and advice and to Professor G. L. Huxley for Latin translation. I am grateful for the help of the librarians and archivists of the Museum of the History of Science, the Bodleian, the Royal Society, the Samuel Hey Library at St. Mary the Virgin, Steeple Ashton,Wiltshire, Wadham and All Souls Colleges in Oxford.

THE JAPANESE SUNDIAL OF ANCIENT EPIDAURUS

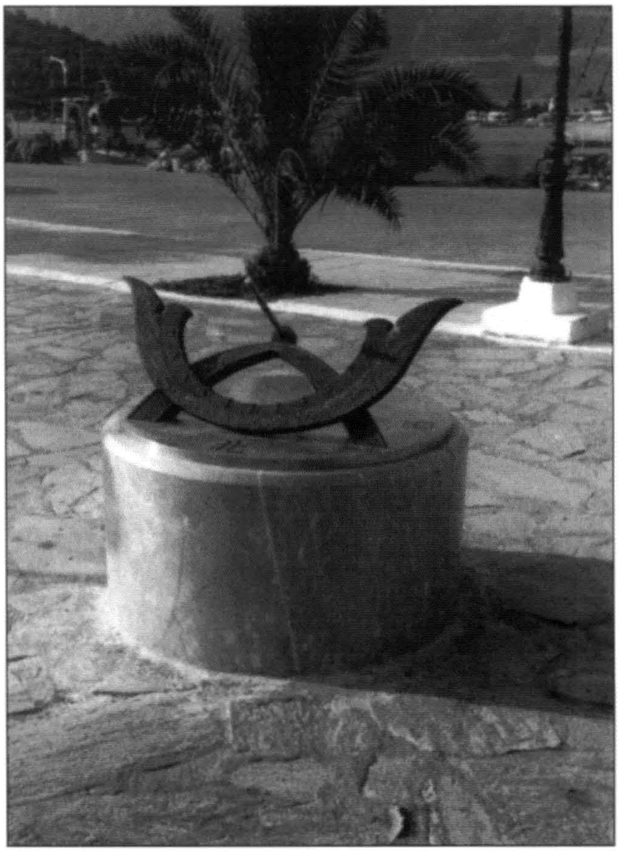
E.Th.THEODOSSIOU & V.N. MANIMANIS

ABSTRACT
A sundial is an instrument used outdoors to show the time (hour) of the day by means of a shadow cast by the Sun. This instrument shows the true solar time. The hour lines are usually drawn on a horizontal or vertical plane and the shadow is cast by a style (a thin piece of metal) fixed to the horizontal or vertical surface.

A Japanese horizontal sundial is placed since 1998 in the famous town of Ancient Epidaurus, in Peloponnese, as a gift of the ten-year friendship between Epidaurus and the Japanese town of Nishiki.

1. GNOMON AND POLOS
At the present time, sundials are made mainly in order to provide a decorative feature on several squares of some towns or in churchyards (horizontal sundial), or on the walls of old buildings such as town halls, law courts, etc.

However, in ancient times sundials were the basic method to measure true solar time during daylight hours. Greeks in Ancient Greece used various types of sundials. Eusebius[1], the father of ecclesiastical history, says that Anaximander was the first to construct gnomons for the purpose of distinguishing the turning-back of the Sun at solstices, times, seasons, and equinoxes. However, as Herodotus[2] (Book II, I 09)claims: "*The sunclock and the sundial, and the twelve divisions of the day, came to Hellas not from Egypt but from Babylonia*". That means: "*The Greeks learned from Babylonians the use of gnomon and polos, and also the twelve parts of the day*".



The modern Japanese sundial in Ancient Epidauras (NNW view).

It seems that the *gnomon*, the simplest form of a sundial, has been known since remote Antiquity. The gnomon is a type of sundial with a vertical needle on a plane base: Gnomon shows local solar time by the motion of the shadow cast by a vertical rod placed on a horizontal plane. In modern Greek we call gnomon the pointer of a sundial.

Another type of sundial has a pointer fixed upright in the middle of a hemispherical bowl; the Greek name of this sundial type is *polos*. Polos is an ancient Greek word, a word that came down to us with many and different meanings. A lot of Greek and English words are derived from this single Greek word: Polaris, pole, polar circles, polarisation, and many others.

2. ANCIENT GREEK PHILOSOPHERS AND SUNDIALS

It is obvious that, according to Herodotus, ancient Greeks obtained their knowledge of both these instruments from Babylonians. It is certain that the philosopher Anaximander (610-540 BC) was the first who taught the use of sundials in Greece, even if he did not invent them. It is said that Anximander was the first to have set up in Sparta a gnomon and to have marked on it the solstices, the equinoxes etc.. Indeed, according to Diogenes Laertius[3] (II, 1), the first sundial in Greece had been constructed in Sparta by Anaximander and it had a pyramid-shaped gnomon showing the true noon. Also, Anaximander was the first to construct vertical sundials for the walls, maps of the then known world and a celestial sphere: "*He was the first inventor of the gnomon and set it up for a sundial in Lacedaemon, as is stated by Favorinus in his Miscellaneous History, in order to mark the solstices and the equinoxes; he also constructed clocks to tell the time. He was the first to draw on a map the outline of land and sea, and he constructed a globe as well*".

A century later, Anaxagoras (500-427 BC) constructed (circa 450 BC) a type of sundial he called '*scaphe*' (bowl). A similar sundial was discovered at an excavation on the island of Naxos. To Eudoxus of Knidos (534-407 BC) is credited the construction of a horizontal sundial he called '*arachne*' (= spider). Finally, Aristophanes[4] in his comedy 'The Ecclesiazousae' (739-761) makes a reference to the use of sundials in Greece during his period.

3. THE MODERN SUNDIAL OF EPIDAURUS

Palaia Epidaurus (= Old Epidaurus) is a town built by the sea, near the ruins of Ancient Epidaurus, at the northeast part of Argolida prefecture in Peloponnese, with a population of 1647. Although small, this town is famous for the Epidaurus ancient theatre, one of the largest and best of all ancient Greek theatres, built during the 4th Century BC with fantastic acoustics. The performances of ancient drama at this open theatre are well known throughout the world and constitute the main reason of the town's fame.

Some Japanese admirers of ancient Greek drama from the city of Nishiki who visited Greece marveled at its

The modern Japanese sundial in Ancient Epidauras (West view).

monuments, and they were fascinated by the performances of ancient drama at the ancient theatre of Epidaurus. Wishing to honour the Peloponnesian town of Epidaurus, these Japanese from Nisluki had the idea to offer as a gift of friendship a sundial, since it was in Peloponnese that the first sundial in Greece was set up by Anaximander. The mayor of the town accepted the donation and placed the Japanese sundial at the side of the central square of the town, next to the sea.

This sundial is of Japanese style, apparent in the metallic construction which supports the gnomon, or is at least reminiscent of something from the Far East. It is a simple horizontal sundial whose plate is decorated with Japanese ideograms, while the whole construction is based on a cylindrical base made of granite. A tablet on this cylindrical base reminds us of the donation, by writing:

Αρχαια Επιδαυρος - Nishiki
1988-1998
10
ΧΡΟΜΑ ΦΙΛΙΑΣ
«ΤΟΝ ΦΙΛΟΝ ΤΙΜΩΜΕΝ ΕΞ
ICOY ΠΑΤΡΙ»
1998.8.29

As one can infer from this commemorative plaque, the Japanese friends of Epidaurus from Nishiki were visiting Greece for ten consecutive years, and they continue to visit it, as the local people informed us. In the tenth year of acquaintance they donated the sundial to the town of Epidaurus, on August 29, 1998 after ten years of friendship, as they themselves mention.

Finally, the residents of Epidaurus responded to this act of friendship with an ancient Greek saying, which is also written on the commemorative plaque: "*Ton philon timomen ex isou patri*". This saying translates as: "*We honour the friend equally to the father*", and it represents the feelings of friendship of the Greek people towards the Japanese friends.

Map of the Epidaurus area

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THE SUNDIAL AT CASTLETOWN, ISLE OF MAN

E. Wilson

(We received the article below as a letter addressed by Mrs. E. Wilson, a resident of the Isle of Man, to Piers Nicholson. We are grateful to Mrs. Wilson and Mr. Nicholson)

In the Market Square, Castletown, Isle of Man, is a facetted sundial. It is set on a pillar which rests on a slate platforrn at the edge of the glacis of Castle Rushen. The south face is inscribed with the date 1720. There is surprisingly no local history attached to this sundial, except a local nickname the 'Babby House' -baby house - which appears to be a folk memory of its earlier position on a Market Cross. In a watercolour from 1774, the sundial is seen on the top of the cross which took the form of a three-arched structure. The Market Cross was pulled down before the end of the eighteenth century. Nobody knows what happened to the sundial before it was placed in its current position on a pillar, probably sometime in the 1820-30s.

There is only one other facetted sundial in the Island. It is of a different design and was made in 1774 from local stone.

A Miss Crellin was the first to describe the Island's sundials

(AM. Crellin: ‘Sun dials in the Isle of Mann’, *Yn Lioar Manninagh* vol.1, part II, 1889) She lists 48 dials and states ‘.... At the beginning of the 18th century the Island went nearly crazy on the subject of sundials, any amount of people getting to work to rnake or procure them.’ On the Castletown dial she remarks that 'very little is known’.

In the 1920s the Island was visited by an engineer, Mr W.H. Harmer, of Alderley Edge, Cheshire, who as a hobby explored the Island for sundials and left behind him others of his own construction. The extensive manuscript account he deposited in the Manx Museum gives all the details then obtainable of dials existing here, together with his observations on dials and dialling in general, many pages of purely scientific calculations, and a collection of photographs, drawings and rubbings. On the Castletown dial he writes:

28.3.27 Facet dial - "Babby Horse" at Castletown dated 1720. This dial is a very interesting and unusual one. It cannot be read easily from the pavement on account of its height, about 15 ft. It is weathering and decaying and needs care and attention. It would be well if it could be carefully cleaned and preserved and moved to a site and height where it could be useful and protected.

