The British Sundial Society

BULLETIN

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Cover Illustration - Young man consulting a pocket sundial. Engraving circa 1530 by URS GRAF, of the Swiss School

IN MEMORIAM
DR. MARINUS JOHANNES HAGEN
26th January 1915 - 21st January 1996

Tot onze grote droefheid is in vrede van ons heengegaan mijn lieve man, onze dierbare vader, schoonvader en grootvader

Marinus Johannes Hagen
huisarts

Nieuwe Pekela, 26 januari 1915 — Rijswijk, 21 januari 1996

Wij gedenken zijn levensblijheid en bewondering in God's hele Schepping.

Rijswijk:	C. Hagen - van den Bout
Capelle a/d IJssel:	M. D. Hooykaas - Hagen P. G. Hooykaas
Linschoten:	T. J. Hagen H. A. Hagen - Minderhoud Mariët, Annemiek, Nynke
Goes:	P. J. Max - Hagen N. J. P. Max Floortje, Thijs
Zoetermeer:	C. M. van Vark - Hagen A. van Vark Taco, Judith, Loek

Dr H. Colijnlaan 4, flat 33
2283 XM Rijswijk

De crematieplechtigheid zal plaatsvinden in het crematorium Eikelenburg aan de Eikelenburglaan 7 te Rijswijk, vrijdag 26 januari om 16.00 uur.

Na de plechtigheid is er gelegenheid tot condoleren in de ontvangkamer van het crematorium.

To those who knew him, the death of Marinus Hagen came as a considerable shock. He was not only one of the most distinguished world authorities on sundials, but one of those remarkable people who have a magnetic personality, who inspire respect and gain affection from those with whom they come into contact.

Members of the British Sundial Society will remember him as a Vice-President of the organisation and as the eminent chairman of the Dutch sundial society. The will remember him with much warmth, as a friendly, unassuming man with an eagle-eye for detail and accurate work. This is not surprising, for by profession, Marinus was a medical practitioner, or rather a family doctor. He was a caring and considerate man, whose passing is a great loss to us all.

I first came to know Marinus Hagen through correspondence about the origins of the figure of the equation of time, delineated as a figure-of-eight. I think that this initial exchange must have taken place about ten or twelve years ago, about 1984, when I became a member of the sundial society of the Netherlands, *De Zonnewijzerkring*. Since then, we corresponded on several occasions (when I have known him to take me to task over a difference of opinion), and exchanged sundial literature. He was a man of great gnomonical stature, designing, calculating and delineating sundials and writing about the subject in great depth. He revised the work on *Sundials in the Netherlands* by Dr. J. G. van Cittert-Eymers, which was published in 1984. Before this time he had discussed with her the possibility of forming a sundial society in the Netherlands, which was duly formed in 1978.

As with the British Sundial Society, the Dutch sundial society was founded with only four members and, in the beginning, Marinus was chairman, secretary, treasurer and editor of the Bulletin. He saw the Bulletin as being the most vital ingredient of such an organisation, which it is, and he quickly established a most reputable and authoritative publication. Through this medium, the Dutch sundial society set an example which no doubt encouraged the formation of our own society. Whilst he considered it to be an honour to be invited to be one of our Vice-Presidents, for the British Sundial Society it was an honour for us that Marinus Hagen accepted. Not only did he accept, however, but he attended many of our meetings, by which we came to know him well. Who would have thought to see him gleefully step into a light-aircraft, on a windy afternoon, for a flight with Mike Cowham? In his late seventies, during a break at the Cambridge Conference, he was taken for an aerobatical spin and thoroughly enjoyed it!

In the Netherlands he was honoured with the "Simon Stevin" prize of the Dutch Astronomical Society.

We shall remember and miss Marinus Hagen, not merely in the loss of an international sundial expert, but as a friend of whom, I know, we all had a very great personal regard.

CHRISTOPHER DANIEL
Chairman, British Sundial Society

DIALOGUE

DE ZONNEWIJZERKRING

Bulletin 95.3 - the summer excursion was to Ootmarsum in Twente. One member brought a special calculator and was able to demonstrate it as the bus passed along meridian 7°E. The party was received by the Burgomaster and the town contains many dials.

Professor Kiyoshi Takada of Japan is studying Chinese sundials and wishes to exchange information with those interested. His address is 2 John Street, Cambridge, CB1 1DT. Tel: 01223 324140.

A discussion follows on the Lambert circles crossing the ellipse of an analemmic sundial. There is a description of a dial at Snellegem near Brugge. This has a number of subsidiary dials for showing the time at various places. The gnomon is not pointed directly at the pole star and the explanation for this is given. A comparison of this dial is made with the one at Heverlee which has three scales, including one for Jewish hours.

A description is given of a Venetian ship dial sold at Sotherbys February 1993 followed by a dial in Prague with four dials arranged at angles to each other. There follows a discussion on the dates when the seasons begin.

Behind the old merchants' houses in Amsterdam are some beautiful gardens and a member set out to search for sundials in them. Then follows a discussion on when the 21st century begins, 2000 or 2001. Editor: 2001.

The list of fixed dials in the Netherlands continues and is followed by a review of literature occupying ten pages.

Bulletin 96.1 - contains a number of interesting articles. At the meeting in September 1995 it was reported that the next year's excursion will be in Belgium organised by the new Belgian Sundial Society. About a dozen members gave a short report on their activities in connection with sundials, drawing attention to the importance of co-operation in research.

René J.Rohr recently celebrated his 90th birthday and was surprised to receive more than 90 letters from enthusiasts in the Netherlands.

The sundial which was formerly on the Town Hall at Middelburg has now been replaced after 85 years.

The Belgian Sundial Society has its HQ in Rupelmonde SW of Antwerp. On 27 September 1995 the official "Sundial Path" was opened by the Burgomaster. A walk of about 3km leads past about 20 sundials and through the village.

A member gives some advice on constructing a mural sundial and recommends a waterproof plywood with an aluminium gnomon. The indications on the dial are made from "Snijfolie" which is used for advertising on commercial vehicles etc. It is guaranteed 8 years and is only as thick as a coat of paint. (Is there any English equivalent of this?)

An article describes a dial on a building looking over a field in Leiden where cloth was formerly hung by fullers. The dial was officially unveiled after being covered with a piece of Leiden made cloth.

There is an interesting article on pillar dials. The earliest mention of them was in 1040 and two mediæval MS have been discovered describing how such dials are made. A Saxon dial on the church at Great Edstone, Yorks, is mentioned with the words "orologium viatorum" on it, the same term as used in the MS for a pillar dial. The Latin texts from the MS are reproduced from Robert T. Gunther's "Astrolabes of the World" and then the author describes his methods of constructing a dial.

A description is given of the making of a sundial for a wall declining to the west, followed by a description of a "Greek" sundial at De Bolderberg in Belgium and a "Natural" sundial in Switzerland near Glarus. The author then describes the calculation for his west declining dial.

The next article deals with finding latitude and correcting horizontal and south facing dials with comments on choosing a site for a dial. There is a table showing the height of the sun at 52°N for various times of the year.

The list of sundials in the Netherlands is continued together with a review of current literature.

E.J. TYLER

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ASTRONOMIA

In the March-April issue of the Unione Astrolfili Italiani Astronomia, page 2-8, is an article "Il mondo sulla punta di uno stilo" by Nicola Severino. The author presents the gnomonic concepts of the Jesuit priest Athanius Kircher through the study of four sciateric tables found by Dr. Guiseppe Monarco, now in the Astronomical and Copernican Observatory in Rome. Kircher's work operated in cultural synthesis between the related fields of astrology, astronomy, geometry and gnomonics.

This article is illustrated by 13 plates, of which Figure 1 draws these together and is taken from part of the voluminous work by Kircher - *Ars Magna Lucis et Umbrae*, published in Rome in 1646 (The Art of Light and Shadow). It is in ten books, of which books III, IV, VI and VIII deal exclusively with dialling. The later edition of 1671, Amsterdam, is a massive tome of xxix plus 810 pages and covers the whole field of horology as it existed at the time.

The text of the article is in Italian, Kircher's work is in Latin.

The author of the article has also published three books:

Storia dell Gnomonica (The History of Gnomonics), 1994.

Bibliografia della Gnomonica (Bibliography of Gnomonics), 1994.

Il Libra degli Astrolabi (The Book of the Astrolabe), 1994.

If the Editor's translation is correct, these are available at 50,000 lira per book - about £20, from the author at:
Via Lazio 1, 03030 Roccasecca Scalo FR, ITALY.

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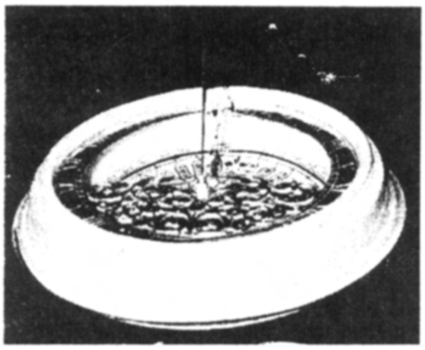
ELIAS ALLEN

In the *Antique Trade Gazette* for 29th July 1995, under the heading "Auction Reports" by David Moss was a short note about a pocket sundial made by Elias Allen under the title of "Pocketful of unexpected sunshine brightens Cornish day".