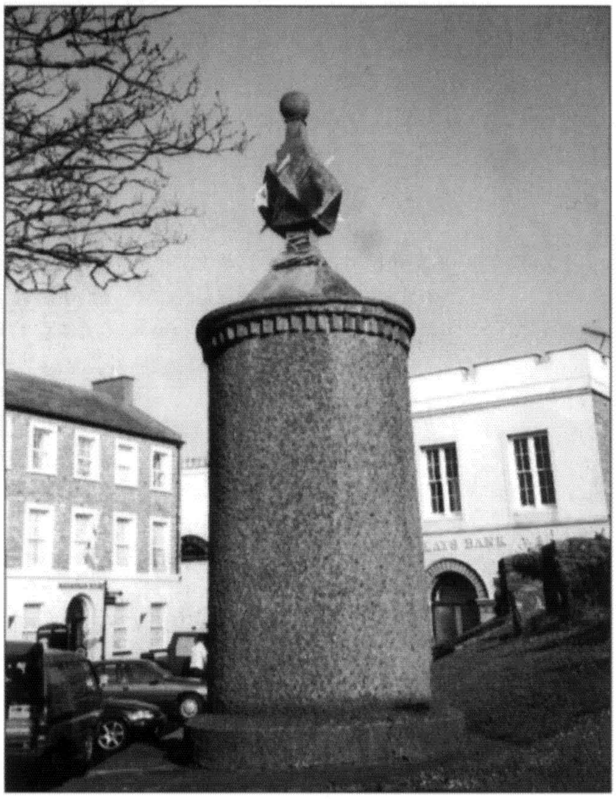


Fig.1. Multiple Sundial, Market Square, Castletown, I.O.M.

He describes and tests the time: 'Lat. 54 deg.4 min.55 sec.N, Long. 4deg. 39 min. 00 W. Time 18min.36 sec W of Greenwich. About 4.15 pm today sun was on four faces, viz.S, W on one reclining and one inclining facet. The upper or reclining facet could not be read on account of angle and height. Other three coincided in solar time. Test showed that one was 6 min. and the other 7 min. too fast. The difference will be in the incorrect gauging of the exact minute from so much below the level of the facets.'

Another test from 3 March 1927 is appended below and a note from September 1927. 'N.gnomon has been reset upside down. Other faccets are very erratic and vary largely in short time.'

To my knowledge nobody has looked at it closely since then. In its present position it is not possible to examine the faces and their markings in any accurate detail. It is, however, possible to see that it is made from a dark yellowish sand- or grit-stone which does not occur in the Isle of Man.

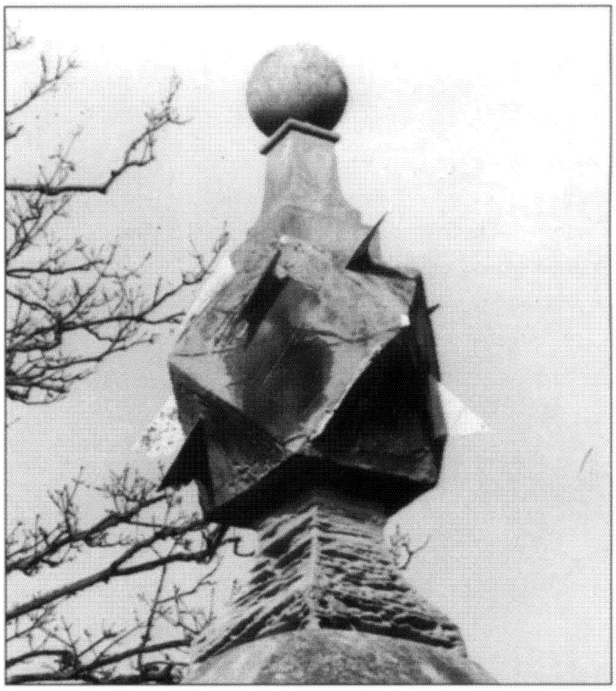


Fig.2. A closer view of Castletown Sundial

Harmer further states that this type of dial is more common in Scotland than in England and refers to Ross, T: 'Ancient Sundials of Scotland' *Proceedings of the Society of Antiquaries of Scotland* Vol.XII New Series 1889-1890, 161-280.1 was particularly interested in Ross' section on 'Dials on Market and other Crosses': 'We are not surprised to find that many of the Market Crosses erected during the seventeenth century have been adorned with dials; the sentiment peculiar to a dial is well fitted for such a symbolic structure.'

In correspondence with Dr Robert Anderson of the British Museum I was referred to A. Somerville's 'The ancient sundials of Scotland' *Proc. Soc. Antiq. Scot* 117(1987) 233-264. I was particularly interested in the point he rnakes about the connection between sundials and freemasonry.

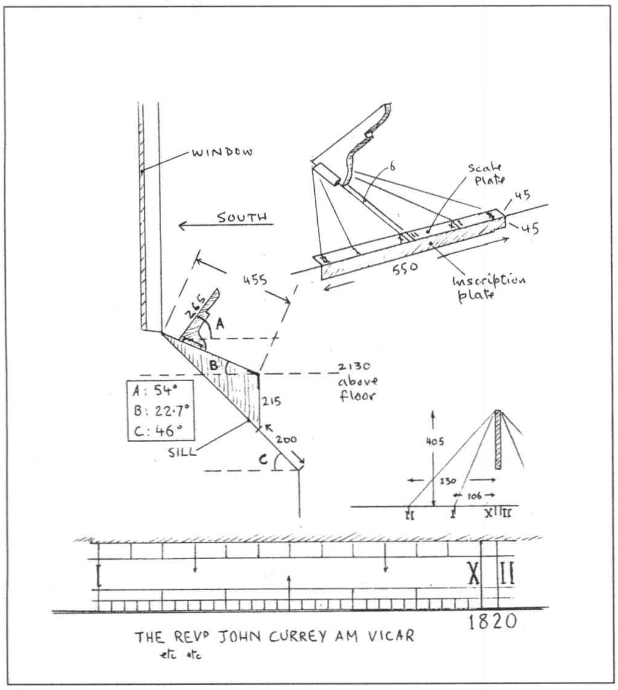
In summary, the dial was brought to the Island in the eighteenth century and it is illustrated attached to the top of the Market cross in 1774. The cross was demolished before the end of the century. The sundial is next mentioned in its present position in 1834. For reasons concerned with the development of the Market Square it could have been put up a little earlier, perhaps from the mid-or late 1820s. It is unlikely that it was made in the Island and the stone, a sand- or gritstone, is of a type common in the North-West of England.

It is tempting to try and associate it with the Lord of Man who in the early eighteenth century was James, tenth Earl of Derby, and his Lancashire estate Knowsley. There was also a very powerful bishop in the Island at the time. Bishop Wilson took a great deal of interest in science and kept in close touch with the learned Societies of the period. I would dearly like to find that he was responsible for our sundial, but although much is known and written about him, I have so far found nothing to associate him with it. A possible connection with freemasonry could prove a lead. I would like to know more about this aspect of the use of sundials.

AN UNUSUAL INDOOR SUNDIAL

JOHN FOAD

I recently came across an interesting dial in the Parish Church of Dartford in Kent, located on the interior sill of a stained glass window. The window is well above head height, and the dial is seven feet above floor level, so is not very convenient for actually telling the time. The side of the window, and a mullion, restrict the access of the sun to a period of about two hours each side of noon. The dial plate reclines downwards towards the North at about 23°, and in the winter months receives no sun at all. I have not yet seen the dial in summer sunlight, but it must be beautiful, with richly hued sunbeams spreading a patchwork of colour across the plate. Beautiful, but again not ideal for telling the time! To be fair to the designer, it is likely that at the time of installation, the window held clear glass, though even this was probably leaded in small panes.



Sketch of window-sill dial, Holy Trinity Church, Dartford, Kent.

The dial itself is nicely laid out and engraved. The sketch shows that the Style Height is 54°, while the church is located at about latitude 51.5° North. The hour lines are accurate for the Style to Dial Plate angle of 76.7°. I suppose the dial was accurately delineated and made, but that the

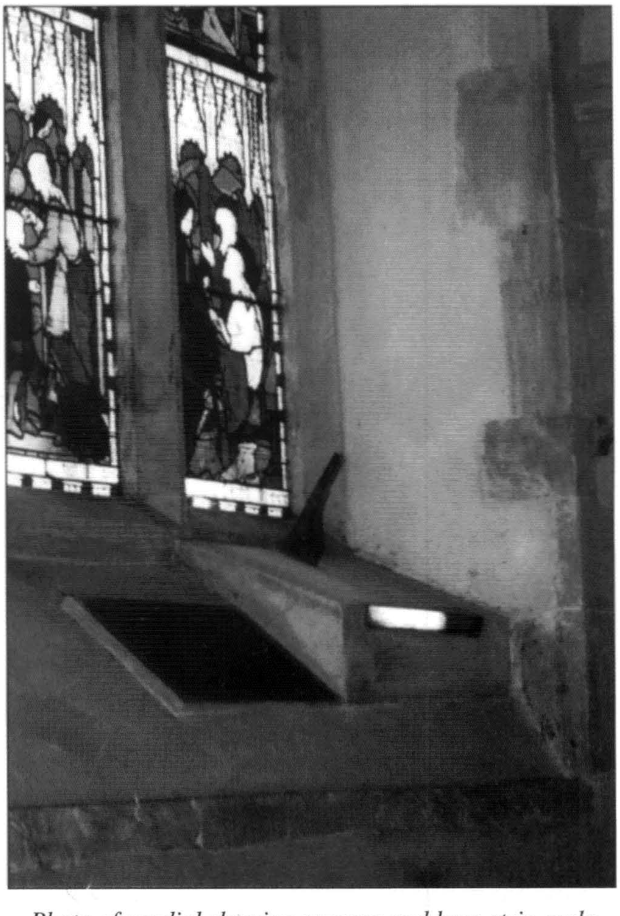


Photo of sundial showing gnomon and bass-strip scale

stone mason mounted it at an angle 2.5° too steep. The hour scale, from 10 am to 2 pm, is contained on a brass strip measuring some 550mm by 90mm, let in to the corner of a wedge shaped stone base, which serves to elevate the dial from the even more steeply reclining sill of the window. Two scales are provided, one showing 5-minute and 15-minute intervals, and the other with 2-minute and 10-minute divisions. The only other items on the plate are the date (1820), the name of the vicar of the time (the Reverend John Currey A.M.), and the names of two churchwardens (Mr James Colyer and Mr Thos. Sears). A memorial to the Rev Currey, elsewhere in the church, records that he died in 1824 at the age of 89, having been vicar for 47 years. He was previously a Fellow of St John's College, Cambridge. His parishioners saw in him "benevolence tempered with discretion; zeal controlled by sober judgement; piety adorned with a simplicity approaching to that of the Apostolic Age".

You will see from my comments that the dial is unlikely to be the first thing to strike a visitor to the church. Sporting no motto, there is naturally no reference to it in Mrs Gatty's "The Book of Sun-Dials" (2nd Edition) of 1889, nor is it in the 4th Edition of 1900. It does not appear in Henslow's "Ye Sundial Booke", nor can I find any mention in any history of Dartford. The only reference I know of is a letter in "Notes and Queries" of March 17th, 1906, where it is described (rather inaccurately), by a Mr Harry Hems. This item was drawn to my attention by the local Social Historian, Mr John Gilbert, who had no further background information.

It would be interesting to know more about the origins of this dial. How did it come to be commissioned; did it commemorate some anniversary or event; who designed and made it; and were there any discussions on its rather unusual positioning? I like to think that it was a gift to the Rev John Currey from his admiring parishioners on the occasion of his eighty-fifth birthday, but unfortunately I have nothing to support this hypothesis other than coincidence of dates. I wonder if any reader can provide more reliable information? I see from items in the Bulletin that Mass Dials have been found on interior window sills, using the vertical side of the window as a gnomon; but are there any other examples of scientific dials in such a location?

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A SUNDIAL FOR DUNSCAR WOOD, BOLTON, LANCASHIRE

ANNE JAPPIE

(This short article is the Press Release sent by the Press Officer of the Woodland Trust, to announce to the public the official opening in April 2002 of new woodland and its sundial_Ed.)

GO WHERE GNOMON HAS GONE BEFORE!
Become a time traveller and follow the sun at Dunscar Wood

Visitors to Dunscar Wood can become part of time by using their bodies to form the centre part of a new sundial. The raised centre "pointer" in a sundial is called the gnomon (pronounced the no-mon). The sundial, which is being officially unveiled this April, forms the centrepiece feature in the wood.

Just north of Bolton, Dunscar Wood was created by a special partnership between the local community and the Woodland Trust, the UK's leading woodland conservation charity. The project was part of the Trust's "Woods on your Doorstep" scheme (Note 1) that has created 250 community woods across the UK.

At Dunscar, local people were involved in fund-raising for the 6-hectare (15 acres) wood at the start. Helped by the Trust, they also decided on the design of the new wood, its name, and what they wanted as the millennium feature.

Time-scale block of Dunscar Wood sundial (DEC and JAN closest to camera)

Local people helped plant many of the 9000 trees in the wood, where there is a mixture of oak, ash, wild cherry, rowan, downy and silver birch, aspen, hawthorn, holly, willow and alder. The sundial is on a flat plateau, so the sun will still hit it even when the trees are fully grown.

Appropriately, a sundial was chosen to mark the passage of time and the new millennium. The science of sundials is itself centuries and millennia old, (Note 2). Physics, mathematics and astronomy are the basis of the working of these remarkable time-telling marvels. There are many different types of sundial, and almost anything can be made into one, provided the placement of time marks is calculated properly.

At Dunscar Wood, a five-foot flagstone has been carved with the date-scale, and chunky stone cubes cut from old kerbstones have been carved with Roman numerals which indicate the hours. The carving was done by Peter Isherwood, a master dry-stone-waller who lives in Edgworth. The reclaimed local stone came from the Lancashire Stone centre in Haslingden.

Margaret Ribchester of Bromley Cross designed the sundial. She explains:

"I'm not a mathematician, and the concept made my head spin! The sundial is set to Greenwich Mean Time, so during British Summer Time you need to add the hour on. It should provide an interesting feature for woodland walkers, but if you want to catch a bus you'd better wear a watch."

Human gnomon standing on Time-scale

Colin Riley of The Woodland Trust says: "The sundial marks the final stage of creating the wood. None of it would have been possible without the support of local people like Margaret. We were slightly delayed, but I suppose we were working on sundial time!"

NOTES

1. 'Woods on your Doorstep' was generously supported by the Millennium Commission, the Sainsbury Family Charitable Trust and the Forestry Commission.

2 . Sundials
For excellent information about sundials, contact Douglas Baternan, Secretary of the British Sundial Society at doulas.bateman@btinternet.com or telephone him on 01344 772303. Also visit www.sundialsoc.org.uk

Anne Jappie
Press office, Woodland Trust
Dysart Road, Autumn Park
Grantham, Lincs, NG31 6LL

THE DECLINATION AND POSSIBLE RECLINATION OR INCLINATION OF A WALL

A. F. BAIGENT

Very few walls are plane vertical surfaces and no matter how accurately the declination is calculated, if the position chosen for the measurement is moved just one course higher, the chances are that the result will be a degree or two different. This is particularly true for old walls built of handmade clay bricks, which often became distorted in the kiln. Even if a dummy of the same dimensions as the proposed dial is pre-mounted and its declination measured, it is unlikely that the finished dial will take up exactly the same position. Screws or nuts may be tighter of looser in different corners.

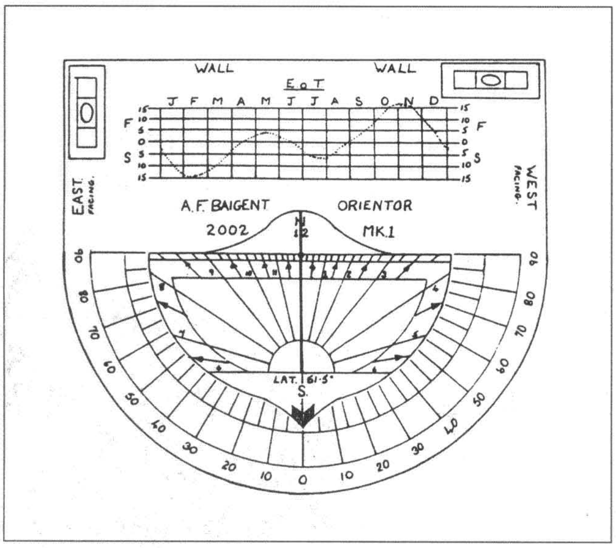


Fig. 1. Plan view of Orientor as it would appear on a direct south facing wall

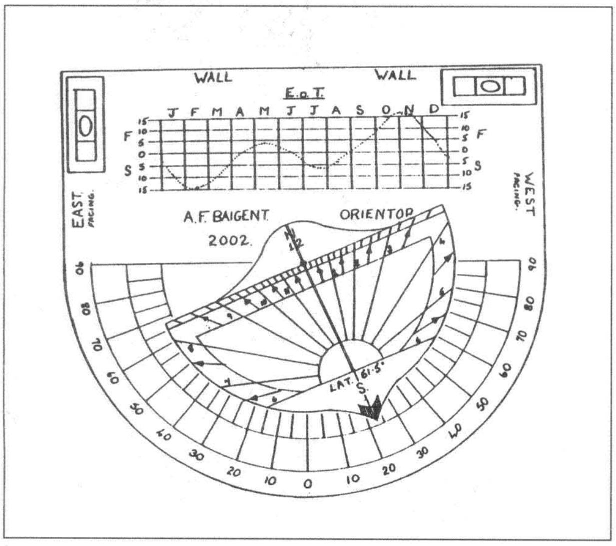


Fig.2. Plan view of Orientor measuring the declination of a wall south 230 west

I therefore suggest that measuring a declination to the nearest two or three degrees is sufficiently accurate for calculating the angles for a dial to be erected on this wall. Then, when the dial is mounted, its position is adjusted such that it faces the exact direction used for the calculation.

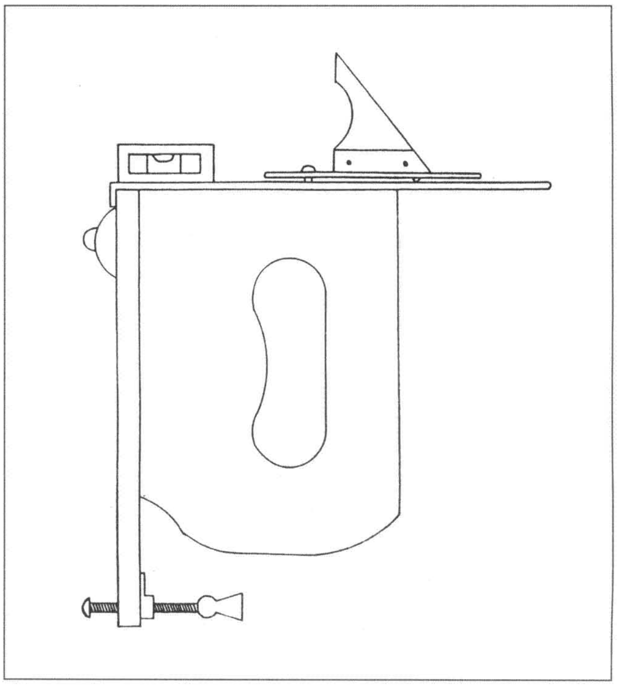


Fig.3. Side view of Orientor showing rotating horizontal dial, 'vertical spirit level' and adjusting screw.

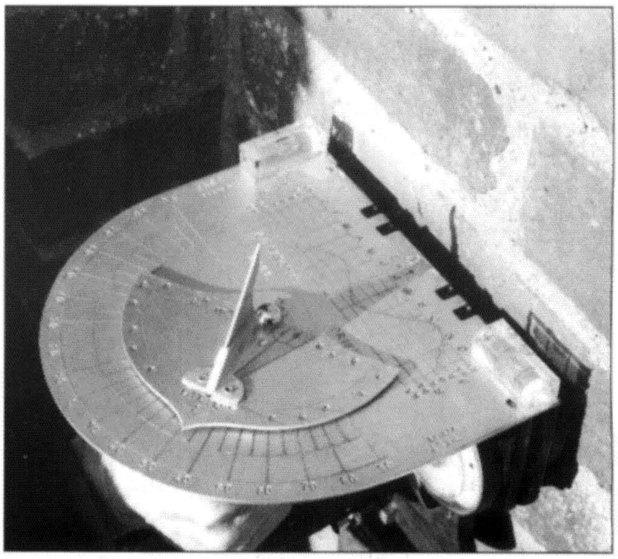


Fig.4A. Orientor in use at 2 p.m. The wall declines south 31° west

As a result I designed and made the ***'orientor'*** , a means of finding the approximate declination of a wall, instantly, during a wide range of daylight hours when the sun is shining.