It was sold by the well-known auctioneers Jefferys at Lostwithiel on 28 June 1995, and on a hot summer's day it was appropriate that a sundial brought a big ray of sunshine into the business of Cornish auctioneers Jefferys at their general sale of some 880 lots - the kind that has been proving quite difficult to dispose of in the present economic climate. The sale netted some £27,000, not a memorable total but a fair proportion of that was provided by the pocket sundial shown here. It is just 2¹/₄in (7cm) in diameter.



The sundial has a silver hour ring and hinged gnomon, in a turned ivory case. It was entered in the sale by a Penzance family who had no idea of its true value, nor were the auctioneers too sure when the piece was catalogued, for they would have been happy with a winning bid of £1,000.

The importance of the sundial was, however, more readily known to the London trade, for Elias Allen was a most noted instrument maker who worked from 1607 to 1653. This was indeed a rare piece and two specialist dealers from London battled over its purchase until it went to one of them on a telephone bid of £3,900.

Other dealers who had missed the lot, maintained the price was bargain basement, and that the sundial would be sold later for a five-figure sum.

The Editor is much obliged to Mr. John Milburn for supplying him with the above information.

The Editor was also fortunate enough to discover a large Elias Allen horizontal dial in July 1995, if he obtains permission for publishing an article on it from the owner, details will be published on it in a forthcoming issue of BSS Bulletin. The dial was outside in a garden, it is now removed and stored safely in the house.

* * * * *

COMPENDIUM

The March 1995 issue is No. 1 of Volume 2 and has expanded to 28 pages. It commences with an in-depth study of the Pomfret dial at Pomfret School Connecticut, U.S.A. Diallists familiar with the Pelican dial at Corpus Christi College, Oxford, will be familiar also with this American progeny. The author is Lawrence E. Jones. "Sundial Sources" by Fred Sawyer is a trifle ambiguous but it is meant to indicate actual provider of sundials and is a good assembly of good producers of dials. Fred Sawyer also contributes "Pedigree for an Alidade Dial" in respect of an article in *Sky and Telescope* for December 1994 (pages 88-90), entitled "A Precision Sundial of Bronze by Charles Avila. Avila could find no reference to a dial like his but in fact it is based on the same principle as the Pilkington-Gibbs heliochronometer.

Next is an article "A Timely Return", reprinted from the University of Cincinati Alumnus Magazine of October 1970, describing a sun clock based on an illustration which appeared in *Scientific American*. Basically it is an equatorial ring 16 inches in diameter and is rotated on a polar axis until the image of the sun is centred on an analemma (a lens is used to form the image). The dial was a gift of the Class of 1955 and designed by two chemical engineering students - Ron Rosenweig and Hans Mueller. The dial has had a chequered life ever since.

"Sundials 1901: An Excerpt" is based upon Chapter 17 of Alice Morse Earle's publication *Old Time Gardens - A Book of the Sweet 'O The Year*. It was the response to this from readers that led Mrs. Earle to write her better known work - *Sundials And Roses of Yesterday*. Following is a short contribution "From the Tove's Nest" by Fred Sawyer about sundial connections.

A transparent sundial based upon the concept of our member Taudin Chadot is described in "Ave Arnici". Another article by Fred Sawyer is next - "Extreme Hours of Sunlight". Mathematical formulae are given for calculating the extremes. The BSS Chairman's publication *Sundials* is given a short and fulsome approbation and NASS has obtained a supply for its members. What better commendation could one ask for?

The computer program designed by our member F.J. de Vries is described and is (as with the BSS) offered for sale to NASS members. "Explaining The Equation of Time" is a very clear exposition of the concept by William S. Madox for those who think verbally and also those who are visiospatial. How to tell the time from the Big Dipper is outlined by Steven Woodbury (The Plough or Ursa Major constellation or Big Bear, to the British). This is appropriately followed by an article on designing a Nocturnal, there being a pattern for the component parts given on page 27. Quiz No. 4 is included plus notes on a program for showing the shadow of a gnomon moving across a sundial in time with the computer's internal clock. (Would have thought it more useful if it could be speeded up to watch the sequence in a few minutes.) Two other facets of computer programs are mentioned.

The letters feature includes information on where to get some of the rare early dialling works produced as part of the *English Experience* series.

Finally the Compendium ends on a note from Robert Terwilliger about the BSS Dues Project whereby NASS will pay all the dues to the BSS in one sum to cut down on the bank and conversion charges. The offer is only available once in the year, at the time when the BSS subscriptions fall due.

The Editor of the BSS Bulletin congratulates the NASS Editor on the ever increasing maturity of Compendium. It is, of course, available on a disk, for use by those with a suitable computer. This has the advantage of including programs in addition to the text and it is probably worth having both forms. Perhaps it will not be out of place to mention the meaning of "Compendium" on the title page - "Giving the sense and substance of the topic within a small compass"; which describes the Journal of the North American Sundial Society admirably.

The Editor has acquired a full set of the Compendium disks to date and these are extremely good and easy to use.

THE 1995 BSS CONFERENCE

CHARLES K. AKED

Eighty BSS members registered to attend the 1995 BSS Conference at Grantley Hall, near Ripon, Yorkshire.Three members came from Germany, two from the USA, two from the Channel Islands, two from Northern Ireland and two from Eire. Because of the numbers attending, some had to stay in nearby guest houses. Grantley Hall is set in 35 acres of magnificent grounds in the heart of the Yorkshire Dales, the main building being Georgian in origin and it was a private house until 1939. Since 1949 it has been used as an adult residential college which, together with the new building known as Ellis House, can accommodate 68 residents. It is a most comfortable place to stay, the food is excellent and the only criticism is that too much is provided.

In response to the comments made by members at previous BSS Conferences, the pace of the 1995 meeting was deliberately reduced to accommodate the older members. The BSS Council members all attended a day earlier than the Conference in order to have the time to spend discussing future BSS plans and to consolidate previous management decisions.

On Friday afternoon the writer took the opportunity to photograph the sundials in the grounds of Grantley Hall, see photos 1-4. That in photo 4 is actually by the roadside near the entrance to Grantley Hall and, according to the person living in the lodge, does not now belong to Grantley Hall. The dials in the Grantley Hall grounds were misaligned, that in photo 3 being completely reversed. Photo 2 was taken by holding the camera as high as possible above the photographer's head and hoping for the best. The dial is so high on its pedestal that an overhead shot is impossible without a tall stepladder. The figures, and scale engraved with hour, half-hour and five minute divisions are scarcely visible on the dial, in the photo these have been inked in to allow the original appearance to be judged. It is probably an early nineteenth century dial. The cube dial in Photo 3 is hopelessly incorrect in orientation, the north face being turned southward! The corners of the cube are cut off at 45° to give octagonal faces on the five visible faces. There are no hour lines cut in the face shown in the illustration. The dial is dated 1696 and was probably brought from another site, the gnomons being of iron and replacements. The supporting pillar is hexagonal and of quite a different stone to the cube.

The dial shown in Photo 4 is not signed or dated but seems to be the work of John Smith, the subject of the article "The Albert Park, Middlesborough, Sundial" by Dr. John Wall, BSS Bulletin 94.2 pages 24-28. The Grantley Hall sundial is just a straightforward horizontal sundial, the dial was not photographed because the tenant in the lodge said that the owner's permission should be sought first, and in any case it was quite impossible without some aid to elevate the photographer to a suitable height.

The writer and Robert Sylvester drove to Kirkby Malzeard a few miles north-west of Ripon on the strength of hearing that there was a sundial on a house in the village. This was not located but three sundials were found on the village church. The earliest is the mass dial below the ridge of the entrance porch, that above is dated 1697 and is a direct south-facing dial with an iron gnomon, see Photo 5. The gnomon is of iron. Carved into a separate panel above the dial is:

"This dial was given by Mr. W. Buck, Minister here in Anno 1697, Floreat Ecclesia".

Below this again is a line of characters which the writer could not decipher.

Shortly after this date, Mr. Buck became vicar at Marton-cum-Grafton and put up another dial there with the date 1700, his initials and the same motto, the meaning of which is "May the Church Flourish". This second dial was removed to the Vestry chimney when the church was rebuilt in 1872 and the original iron gnomon replaced with a copper gnomon pierced with the initials of the then vicar, Reverend J. R. Lunn, plus the Sunday Letter and Golden Number for the year of the rebuilding. An older stone dial was inserted in the internal wall of the vestry, it was found in the original church.

There is another sundial on one of the buttresses of the church at Kirkby Malzeard, it seems to have been cast from a lead-based alloy, see Photo 6. The time indication was quite accurate.

Returning to Ripon, the only sundial found was on one of the buttresses of Ripon Cathedral, see Photo 7 for a view of about half of the cathedral. Photo 8 gives a view of the sundial itself which at first glance is a direct south-facing vertical dial. It is situated so high on the buttress that it is not easy to examine it without the use of binoculars. The gnomon is a few degrees displaced from the vertical, see photo, hence it declines slightly to the East. It is a very utilitarian sort of dial for such a great cathedral, but English cathedrals are not noted for splendid sundials.

Later in the afternoon of Friday 21st April there was a steady trickle of members turning up and registering for the Conference. After an excellent dinner, the Chairman Mr. Christopher St. J. H. Daniel opened the meeting and the first evening session. Four short talks were given:

1. A Local Diallist - John Wall
2. Tales of a Membership Secretary - Robert Sylvester
3. The Lost Continent - Roger Bowling
4. The Liberation Monument in Guernsey - David Le Conte

All were very interesting and much appreciated by the assembled gathering.