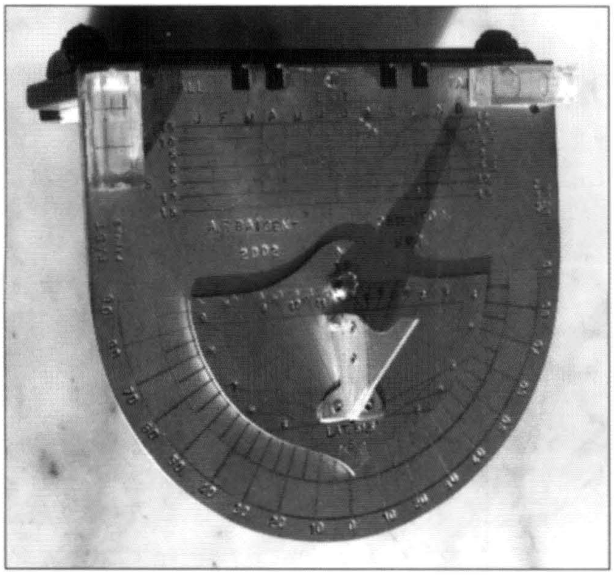


Fig.4B. Plan view of Orientor

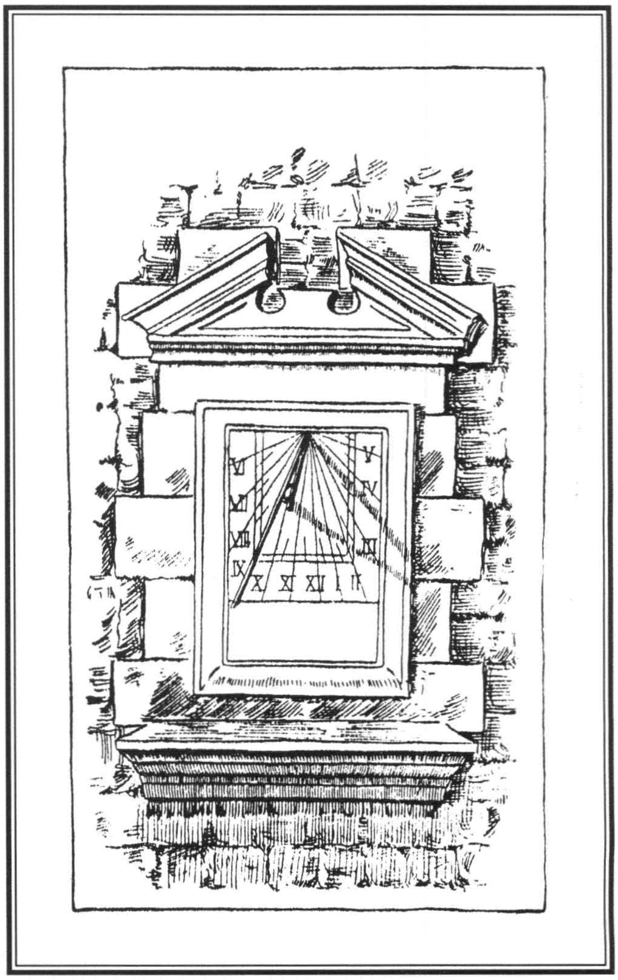
Finding the orientation of a wall using the Orientor

1. Set your watch to correct GMT or BST
2. Find the equation of time for the day and the longitude correction. Calculate the difference between GMT/BST and L.A.T.
3. Hold the Orientor against the wall and adjust its position so that the horizontal spirit bubble indicates that the plate is level
4. Using the adjusting screw, ensure that the back plate of the Orientor is vertical as indicated by the LHS 'level'.
5. Read the time from your watch and correct to L.A.T.

Fig. 5. Measuring the reclination of a wall using a purchased 'level angle finder'.

6. Rotate the sundial until the gnomon shadow indicates the L.A.T.
7. Read the angle from the 'South' (0°) point as shown by the pointer on the dial to the nearest 5°
8. Count the number of degrees above or below the nearest 5° mark by checking the degree lines each side of the pointer.
9. Readings to the RHS indicate that the wall faces to the West of South, and those on the LHS indicate that the wall faces East of South. *(This is the wall's west or east declination).*
10. Using the 'level angle finder' clipped to the back plate, check the *inclination* or *reclination* - if the wall is not vertical.
11. In latitudes a few degrees North or South of 51.5° North, the 'level angle finder' may be used to adjust the plate such that the angle between the style and the horizontal equals the new latitude, and the declination of the wall measured as before.

41 Wallingford Road
Goringham Thames
Reading RG8 0HL



TELLING THE TIME AT NIGHT

MIKE COWHAM

A sundial may occasionally be used for telling the time at night. The famous dial at Queens' College, Cambridge has been provided with tables so that the shadow produced by the gnomon from the moon's light can be converted to equinoctial hours. Many other dials, particularly portable dials have lunar scales on them and may be used for time telling at night.

There are however several good reasons why telling the time at night by the moon is not entirely satisfactory. The first is that the amount of sunlight reflected by the moon's surface is only really sufficient to throw a visible shadow during the second and third lunar quarters. It is fruitless trying to take any readings for the other half of the month. This problem is exacerbated in modern times by light pollution from artificial sources.

The moon's phases are normally divided, for convenience, into quarters. During the first quarter the moon is nicely visible in the early evening and in the second quarter from sunset to early morning. During the third quarter it is visible from mid-evening to sunrise and in the fourth quarter only in the early morning hours. The moon therefore is only of any practical use for time telling during the second quarter and for part of the third quarter for most people.

Another complication arising is that the moon's orbit varies over a period of about 18 years, being higher or lower in the sky depending on its position in this cycle. The moon does not stay within the ecliptic and to use the sun's light reflected by the moon requires detailed correction tables if any real accuracy is required. In the search for a means of finding longitude at sea, several astronomers tried to use the moon, producing some very complex tables in the process. The lunar method, as we know, did not win the £20,000 longitude prize. John Harrison eventually claimed this for his mechanical sea watch or chronometer.

QUEENS' COLLEGE DIAL

The dial at Queens' College in Cambridge needs little introduction from me. (Fig. 1.) Photographs of it are to be found in many books on dialling and there are booklets printed by the College explaining its features.[1,2]

Beneath the dial is a table, (Fig. 2.), showing corrections to be made for each day of the lunar cycle to convert the lunar readings to solar time.

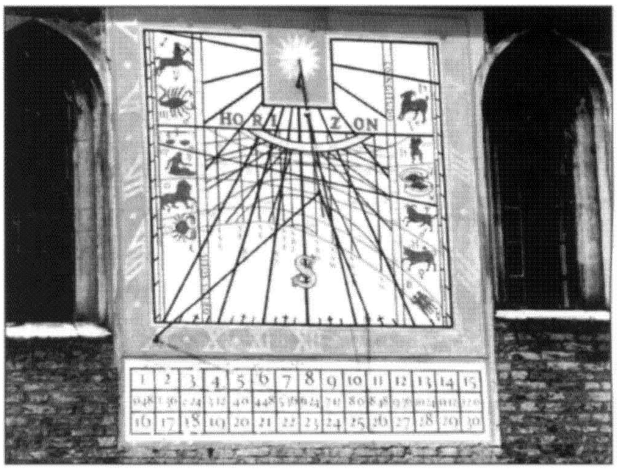


Fig. 1. Queens' College Dial, Cambridge.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0·48	1·36	2·24	3·12	4·0	4·48	5·36	6·24	7·12	8·0	8·48	9·36	10·24	11·12	12·0
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Fig. 2. Lunar Conversion Table from Queens' Dial.

This table is very basic and relies on the fact that the moon rises 48 minutes later each day. These are the figures in the second row and they need to be added to the time indicated by the dial. Increments are to be added each day until the 15th day, (full moon), when the addition of 12.0 hours brings the time back in line with equinoctial time. This, of course, relies on the fact that our convention is to use 2 x 12 hours each day. The table then starts again at 16 days showing the same amounts to be added each day for the remainder of the month. Immediately errors can be seen by using this method. Firstly the period of one lunation is not 30 days but is 29 days, 12 hours, 44 minutes and 2.9 seconds[3], usually accepted as 29½ days. This could cause errors of up to ½ day, or 24 minutes where this table is used. The change of 48 minutes each day is also slightly in error, the real figure being 48.76 minutes. Other errors are caused where the exact lunar phase, (e.g., new moon), does not occur at midnight. In practice it can be at any time of the day, and the complete cycle only repeats itself every 19 years. Hence a further error of up to 24 minutes is possible.

In conclusion, this method of time reckoning by lunar observation should only be considered approximate, but it was certainly good enough 400+ years ago before mechanical clocks were generally available.

PORTABLE DIALS WITH LUNAR SCALES

Many portable dials were made with lunar scales similar to that employed by Queens' College dial. In practice, the correction figure was usually read from a volvelle containing 29½ divisions, thereby reducing one possible source of error. Due to the small size of most dials, and the fact that in nearly all cases they used a compass for alignment, this half-day adjustment did not necessarily add to their accuracy.

Two methods of depicting lunar time differences are illustrated.

Fig. 3. shows a volvelle on the base of an Ivory Diptych Dial by Paul Reinman of Nuremberg, dated 1598. The third scale from the outside is the lunar age, up to 29½ days, the fourth an hour scale (2 x 12 hours) and on the inner brass volvelle also a similar hour scale. In the illustration the inner volvelle pointer is set to day 10 of the lunar cycle. It shows immediately that if the dial recorded a reading of 12 (lunar hours) on the inner scale, then the actual time would be 8 hours (or 8p.m.). Similarly a reading of 4 (lunar hours) would be equivalent to midnight.

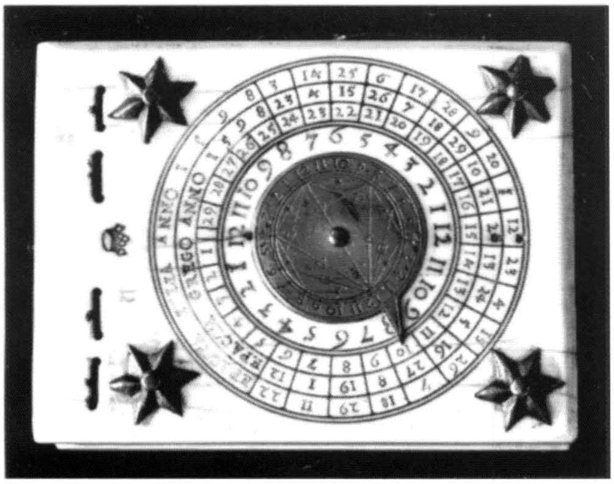


Fig. 3. Lunar Volvelle on Ivory Diptych Dial by Paul Reinman, 1598.

Fig. 4. shows a String Gnomon Dial by Johann Martin of Augsburg, c1700. This dial was specifically made for both sun and moon hours and is labelled *Horizontale Sol & Lunare*. When correctly set, the inner scale with arabic numerals gives the lunar time directly from the shadow of the string gnomon. This scale may be rotated and in this photograph is set to day 11 of the lunar cycle. On this day the moon will then be southing around 9p.m.

THE QUADRANT

Explanation has already been made of how a quadrant may be used for night time recording.[4]

THE NOCTURNAL[5]

This device was a major step forward in time recording from objects unrelated to our sun. Since early in man's

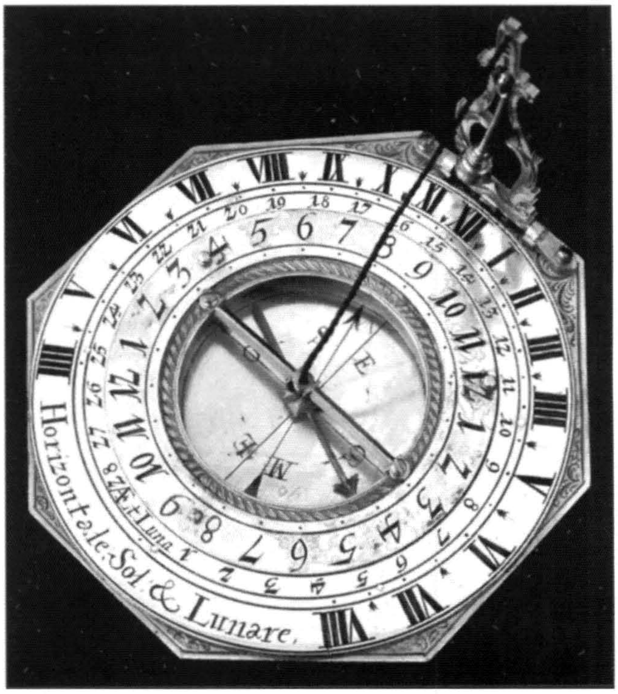


Fig. 4. Sun and Moon Dial by Johann Martin, Augsburg, c1700.

history he will have noticed the stars moving each night, changing their positions to complete a full 360° rotation over a one-year period. Basically the stars make an almost perfect clock, as they only rotate due to the earth spinning on its own axis and its orbit around the sun. The elipticity of the earth's orbit compared with the much vaster stellar distances is of no consequence, making corrections such as the Equation of Time unnecessary for these readings. The main problem is to find some point of reference against which to make an observation. It seems that we on planet Earth are lucky to have one star, Polaris, which is positioned very close to our celestial North Pole and is relatively easy to find. It is not exactly in line with the north polar axis, currently being displaced by about 0° 44′, and its position is changing slightly each year, but it has been conveniently close to true celestial north for several centuries. The nocturnal makes use of Polaris for its basic reference. It is then necessary to find another star, some distance away from Polaris, to give an indication of the Earth's nightly rotation. In practice two constellations are commonly used that have stars that are also easily found and recognised. The first is the Great Bear (Plough or Big Dipper) with its two pointers, Duhbe and Merak. The other is the Little Bear (Little Dipper) with its bright star, Kochab. As the sky apparently rotates above the Earth once in every solar year, some method is necessary to apply a date correction to any reading taken. The Nocturnal solves all of these problems.

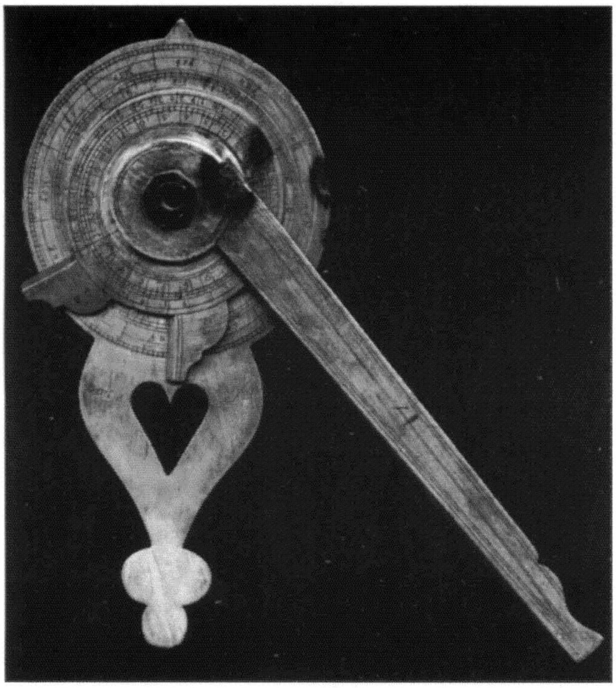


Fig. 5. An English Boxwood Nocturnal, late 17 Century, made for 'BOTH BEARS'.

The Nocturnal, (Fig. 5.), consists of a circular plate connected to a handle. It is held vertically at arm's length, sighting Polaris through a hole in its centre. On this plate is mounted a rotating volvelle, with two projections, one labelled for each 'bear', 'GB' and 'LB'. Once the 'bear' has been chosen, the projection is set against a linear date scale around the periphery of the main plate. A long arm is concentrically fitted that may be swung such that it lines up with the chosen 'bear' star(s). This arm is positioned directly over a 2 x 12 hour time scale, (the innermost scale in this case), enabling a time reading to be immediately taken. Normally, to read the time shown, some form of light is necessary. On this Nocturnal the scorch marks on its surface suggest that someone was rather careless with his light! To overcome this necessity for illumination, on many of the brass nocturnals, teeth or notches were used to mark the hours. (Fig. 6.) These could be counted by touch away from the **XII** midnight tooth, which was usually made longer than the others. If more accurate readings were required, then a portable light was still necessary.

Note that the Nocturnal in Fig. 6. is not dedicated to any particular stars and it may be used with any convenient star. The date volvelle is first set to the Right Ascension for the star required. This is the pointer at the left edge. In the illustration the date has been set to early November, (top left pointer), and the time may be read, (approximately 6:45 p.m.), from where the long arm crosses the teeth, (top right). Note that the hour scale runs anti-clockwise because the observer has his back to the ecliptic when viewing the Pole Star with a Nocturnal.

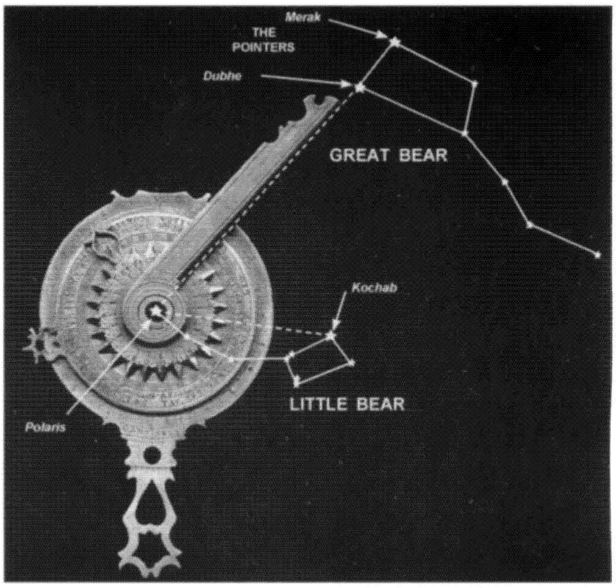


Fig. 6. An early brass Nocturnal with stars superimposed to show operation.

The main sources of error from a Nocturnal are either due to the user not holding it quite vertically or from any error due to the position of Polaris. (It seems that Nocturnals were never fitted with a plumb line or spirit level, but then it would be virtually impossible to see such a device in the dark anyway.)

THE ASTROLABE

This is another potentially accurate means of telling the time, both during the day and the night. It is not proposed to explain all the functions of an Astrolabe and the reader is directed to the many scholarly works on the subject. See the Astrolabe Bibliography below. In this short article the use of just the basic horary functions are described.

Initially I will explain how to use the Astrolabe to tell the time during the daylight hours. Select the appropriate latitude *plate*. For London at 51° 32' a *plate* for 51° is probably the nearest available unless a specific *plate* was provided.

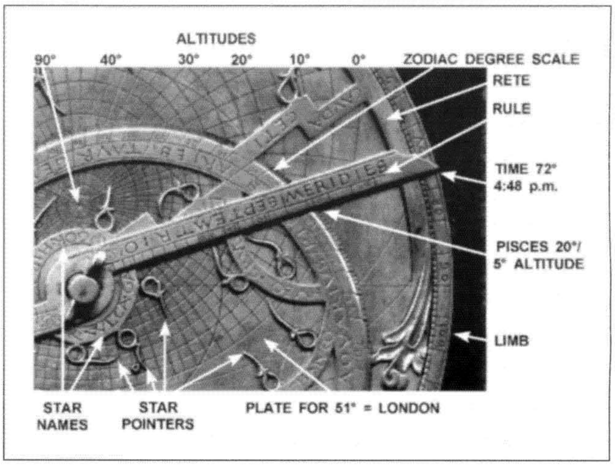


Fig. 7. Telling the Time using an Astrolabe.