Anne Somerville chaired the morning session of the next day (Saturday). Peter Lamont gave an engrossing lecture on Open Book and Conical Dials, in which he showed many models he had made. Next Ian Wootton spoke on the BSS Dial register, elucidating the system now in use. Two dials were dealt with by R. A. Nichols, they were under the title of "Two Unusual Mass Dials in Dorset" but in the writer's opinion were not mass dials as generally understood. Dr. Allan Mills gave one of his sparkling lectures on the Dial of Ahaz and Refracting Dials in general, the latter being the result of medieval diallists to explain the phenomenon used to convince King Hezekiah that he would be spared from his apparently fatal illness.

Alas the afternoon's programme was completely ruined. Light rain at Grantley Hall turned to a torrential downpour by the time the coach reached Otley to allow members to look at the memorial sundial designed by our Chairman,

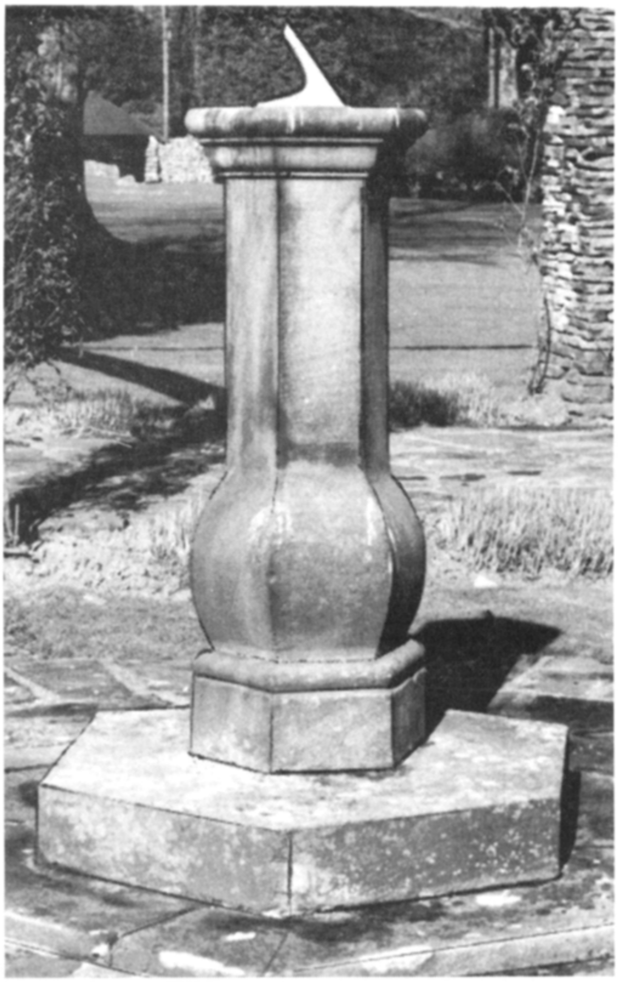


FIGURE 1: Horizontal sundial on tall hexagonal column in grounds of Grantley Hall.

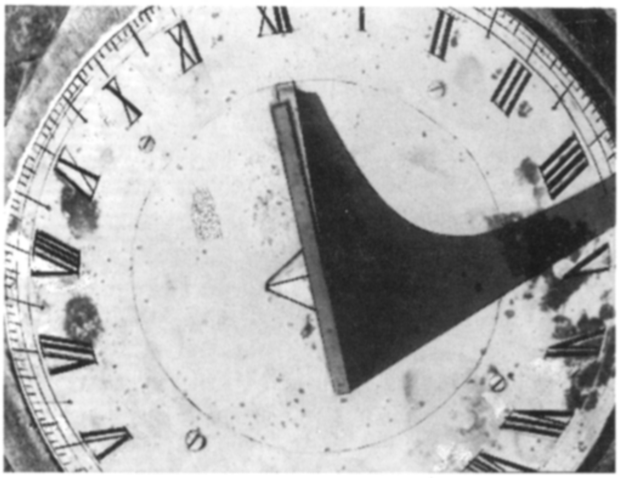


FIGURE 2: Horizontal dial at Grantley Hall, very heavy patinated a rich green with no details visible.

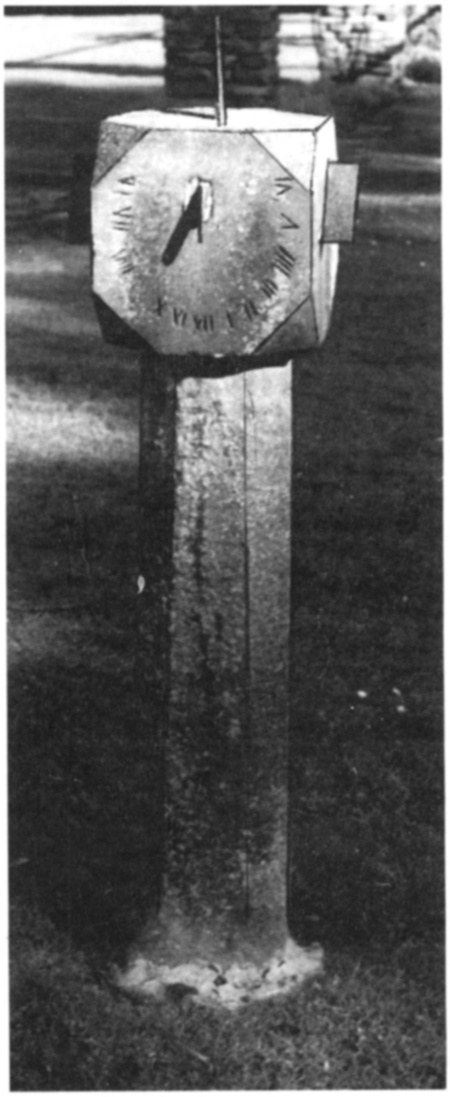


FIGURE 3: A cube sundial in the grounds of Grantley Hall dated 1696.

FIGURE 4: The horizontal dial at the entrance of Grantley Hall drive.

see Photo 9. Although the distance from coach to dial was quite short, those brave enough to face the storm became thoroughly wet in a few minutes.

The panel below the dial at Otley gives the name of the dial - "Double Mean Time Polar Sundial" together with instructions to the viewer on how to obtain clock time from the shadow cast on the east or west panels.

On the reverse of the monument are two panels, the upper one reading:

> 8th July 1993. This sundial was unveiled by MRS·CHRISTINE·M·MORTON& MR·J·HOWARD·CHIPPINDALE. The daughter and son of Sam Chippindale in the presence of COUNCILLOR·JAMES ·L·MONTE, Town Mayor of Otley & Trustees of the Sam Chippindale Foundation
>
> MESSRS·ALAN:·F·SEARGEANT AND ROGER·W·SUDDARDS

The lower small panel reads:

> IN MEMORY OF SAME HARTLEY CHIPPINDALE 1909-1990. Born in Otley, Property and Shopping Centre Developer. PIONEER GENIUS AND LEGEND.

Those members who then proceeded to Newby Hall at least were able to go round the house in reasonable comfort, whereas those who went to the alternative venue of Foundations Abbey were compelled to sit in the refreshment area because of the downpour. It is unlikely that many of the BSS members noticed the sundial at the site, placed on one of the buttresses of the tower. It is a direct south-facing example dated 1646. Over it stands the figure of a pilgrim with his staff in his right and a broad-rimmed hat under his left arm. Judging by the dress of the figure, it is of an earlier date than the dial and really has nothing at all to do with it. There is a 1610 vertical sundial with an iron gnomon over the main entrance of Fountains Hall but here the medieval figure is on the east side of the dial in an alcove.

Newby Hall, see photo 10, has a cube sundial on top of a stone column, the whole being topped by some ornamental ironwork and a wind vane. It is sited in the centre of a circular lawn before the main entrance to the Hall. Unfortunately it was not only raining hard, the lighting was atrocious when the photograph 11 was taken, it was not possible to approach closely enough to see it there were any details worth recording.

In the house there were notices "Do Not Touch" everywhere, so the writer could not resist doing so. When a lady dragon came near to remonstrate, I told her that I was a Russian and understanding not the English very well, thought it was a command to touch the articles. She became immediately solicitous for it is manifestly difficult for a Russian to behave properly in a civilised country like England, and commended me on my apparent command of the English language and asked if there were many Russian members of the BSS. I had to admit that I thought I was the only one because of the difficulties in getting English money in Russia to pay the annual BSS subscription, for the society would not accept payment in roubles.

Being Russian, the signs marked "Private" also meant nothing to me and enabled the photograph of the sundial over the passage in the stable block to be taken (in the pouring rain), Photo 12. A direct south-facing dial with Roman numerals marking the hours, it is doubtful if the horses housed there in former days could make much sense of the indications. There is an indistinct inscription over the dial but the words could not be made out. It seems a relatively modern sundial, in the pediment over the dial is an hourglass with large wings on the sides - a pictorial pun on the phrase "Time Flies". The hour numerals stand proud of the dial and being of the same material as the dial, do not show clearly in a photograph.

Quite definitely not a day for photographing sundials. For those interested in photography, the Otley dial was taken with an aperture of 1·7 and even then the exposure time hovered between 1/15 and 1/30 of a second. Therefore the writer was quite pleased to get a picture of any kind in such conditions.

There was a slight departure from the Conference Agenda when the Chairman presented the BSS Bulletin Editor with a book by L. M. Loske - *Die Sonnenuhren* and a Crested China Sundial from the early part of this century. These unexpected gifts were a very pleasant gesture and much appreciated by the recipient.

Another departure from the usual routine of BSS Conferences was the auction held after the Conference Dinner. The BSS Chairman revealed latent talents in his handling of the spirited bids from the assembled members. The total raised for the BSS funds was about £400 and there were some satisfied customers after the event for many had bought very good bargains. Our German friends successfully bought quite a few of the offered lots.

On the final day with Ian Wootton as Chairman of the session, the lectures began with a lecture by Dog Bateman on making a vertical sundial with modern materials such as stainless steel and perspex sheets. Two of these were shown in the exhibition area. This was followed by the story of the making of a Scottish obelisk dial in bronze to the design of our first Chairman, Dr. Andrew Somerville, by his widow Anne Somerville. It was a well-recounted sequence of events illustrated by excellent slides.

The highlight of the lecture programme was the Andrew Somerville Annual Lecture by Professor Philip Adams on Ulster Sundials - Old and New. A vast variety of Irish sundials was shown in a large number of slides, the majority quite unknown to the majority of the assembled members. The contents of this lecture will be published in a forthcoming issue of the BSS Bulletin but it will be impossible to reproduce the enormous number of dials shown.

At the end of this season there was a short period for members to take a final look at the exhibits in the display area and to examine the books and other items for sale by Rogers Turner of Greenwich. Sales seemed to be brisk enough but not for the books in the several hundred pounds bracket.

The writer's own contribution to the displays was a table devoted to Chaucer's Astrolabe and a rendering in modern words of Chaucer's own text. Colin McVean also had a table showing his dialling work. The German visitor Eric Pollahne showed a wide range of optical sundials on his display stand. The members' displays filled a quite large room.

Following lunch the sixth British Sundial Society Annual General Meeting commenced at 2 pm. The proceedings are covered in a separate report and so will not be discussed here. It is sufficient to say that there were no earth shattering events in the hour-long AGM, and it was

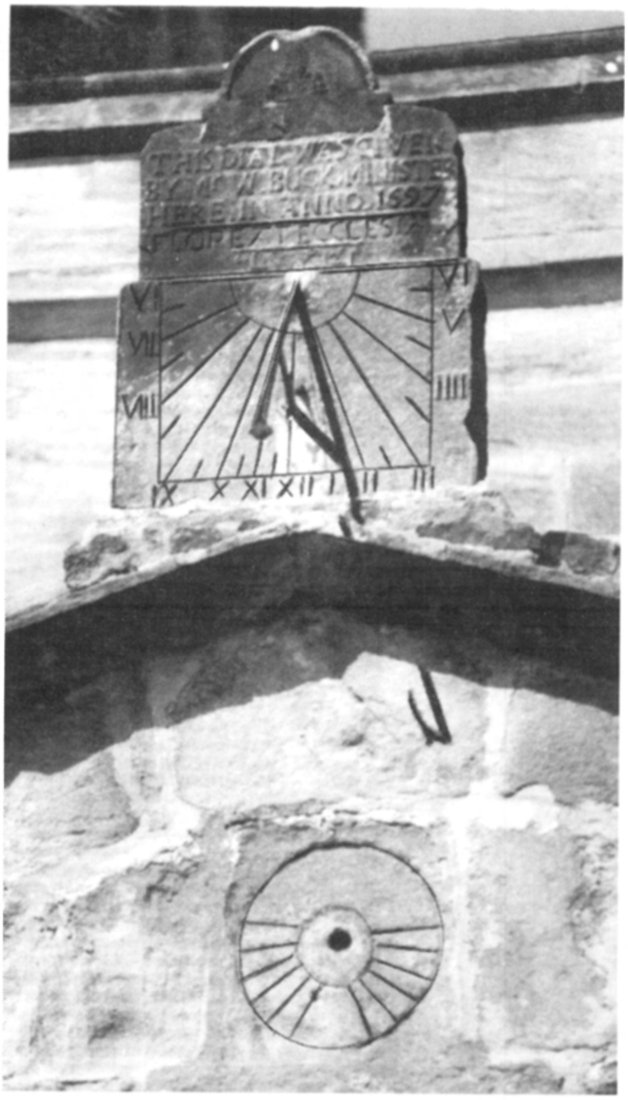


FIGURE 5: The vertical south-facing sundial on the church at Kirkby Malzeard.

FIGURE 6: This vertical sundial is on a buttress of the Kirkby Malzeard church.

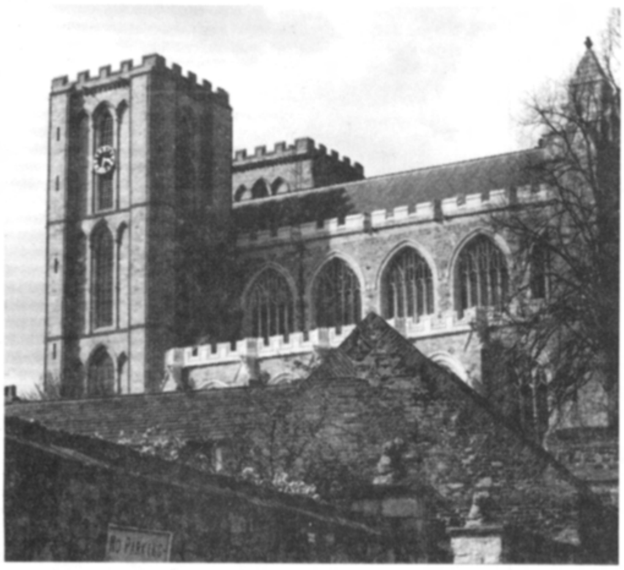


FIGURE 7: Part of Ripon Cathedral showing some of the newly restored stonework.

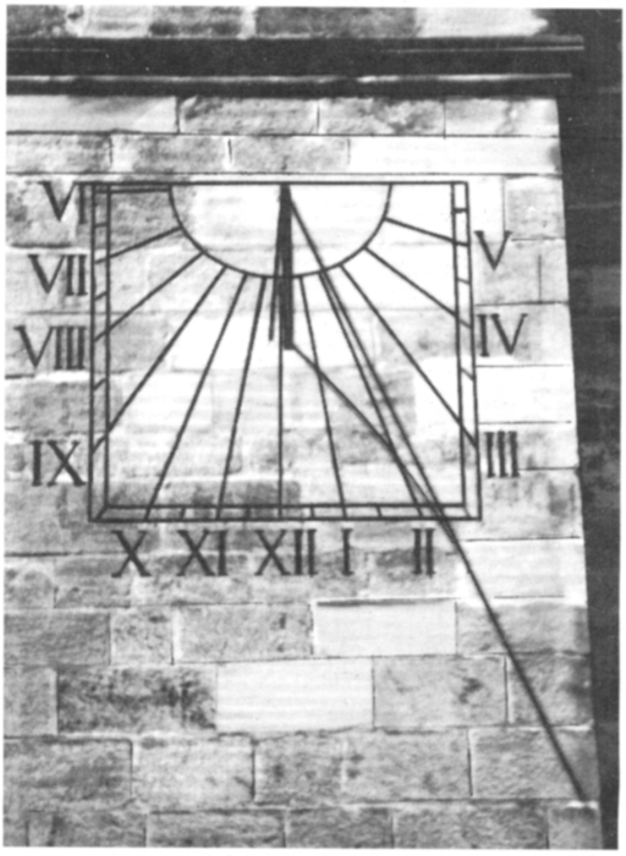


FIGURE 8: The only sundial found in Ripon itself is shown here.

significant that the number of members in attendance had shrunk considerably because of the long journeys some had in order to return home.

A few members were so enamoured of Grantley Hall that they stayed an extra night and left on Monday morning, probably better for those with very long journeys ahead of them. There is no doubt that accommodation in these adult residential centres is far superior to that provided in the University campuses formerly used, and with much of the accommodation being at ground level, ideal for the less active of our BSS members. At each of these Conferences the one regret of the writer is that our founding Chairman, Dr. Andrew Somerville, did not live to see the success of the Society of which he was one of the chief architects. He would have been greatly pleased with the on-going success of the British Sundial Society which is continually expanding and flourishing when many other small societies covering esoteric subjects are finding survival difficult.

Finally a word of thanks to the staff of Grantley Hall for their care in looking after the BSS members, similarly to those who organized the activities of the BSS Conference, and in particular Alan Smith. The friendliness of the meetings and the enthusiasm of the members has to be experienced to be fully appreciated. Suffice to say that not a single hitch occurred apart from the rain on Saturday, for which the Chairman accepted responsibility in full, albeit reluctantly. Apparently he was not born under a lucky star. One day the writer intends to cast the Chairman's birth horoscope to see if this is a valid reason, if it is not, he will be presented with a Garden Centre sundial of the type voted the most atrocious example of its kind in 1995.

Now turn to Readers Letters for a comment on the BSS coach outing, see page 48.

FIGURE 9: The sundial at Otley, Yorkshire, designed by the BSS Chairman.