Refer to calendar scales on the reverse and translate the current date into zodiac degrees. Remember that most Astrolabes were made during the period of the Julian Calendar and now need to have 10 or 11 days added to that date. If unsure, check the First Point of Aries, which is now fixed as March 21.

Using the alidade on the reverse of the instrument, measure the sun's altitude. Do not sight the sun directly but hold the instrument so that the sun passes through the upper pinnule with its spot of light centred on the lower one.

The figures obtained by observation must now be transferred to the face of the Astrolabe. Refer to Fig. 7. for how to read the time from a set of readings. For demonstration purposes the sun's altitude is 5° on a zodiac date of Pisces 20°.

Find the *altitude lines* on the *plate*. If they are not marked, count the rings between the horizon (*0°*) and the pole (*90°*) and divide into 90°. On this Astrolabe the interval between lines is 5°°.

Rotate the *rete* such that Pisces 20° lies immediately above the 5° *altitude* line on the *zodiac degree scale*. (Note that this condition can be satisfied in the morning or afternoon so knowledge of the approximate time of day is necessary. If there is any doubt, take two readings separated by some minutes to find if the sun is rising or sinking.)

Set the *rule* to cross the intersecting point and read the time from the *limb*. On some Astrolabes, such as this one, an hour scale is not engraved on the *limb*. It is then necessary to measure the number of degrees to or from south and convert them to hours. (15° = 1 hour). In this case the reading is 72° after noon giving a time of 4:48 p.m.

To tell the time at night a similar process is used. Firstly pick a star that is marked on the *rete*. Find its position in the sky and measure its altitude by sighting through the alidade pinnules on the reverse. This time a direct sighting through both pinnules will be necessary. Convert the date to zodiac degrees as before. Position the *star pointer* exactly over the appropriate *altitude line* and set the *rule* to cross the *zodiac degree scale* at the point of intersection. Read the time from the *limb* as before.

It all seems rather complicated, but finding the time is only one of many functions possible on an Astrolabe. Once familiar with using an Astrolabe, finding the time becomes quite a simple and quick process. Other calculations using an Astrolabe are beyond the scope of this article.

A very useful cardboard Astrolabe is available from the National Maritime Museum[6] complete with a well-illustrated booklet describing most of the Astrolabe's functions. For convenience it has had its scales converted to the Gregorian Calendar.

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1 G. C. Shephard: *Queens' College Dial.* Queens' College, Cambridge, 1972.
2 M. M. Scarr: *The Dial in Old Court, Queens' College, Cambridge*, Queens' College, Cambridge, 1988.
3 H. Marsden (ed): *Whittaker's Concise Almanack.* Whittaker, London, 1995.
4 M. Cowham: 'Telling the Time with a Quadrant' *Bull.* BSS. 14(i), ???-??? (2002)
5 C. Stott: *Make-it-yourself Nocturnal.* National Maritime Museum, London, 1985.
6 D. W. Waters: *The Planispheric Astrolabe*, National Maritime Museum, London, 1985.

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The following are some publications that will be useful to the beginner trying to understand how to use a planispheric astrolabe.

D. W. Waters: *The Planispheric Astrolabe*, National Maritime Museum, London, 1985.

R. H. van Gent: *De Hemel in de hand / The Portable Universe*, Museum Boerhaave, Leiden, 1994.

H. N. Saunders: *All the Astrolabes*, Senecio, Oxford, 1984.
Janus: The Electric Astrolabe, <astrolabe@i84.net>, New Fairfield, CT, USA, 1997.

This is a fully-functioning astrolabe program that may be downloaded from the Internet complete with its own very useful 109 page manual.

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A NOTE ON THE CONSERVATION OF THE ANGLO-SAXON DIAL AT DALTON-LE-DALE, COUNTY DURHAM

FRANK EVANS

The pre-Conquest dial figured by Cramp[1] and subsequently discussed in more detail by Evans and Evans[2] has been conserved. Having been made aware of the value of this remarkable and ancient artefact, members of the parish recently resolved to award it skilled protection. The project was carried out as a work of dedication to a deceased member of the community.

The dial is set above the south porch of the parish church in a wall of the thirteenth century. It in many ways parallels the famous dial at Escomb which dates from the eighth century, in particular in the relief sculpture, the presence of decorative carvings, most likely of fanciful animals, and in the barley twist edging to the time semicircle carved on the oblong dial plate. Both dials must date from about the same time.

The responsibility for the work was undertaken by the parochial church council under the direction of Rev. Alan Milne, vicar of the parish

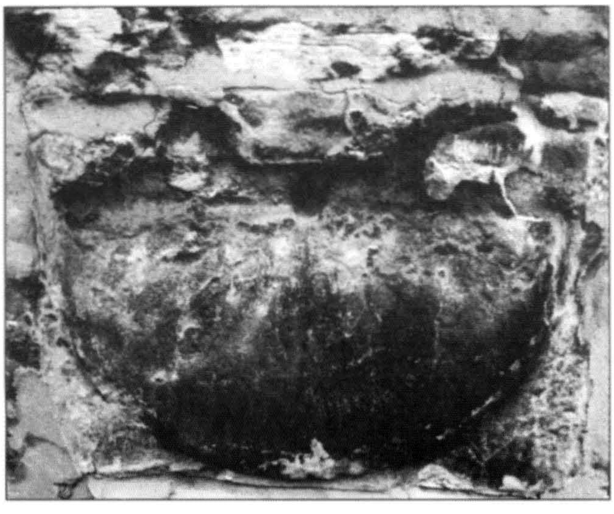
The work itself was carried out by Mr. Seamus Hanna of Hanna Conservation, Kirk Hammerton, York on 1 and 2 September 2001 and much of the succeeding account is derived from his report. Following the erection of scaffolding he first cleaned the dial of its black carbon deposits using a Jetson micro-airbrasive unit with a 0.6mm diameter nozzle at 60 p.s.i. air pressure and aluminium oxide powder of 29 microns as the cleaning medium

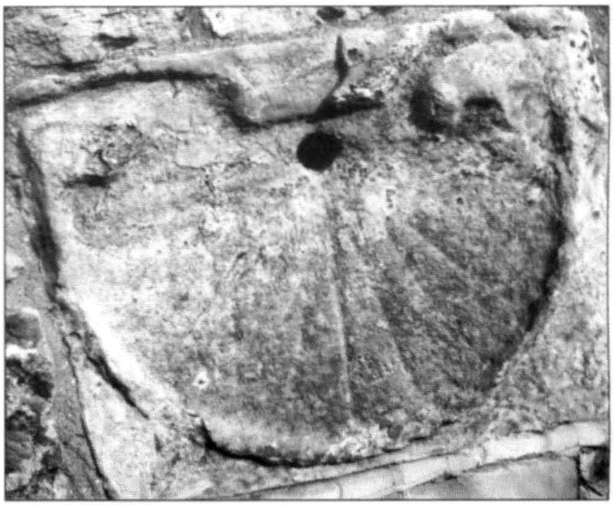
Preservation being the aim the prevention of water and frost damage around and within the stone of the dial was next addressed. Cracks and laminations were bridged and larger voids filled with mortars based upon 1 part masonry cement: 7 parts selected dry sands together with sandstone dust, and modelled to shape with spatulas to follow the existing contours of the surrounding stone. During filling the stone was lightly wetted with de-ionised water applied by sable brush or hand-atomised mist spray and the fillings kept moist by similar wetting.

Cracked and defective pointings from the top and both side joints surrounding the dial plate were carefully removed using a small hammer and chisels. The cement mortar was not removed from the bottom joint-line as this secures the lead flashing above the porch roof.

The joint lines were pre-wetted with water from a hand-atomised mist spray and a mortar composed of 1 part masonry cement: 6parts dry sharp sand sieved to below 2.36 mm particle size was inserted with a spatula to remain slightly recessed below the outer edges of the dial.

This completed the work. It may be noted that Mr. Hanna had previously conserved the dial at Escomb but that in neither that case nor this did he use any consolidant or water repellent on the dial, regarding the use of these substances as a final option rather than as a routine treatment.





The Dalton-le-Dale dial before and after conservation. Photographs courtesy of Mr. G. Gustard and Mrs. Edna A. Robinson.

The result of the cleaning has now revealed that the Dalton dial is not, as was earlier stated, divided into tides but into seasonal hours. In this way it differs from the Escomb dial.

More recently Mrs. Edna Robinson of the Dalton parish has made drawings enhancing the eroded figures of animals at the upper corners of the dial to give an impression of how they may have looked in earlier times. A dedicatory plaque has been prepared for installation in the church giving an account of the dial's provenance.

It has been suggested that a short canopy, perhaps in the form of a few tiles, might be constructed above the dial to protect it from the worst of attack by acid rain but this has yet to be agreed.

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1. R. J. Cramp: *Corpus of Anglo-Saxon Stone Sculpture. Vol.1, Part 1. County Durham and Northumberland* OUP, Oxford, 1984.

2. F. and R. Evans: 'Some early sundials of Northumbria'. *Bull. BSS* 11.2 (1999)100-103.

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JOHN HARRISON'S UNUSUAL AND UNIQUE MAGNETIC COMPASS

MAURICE J. KENN

This article, concerning John Harrison's virtually unknown and unique magnetic compass, stemmed from a chance remark made to a visitor at the British Sundial Society Meeting, in York, in 2001. The visitor was O. Howard Boyde to whom acknowledgement is given later.

John Harrison, the carpenter, lived from 1693 to 1776 and is renowned for the time-keeping accuracy of the numerous clocks he made during his life-span, three of which were made, in wood, by 1717.

In 1718, at the age of 25 years, John Harrison made for himself an unusual, and unique, magnetic compass. This compass, shown in Plate I, comprises a wooden frame, believed to be in pear wood, carrying a $3^3/_4$-inch long magnetic needle, centrally pivoted over a $3^3/_4$ inch diameter paper dial, which is carefully inscribed, in ink, by hand. On top is a very thin glass cover. Sixteen cardinal points are shown on the dial, together with individual degree markings from 0° to 360°.

The magnetic needle has a measured period of oscillation of 8 seconds, and, unusually, points to the South. However this innovation appears to be deliberate because unusually also the East and West cardinal points are transposed.

If this compass is carefully oriented with the North cardinal point facing South, and with the needle also pointing South, the East and West cardinal points are then correctly oriented. In addition, if an observer faces South and views an image of the compass in a mirror held at 45° to the horizontal, the observer can, or example, view simultaneously a Southern star-lit night sky and an image apparently of a conventional compass dial.

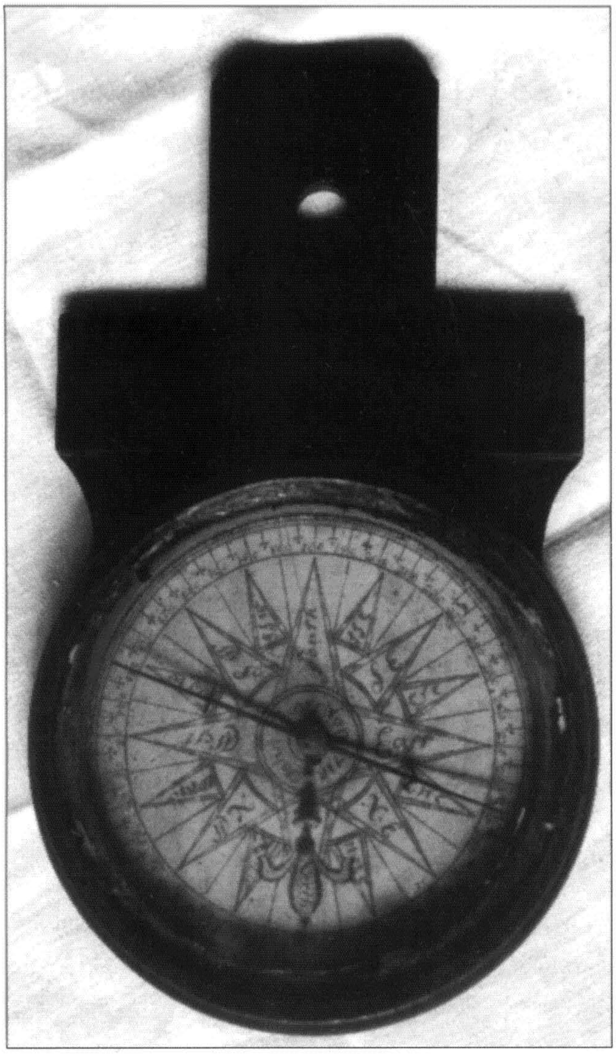
Alternatively, if necessary, the observer can, with his mirror, likewise simultaneously view the Northern night sky and an image apparently of a conventional compass.

The dial of this unusual compass is dated 1718 and is signed by John Harrison. This signature and the dial lettering have been authenticated by Andrew King who has made comparisons with other signatures on John Harrison's contemporary clock faces. I am greatly indebted to Andrew King who normally undertakes commissioned reproductions of John Harrison clocks in authentic replicated materials.

Equally, I am indebted to O. Howard Boyde for my introduction to Andrew King.

O. Howard Boyde normally carves Figureheads, in wood, for modern sail-training ships; but he has also recently undertaken a commissioned life-size carving of John Harrison, in limewood,

John Harrison's compass was seen originally, by me, in Somerset, in 1957 and hence, 25 years or so later, was graciously presented to its present proud and indebted owner.



John Harrison's unusual and unique magnetic compass

It is just possible that the compass found its way to Somerset by the same route as a 19th century gold watch now held, since 1978, by the Hull Museums. In July 1968, Arthur G. Credland of the Town Docks Museum stated, in his "Jottings on the Harrison Family of Clock-makers at Hull" (July 1988), that John Harrison's great grandson, a bachelor and Civil Engineer, bequeathed a 19th Century gold watch, together with his house and effects, to his housekeeper Miss Emma Thornton. She, in turn, passed the watch to Miss Hilda Thornton, her niece, of Bridgewater, Somerset, who in turn gave it in 1978 to the Museum.

Other correspondence records that, in August 1941, the previous owner of John Harrison's compass had invited the National Maritime Museum to inspect his instrument. However, because of the war-time situation, the invitation was not accepted until later, in November 1946,
John Harrison, of course, had a keen interest in the Southern night sky because calibration of his time pieces was achieved by observing on successive nights and from a fixed position the passage of particular stars past the silhouetted edge of a distant chimney stack.

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A CURIOUS SUNDIAL AND A QUESTION OF ATTRIBUTION

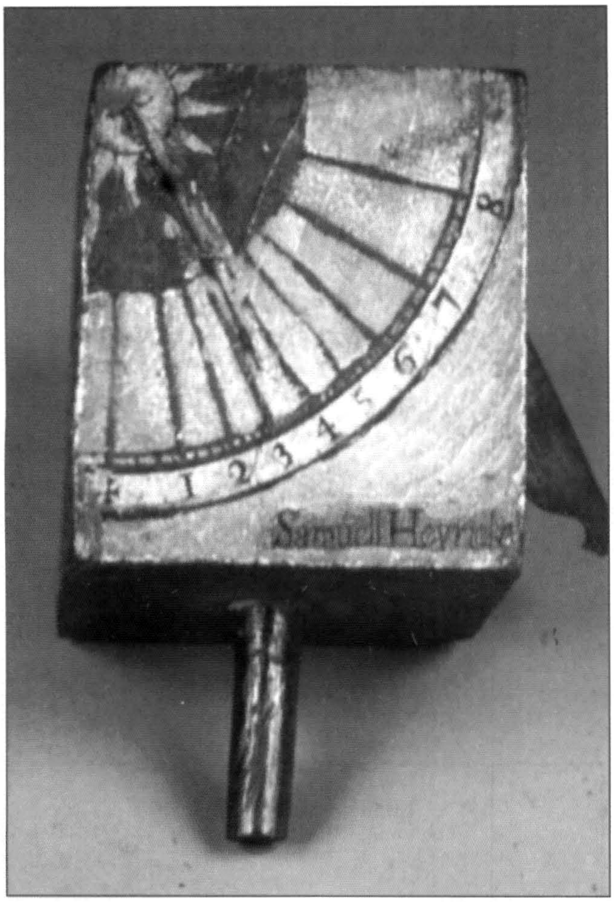
WALTER WELLS

"Gather ye rosebuds while ye may" wrote the 17th century poet Robert Herrick, "Old time is still a-flying . • ." Not so widely known was his young cousin Samuel, who was a lifelong scholar and country parson. However Samuel Herrick may have been thinking along the same lines as the poet when he decided to make himself a device to measure the passing of the hours.

When he was a student at Trinity College, Cambridge, he may well have been taught by Isaac Newton who was the Professor of Mathematics. We know that he was certainly aware of the new discoveries in astronomy because in 1687, the year after he was awarded his degree, he constructed a scientific instrument which carries his signature and has survived in Leicester[1] to this day. He made a wooden block in the form of a cube which carries five separate sundials mounted on appropriate faces. Each one is furnished with hour-lines painted in red and radiating from a yellow sun, embellished with a human face.

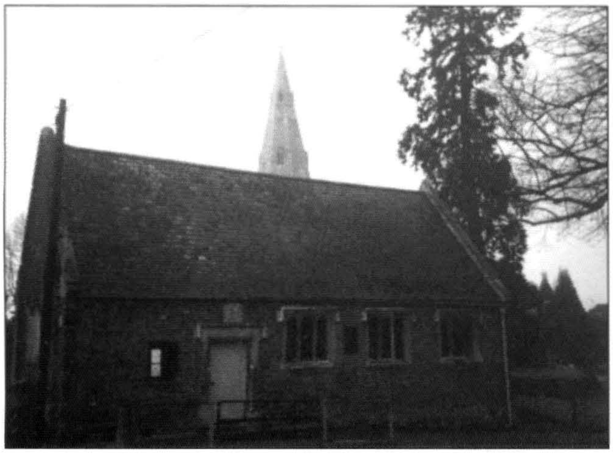
We need not be surprised that an educated man in the seventeenth century found an interest in such a task. King Charles I had provided multi-faced sundials for the privy gardens of three of his palaces. We know that books on the construction of sundials were much sought after and the first Astronomer Royal had just published a printed table that could be used at any time of the year to convert the apparent time shown by sundials to the mechanically regular time given by an accurate clock.

Even so we may still wonder at his achievement. To make a sundial today is not difficult. We begin by checking a few



Samuel Herrick's Dial, SW face, with signature

facts about the place where it will stand and we can use a local map which will give us both the latitude and longitude of the site. Next we must observe the direction of the Sun at mid-day and we can find out from an almanack how far it will have progressed on its yearly cycle to the north or south of the Equator and also the actual difference between sun time and clock time. A few minutes in the public library will be enough to give us all the information we need and we can even set our watches by broadcast time-signals.



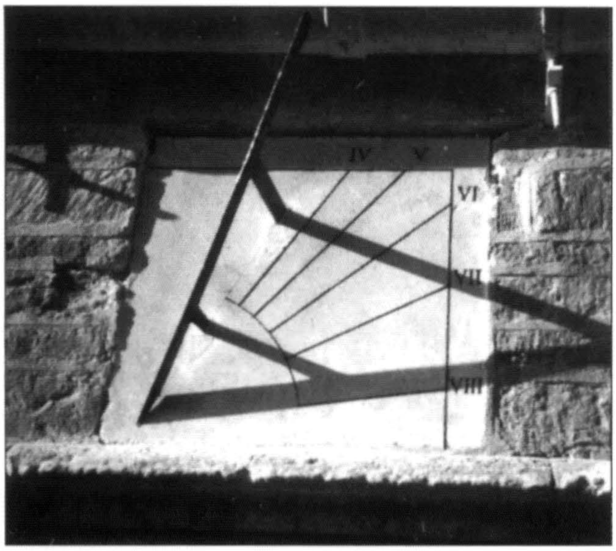
The Old School, Billesdon, Leicester

But things were very different in 1687. The maker of a sundial for a country village three hundred years ago would have had to measure everything for himself. He might well have to start by making himself a sextant to obtain the facts he needed to set out his dial. A surprising number of enthusiasts at that time were doing just that.