FIGURE 10: Newby Hall. In the centre of the circular lawn is a cube sundial

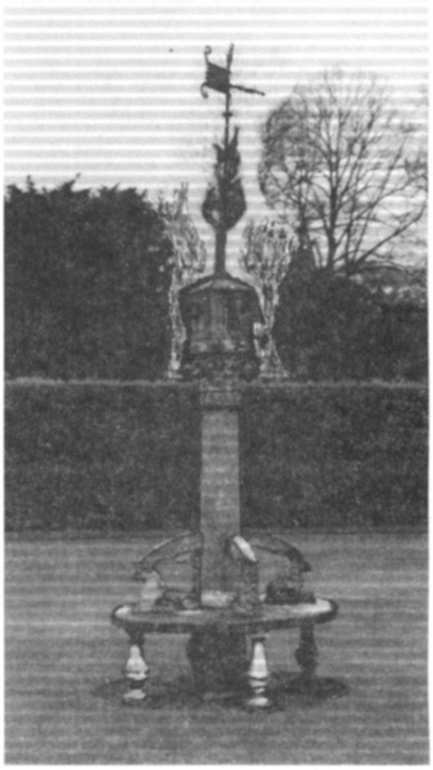


FIGURE 11: The cube sundial mounted on a pillar of unknown order.

FIGURE 12: A sundial on the former stable block of Newby Hall.

OPEN BOOK AND CONICAL DIALS

PETER LAMONT

INTRODUCTORY

As one of the newer and, at 85, possibly also one of the older members of the Society, the Author (after a sporadic and generally solitary interest in Astronomy and Sundials going back over 60 years) has become increasingly devoted to sundials in the past seven years, during which he has produced over fifty different dials, many of which, of course, amount to re-inventions of the wheel.

During these latter years - with the aid of another new enthusiasm, - the computer - he has also become increasingly interested in adding the so-called "Furniture" to the dials and also in including these items during the awkward hour or so after Sunrise and before Sunset when shadows wander off to infinity on flat dials.

The object of the Author was to plot Altitude, Azimuth and Declination on the dials, as well as the Hour Angles from Sunrise to Sunset, and in addition, wherever possible, to show Dates and Sun/Clock time corrections. Various experiments led progressively to the concept of the Open Book dial and then to the Conical dial (in effect a circular Open Book). These were the subject of a talk delivered on 22 April 1995 to British Sundial Society members attending the BSS Conference held at Grantley Hall.

OPEN BOOK DIALS

The development of these started with a plain obelisk type of dial (see photo 1) casting its shadow on a dial set in a horizontal plane. To catch the various factors during the awkward hour or so around sunrise and sunset, the first idea tried was a pair of vertical walls running north to south on each side of the dial, each the same height as the obelisk. At sunrise and sunset, the shadow would be at the top of these walls and the plots of the various factors at low altitudes would continue from the horizontal dial up the sides of these walls.

The computer program to calculate the required lines was arranged so that everything could be plotted on millimetre graph paper as linear coordinates and there was some relief when everything - including the walls - worked out as they should when tested in sunlight. The wall coordinates were not particularly convenient to read, however, so another concept was tried out.

The new idea (see photo 2) was to replace the dial and side walls by a pair of inclined planes running upwards from the central NS axis of the dial to the tops of the walls. This was developed with a new computer program, the results plotted on a new card base and mounted directly on top of the original dial. This proved to be a great improvement, it was much more compact and all the factors were now much easier to read. As the dial now looked rather like a church bible, it began to be thought of as the "Open Book Dial".

A gnomon was added and a third inclined plane, calculated in outline only, was also added (see photo 3) to save space at the north end of the dial.

The Open Book principle was next applied to a vertical south-facing wall dial where it enabled the full range of Azimuths from E to W to be included (see photo 4). This dial proved to be particularly easy to read although it incorporated a full range of additional factors - including Altitude, Azimuth, Declination, Date and Sun/Clock conversion.

Next came a polar type dial with the sides of the dial inclined laterally upwards at 30 degrees (see photo 5). In this dial, the hours are plotted as parallel lines. The time lines on this dial were particularly easy to read, as also were the Altitude, Azimuth and Declination lines, but Dates and Time/Clock conversions proved rather less so.

The final experiment with the Open Book principle to date has been the construction of a small-scale dial (see photo 5), with the central axis sloping upwards from South to North at a small angle (20 degrees in the model shown). The sides of the dial also sloped laterally upwards at 20 degrees terminating in horizontal sunrise/sunset edge lines, each inclined horizontally outwards at just over 40 degrees.

The computer program for this type of dial was more difficult to calculate the lines than any of the others and was equally difficult to plot in semi-polar coordinates. Although the final result was technically correct when tested in the Sun, it was not a very satisfactory practical dial in the "Furniture" plot on its western side was not completed. I could perhaps be considered as it resembles a glider or a flying bird. Constructed in the right material, and without the furniture, it could be quite an attractive Garden Dial.

It was thought at first that the above experiments had exhausted that particular vein of exploration, but looking at the northern extension to the first of the Open Book dials and remembering the beautiful Holker Hall dial, thoughts then went towards cones as a further step in the evolution of the Open-Book concept. After all, Cone dials could be regarded as all-round Open Book dials.

CONICAL DIALS

The first experiment with cones took the form of a composite dial in which a truncated cone was mounted loosely on the original horizontal dial (photo 1), with its base coinciding with the 30 degree altitude circle of that dial. Its sides were inclined outwards all round at 45 degrees, and its top, registering zero altitude, coincided with the height of the original gnomon and the vertical sides of the dial (see photo 7). This arrangement, which is broadly similar in appearance to the Holker Hall dial, shows the saving in space achieved and there was also a marked improvement in convenience of reading the various factors.

The calculation and plotting of the various factors involved in the furniture of Conical dials proved to be easier than anticipated. Although three-dimensional, they can be unwrapped into plane form as circular segments, the dimensions of which can readily be calculated in terms of the shape and size of the required dial cone. In this form the Azimuths are equally spaced radial lines from the common centre, whilst the Altitudes are concentric circles of readily calculated radius. In effect these two factors form the graph paper on which the other factors (Hour Angle and Declination) can be plotted by means of the usual astronomical equations. The computer, is of course, invaluable in printing out the various tables and data required.

The next step was to construct two entirely conical dials with the same obelisk height as the earlier dials (7 cm). The first had an upward cone angle of 22·1 degrees, making it identical in size to the earlier composite dial (see photo 8). A steeper cone angle of 30 degrees was used in the second dial, making it smaller overall. Having no interlocking boundaries, these dials were simpler to design and calculate than the earlier composite dials and were equally convenient to read.

Finally a composite dial was constructed in emulation of the imagined Hemisphere of Berossus, but as this had to be conceived as a triple composite - part cylindrical, part conical, and part flat - it can perhaps only be though of as the "Pseudosphere of Berossus".

As finally constructed, the cylindrical upper element covered Sun altitudes from zero to 22·5 degrees, the conical element from 22·5 to 67·5 degrees, and the flat base from 67·5 degrees upwards, (not in fact required in British Latitudes). The conical portion was in fact left removable as that the dial could be used as a composite cylindrical/horizontal dial and was also calculated and constructed on this basis, with the cylindrical portion registering Sun elevations up to 45 degrees and the horizontal base dealing with elevations above 45 degrees.

This dial was reasonably easy to read either with or without the conical portion, but did not prove to be the most aesthetically pleasing dial in the collection. The hemisphere shape appeared to be too deep with altogether too much shadow. It possibly explains why the few remaining ancient examples of this type of dial have the southern portions omitted to permit easier access of sunlight.