NE Sundial at Billesdon before restoration

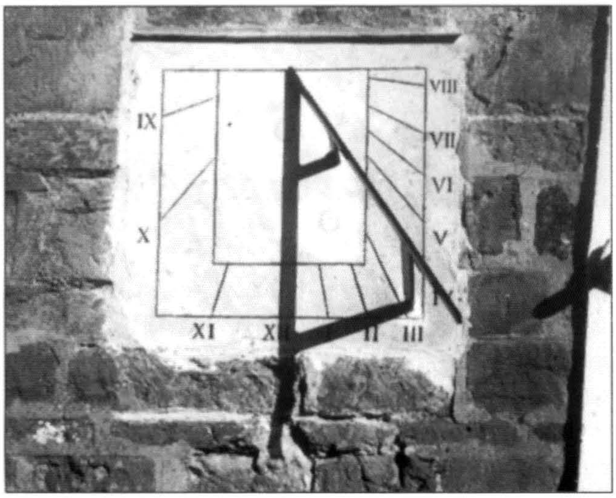
NE sundial being restored

One rather unusual feature of Samuel Herrick's sundial is the orientation of the four vertical faces, which we can tell from the different patterns of the hour-lines. We might have expected that one dial would face due South in the direction of the Sun at mid-day and that the others would face to the North, East and West. In fact he chose to set the faces obliquely, pointing midway between those directions. This curious arrangement may have an interesting explanation.



Billesdon School sundial, NE face

Samuel Herrick's grandfather had been rector of Houghton-on-the-Hill and the young man will have been familiar with the nearby village of Billesdon. The Old School which stands by the church there was given to the village in 1650 and still serves the parish as an infant school. High on each of the four walls there is a sundial, recently restored with the aid of a grant of money from the district council. These dials were carved in soft stone and the acid rains of three hundred years had eaten away most of the hour-lines. When the necessary measurements had been made to re-draw the lines it became obvious that the Billesdon sundials made a close match with the four vertical dials on the wooden block made by Samuel Herrick. It so happens that the site of the building faces North-East and consequently the four walls have the same orientation as the faces of his wooden cube.



Billesdon School sundial, SW face

The similarity is surely not a coincidence. Did this young man gain inspiration for his model from his familiarity with the Old School building? Or are we looking today at a wooden test-piece made by the designer of the Billesdon sundials[2], who signed it for posterity with his own name: 'Samuell Heyricke fecit 1687'?

NOTES

1. Newarks Houses Museum, Leicester
2. Suggested by Allan Mills, 1998

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A GARDEN ORNAMENT

This curious object, called a 'sundial', was depicted in a catalogue called 'Ancestral collections' sent to us by BSS member Tony Wood. Readers are invited to give 5 reasons why it could not possibly tell the time, in any latitude.

AZIMUTH MEAN TIME DIAL

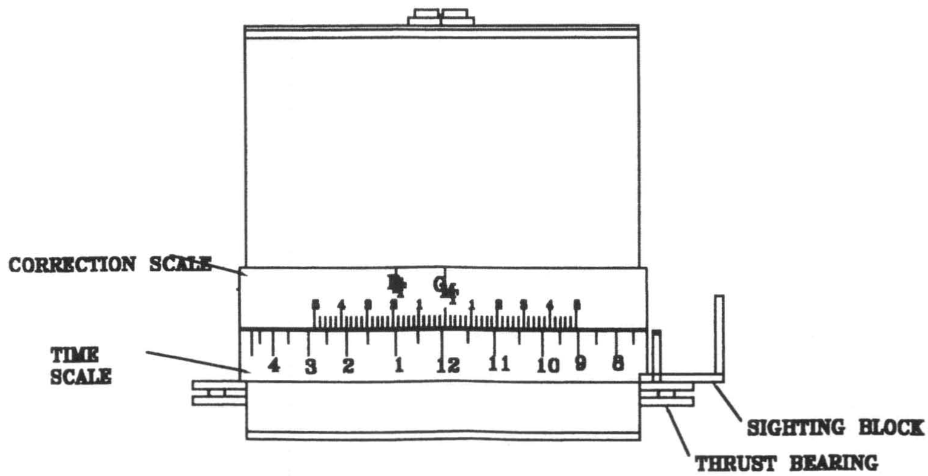
SILAS HIGGON

Ideally the dial should be at least 0.6m diameter x 0.75m high and made from stainless steel. There are two types: a 2-band and a 4-band.

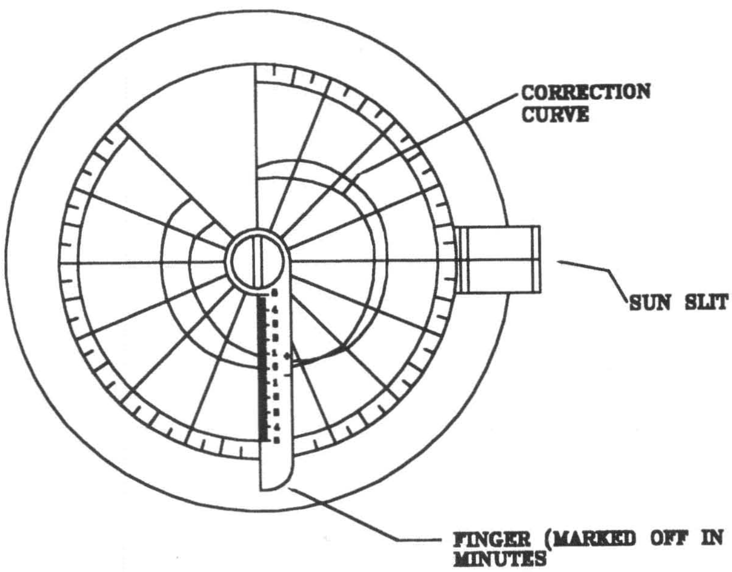
2 BAND

The dial consists of a circular drum around which a sun sight can be rotated. The reading is taken on a fixed scale attached to the drum. Above this is a rotating collar which carries a correction scale.

At the top of the drum is a circular plate with a set of correction curves for the months of the year and for times of day between 6am and 9pm. There is also a rotating finger which can be set to any time between 6am & 9pm and the required correction for the time of year is read from a scale on its surface.



Dial using two bands



Dial using two bands

USING THE DIAL

There are three operations to perform

1) Taking the azimuth reading (as a function of time)
2) Finding the correction.
3) Applying the correction.

1) The sighting block is rotated so that a slit of light is showing on the time scale

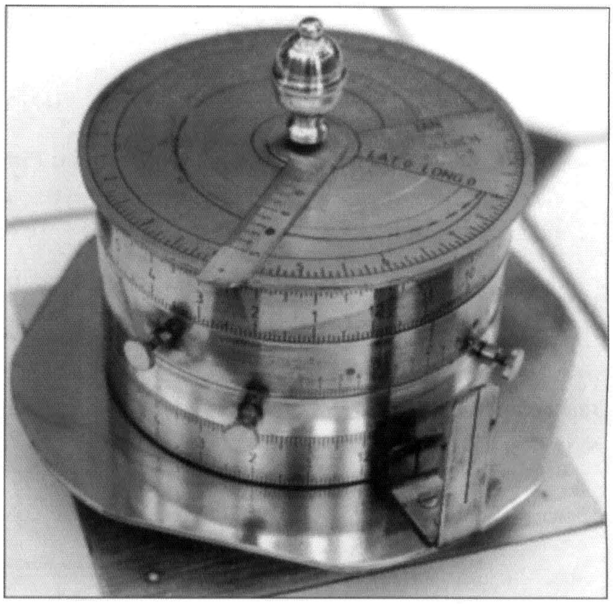
2) This reading is transferred to the disc on top of the dial by setting the rotating finger to the time shown. The amount of correction is measured along the finger scale.

3) This correction is applied by rotating the correction scale until the correction indicated is opposite the slit of light. Mean Time can now be read from the time scale opposite the GMT mark. There is also an index line for reading Summer Time.

The correction curves are colour coded to identify the month. The finger scale and correction scale are also colour coded; red positive and blue negative.

4 BAND

It is possible that whilst finding the correction the sun sight could be accidentally moved and the process would have to be repeated. To overcome this a further two bands are used, one to set the position of the sun reading and another to take the azimuth reading.



Photograph of a 4-Band design

Immediately above the azimuth band is a rotating band with a cursor line that can be set to the azimuth reading and locked.

Above this is a rotating collar with the correction scale which is now used in conjunction with the cursor line.

The topmost band is a fixed dial scale from which the mean time is read.

Lane's End, Strefford
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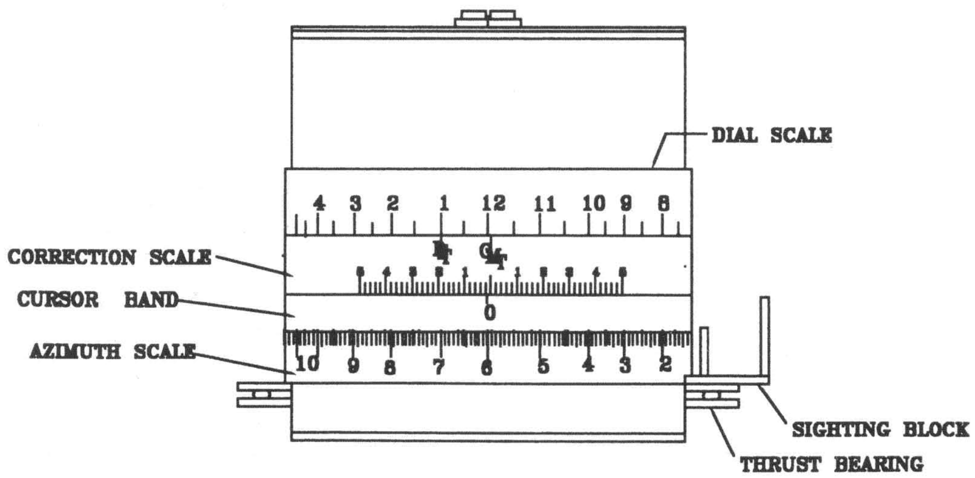

Dial using four bands

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