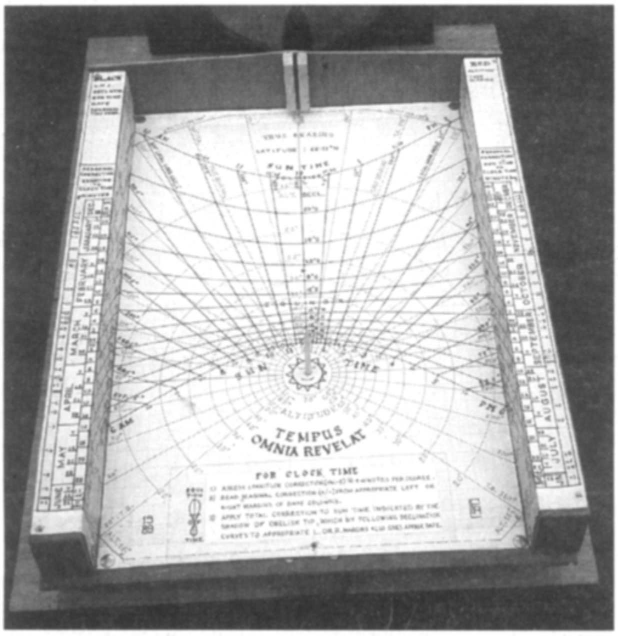


Photo 1

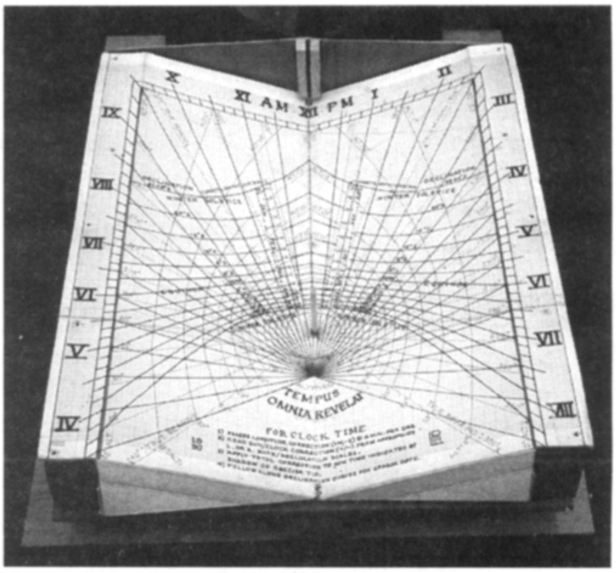


Photo 2

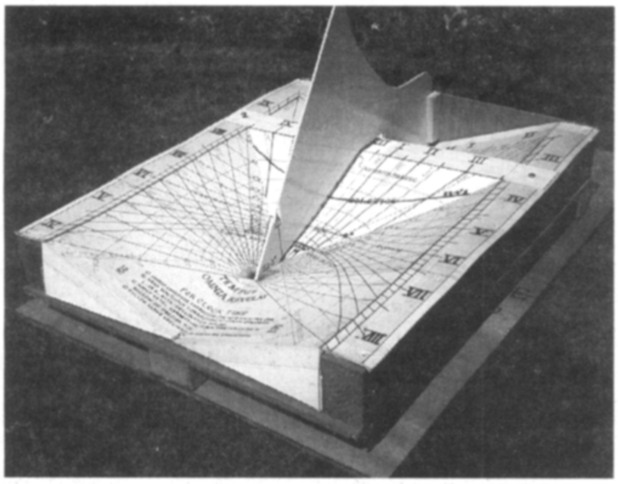


Photo 3

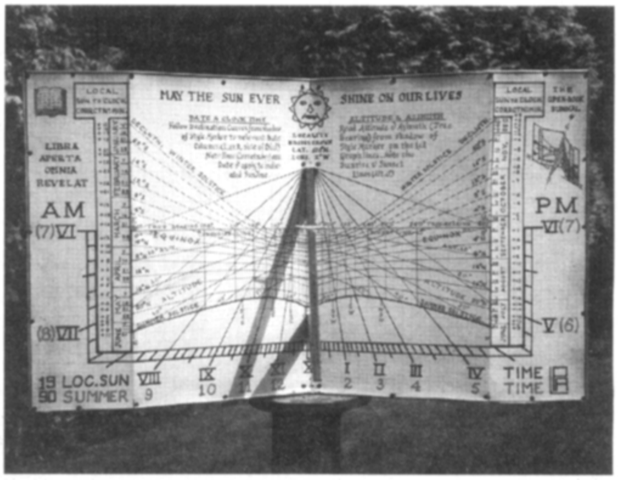


Photo 4

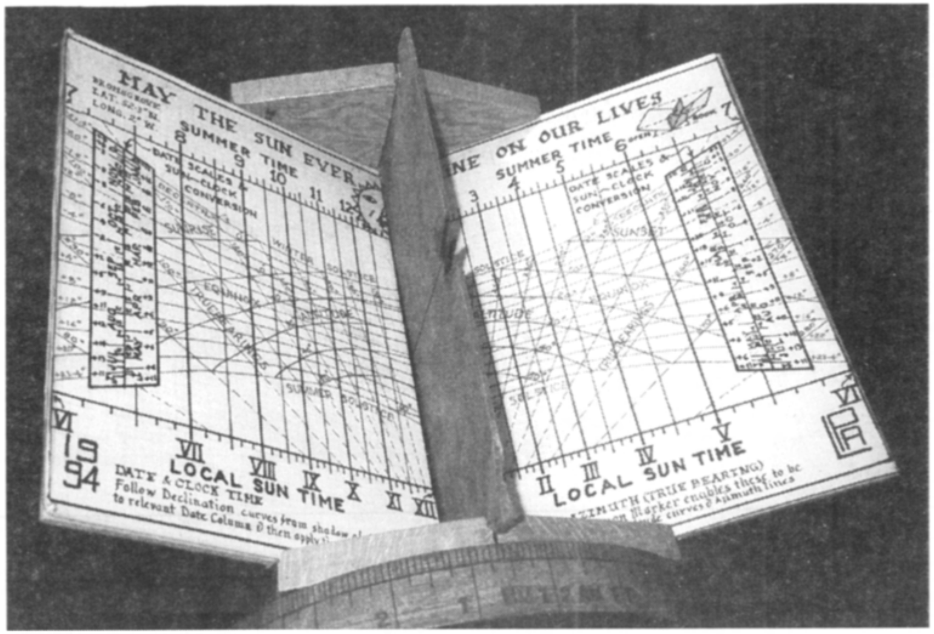


Photo 5

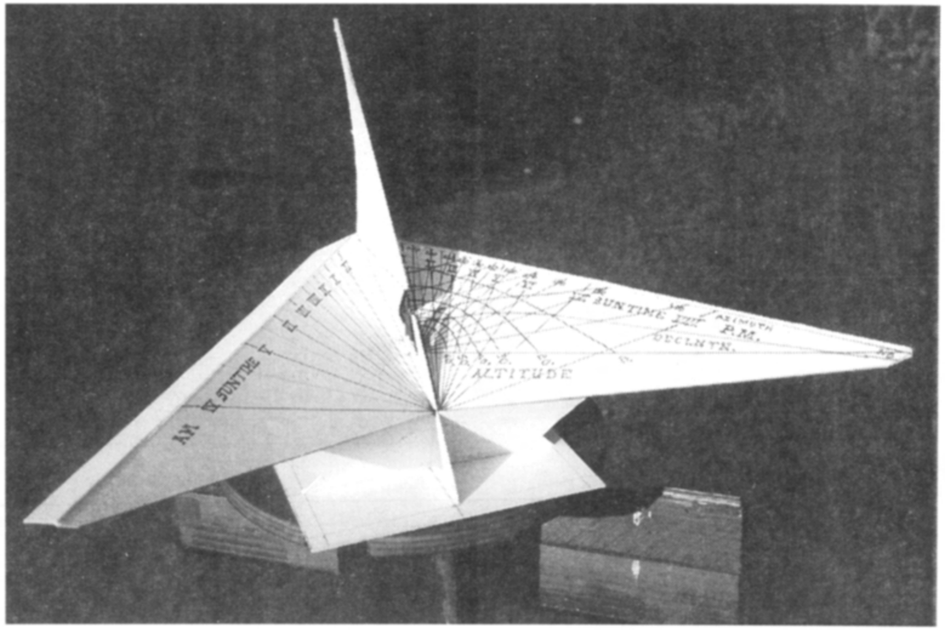


Photo 6

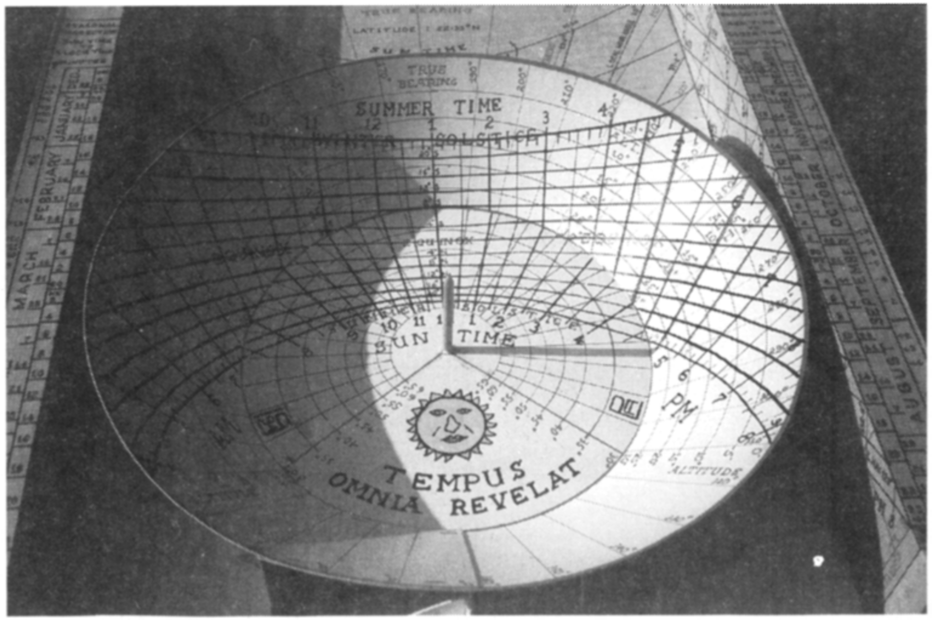


Photo 7

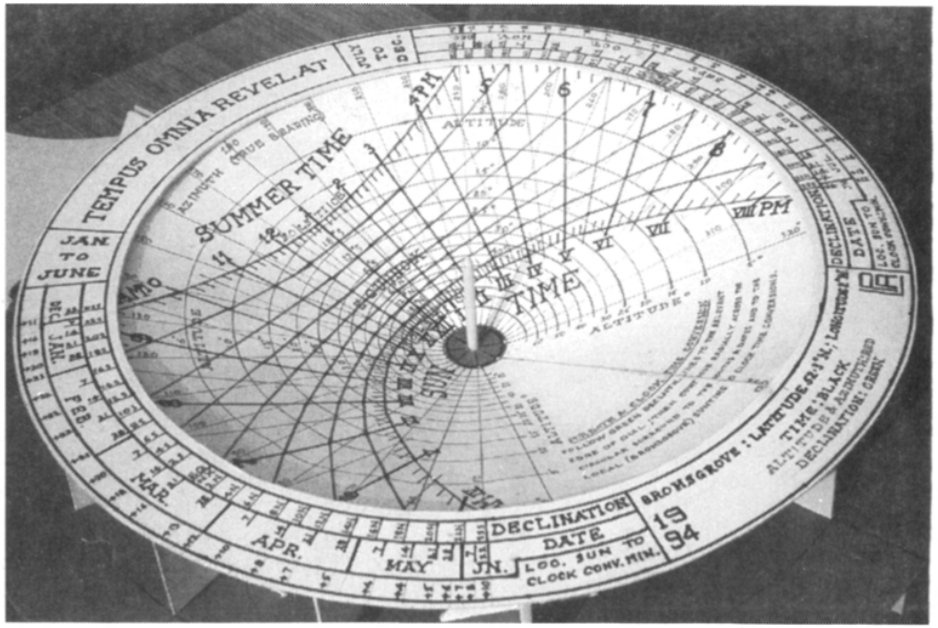


Photo 8

TWO UNUSUAL MASS DIALS IN DORSET

R.A. NICHOLLS AND C.M. LOWE

INTRODUCTION

It is tempting fate to describe these two dials (generally accepted as mass dials) as being unique in the British Isles, but with present knowledge this appears to be the case. Their presence, as scratch-dials, is noted in Volume 1 of the Report of the Royal Commission on Historical Monuments in Dorset, 1952.

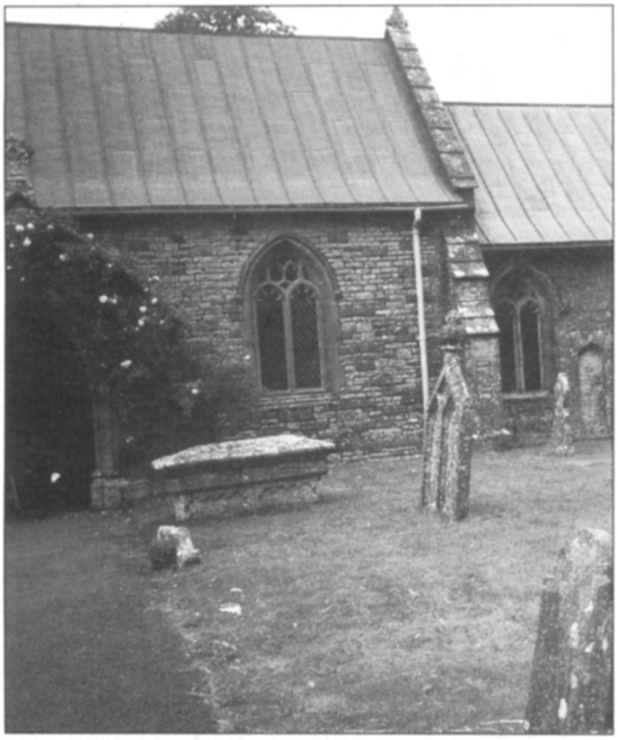


FIGURE 1: General view of south elevation

The two dials are cut into the ashlared Ham Hill stone of the church of St. Mary Magdalene, Thornford, Dorset. The village of Thornford is 3 miles west of Sherborne, and the church itself is a typical Dorset village church building, dating from the 14th century with a major restoration in 1866, and now in good repair.

GENERAL DESCRIPTION

The dials are cut into the stone sills of two cinquefoil windows on the south wall of the chancel. The wall was re-built in the 15th century. The church is orientated so that this south wall declines 25° east of south. There is no obvious reason why the church is twisted from an east-west axis by so much. Figure 1 shows a general view of the south elevation of the church, with the two windows with dials on the right.

Figure 2 shows a closer view of the two windows with a blocked-up priest's door between them.

DETAILS OF THE DIALS

The dials are cut into the right hand end of each sill, and each of the vertical arrises of the window jambs on the east side is used as the style of a gnomon. The shape of the stone frame gives two usable arrises per dial. The sills themselves slope downwards and outwards at about 20° from horizontal.

The dial lines have been chased into the stone sill but are not truly straight. The lines are 2-3mm deep. The lines and sills have weathered and are partially covered in lichen. The dials, differing from each other in detail, are described fully below. Figures 3 and 4 show the east and west dials respectively, in near vertical close up. The dial lines were

FIGURE 2: A closer view of the two windows with a blocked-up priest's door between them

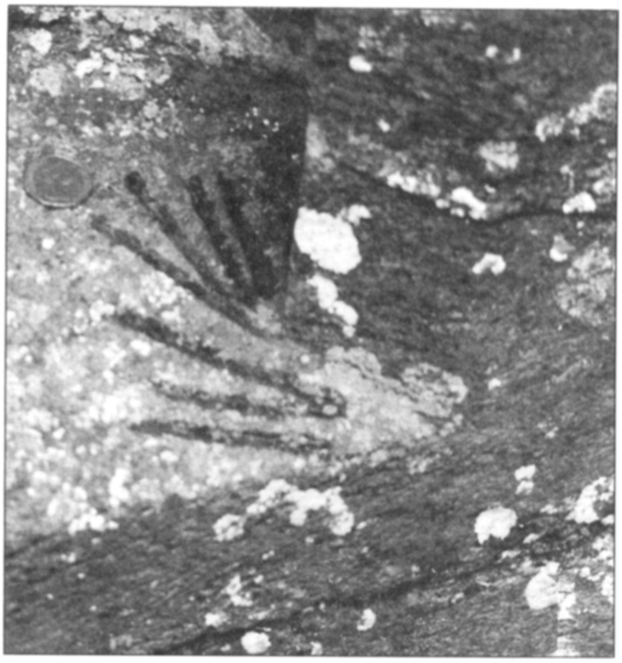


FIGURE 3: The east dial in near vertical close up

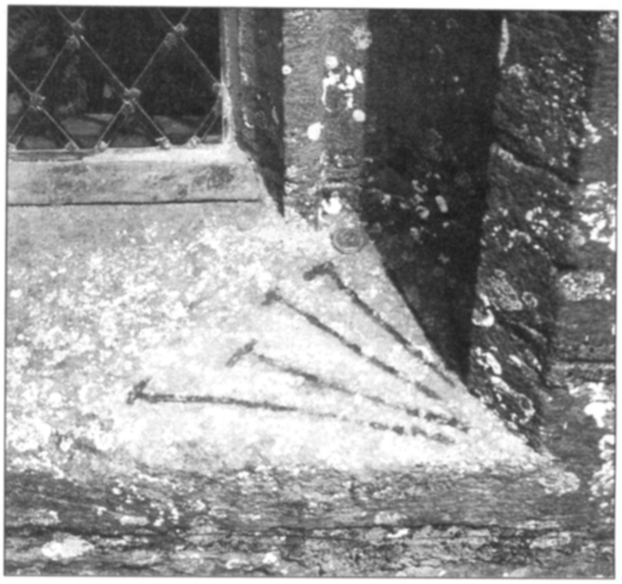


FIGURE 4: The west dial in near vertical close up

wetted for clarity, but this has over-emphasised the roughness of the edges and the width of the lines. Figures 5 and 6 are full scale drawings of the two dials. The lines are plotted from co-ordinates measured from a frame placed on the sill. The lines are plotted as straight, and do not follow exactly the true lines. The view is thus directly above each dial, but all measurements are on the sill slope. All arrises and stone surfaces are weathered, and finding a true base line from which to measure co-ordinates was difficult. The accuracy of the angles marked on Figures 5 and 6 is thus not likely to be better than ±2°. The jambs in both windows appear to be as vertical as good masonry can be.

DIAL ON EAST SILL (Figure 5)

The first impression of this dial is that it appears more primitive, more carelessly cut, than the west dial. The lines are shorter and appear to have been cut with a blunter tool.

Line a-b is vertical to the front chancel wall. An extreme right hand line is shown, but this may be a line arising during construction of the window frame. Including this line there are 8 lines cut into the sill - three pointing to the front vertical arris, four near the inner arris, and one cut as an extension of the stone face between these two verticals.

DIAL ON WEST SILL (Figure 6)

The lines are longer and appear more carefully cut than on the east sill. There is a cross-cut to mark the end of four of the lines.

The line a-b is vertical to the chancel wall. There are 7 lines, three pointing to the front arris, three using the inner arris, and one as an extension to the stone face between arrises.

COMPARISONS BETWEEN DIALS

The early morning lines on both dials seem to be marking much the same time or events, but the smaller lines, hidden in the curve of the sill into the jamb, differ considerably between dials. It is difficult to understand the use of the two lines in the east dial which do not point to either arris. No shadow falls even approximately along either line. It is just possible they were construction or setting-out lines, as one is vertical to the chancel wall.

THE POSSIBLE FUNCTIONS OF THE DIALS

The angles of the two dials have been analysed in an attempt to deduce their intended functions. Two analyses have been made, first to compare the dials with the more usual patterns of mass dials, and secondly to test their use as azimuthal dials. The pattern of lines on the two dials is in general quite similar, and it seems probable that they had the same purpose: perhaps the cruder east dial is an earlier version.

COMPARISON WITH THE MOST FREQUENT MASS DIAL PATTERNS

Neither dial is a very convincing fit to any of the commoner mass dial patterns, duodecimal, decimal or octaval. In the case of the west dial there is, however, an intriguing feature to the match with the octaval pattern, with line intervals of $22^1/_2$°. Figure 7 shows a plan of the dial, idealised to have only one style and with lines drawn to the same length. These are the thicker lines in the figure,

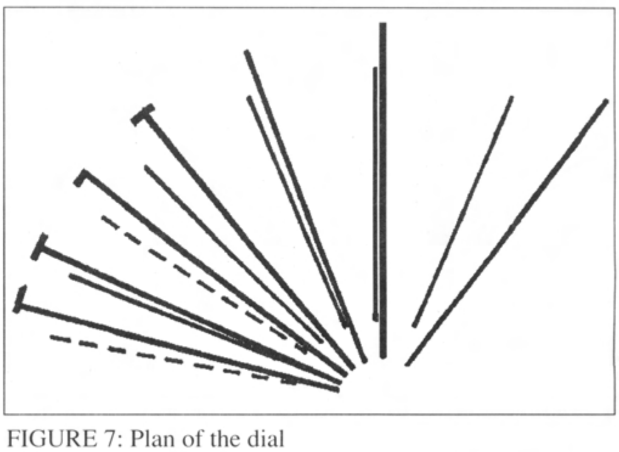


FIGURE 7: Plan of the dial

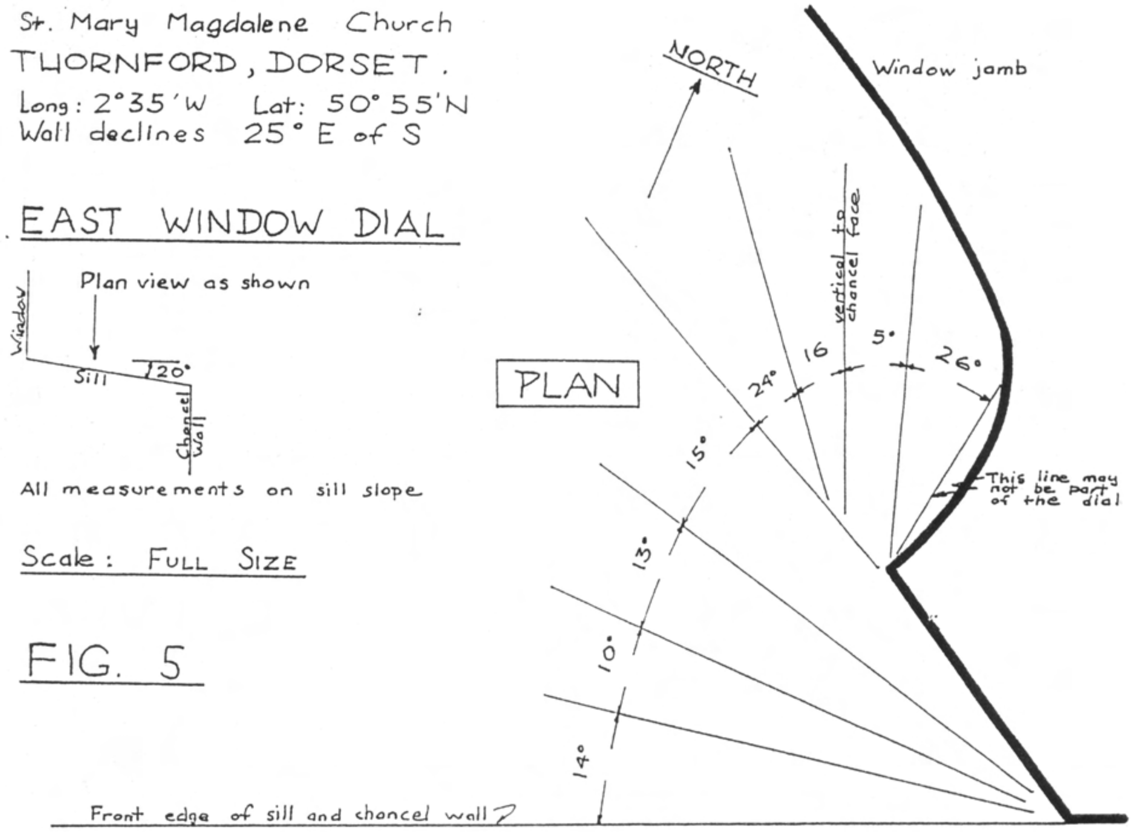

St. Mary Magdalene Church
THORNFORD, DORSET.
Long: 2°35′W Lat: 50°55′N
Wall declines 25° E of S
EAST WINDOW DIAL
Plan view as shown
Window
Sill
20°
Chancel Wall
All measurements on sill slope
Scale: FULL SIZE
PLAN
NORTH
Window jamb
vertical to chancel face
14°
10°
13°
15°
24°
16
5°
26°
This line may not be part of the dial
Front edge of sill and chancel wall

FIG. 5

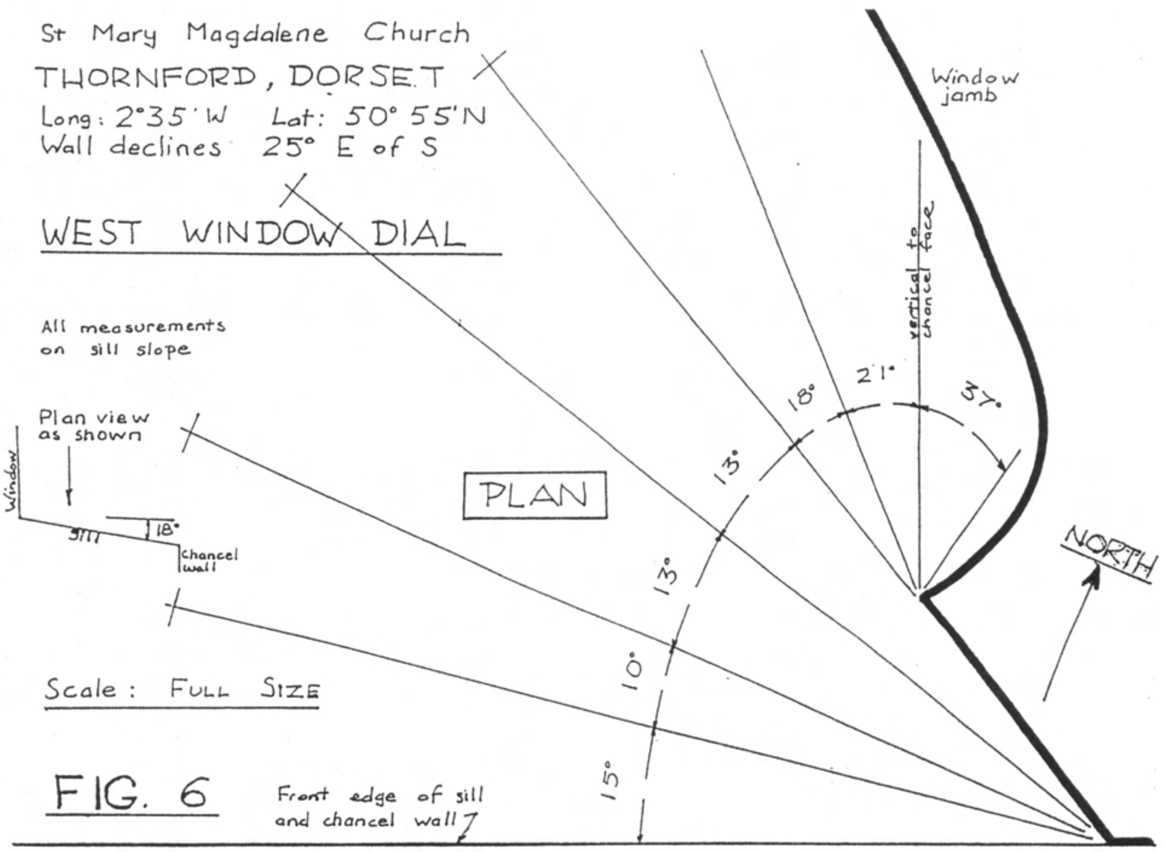

St Mary Magdalene Church
THORNFORD, DORSET
Long: 2°35′W Lat: 50°55′N
Wall declines 25° E of S
WEST WINDOW DIAL
All measurements on sill slope
Plan view as shown
Window
Sill
18°
Chancel wall
Scale: FULL SIZE
PLAN
Window jamb
vertical to chancel face
NORTH
15°
10°
13°
13°
18°
21°
37°
Front edge of sill and chancel wall

FIG. 6

which also shows the short transverse marks at the ends of the first four lines. The octaval pattern is shown by the thinner and shorter lines: to match the number of lines on the dials it was necessary to include two half-interval lines, shown dashed. On the two dial lines which correspond to the half-intervals, the end marks appear to be on one side of the line, whereas for the full-interval lines the marks extend to both sides. Where no half-interval lines are required, there are no end-marks. There may be some significance in this apparent identification of the half-intervals.

The east dial has a broadly-similar match to the octaval pattern, although in this case there is no identification of the half-interval lines.

If the dials are indeed intended to be horizontal analogues of a vertical mass dial, they cannot work in the same way that Mills[1] has shown such a vertical dial to operate, i.e. as quite an accurate event-marker. The projections of the vertical styles on to the sky as seen from the dial lines do not conform even approximately to the locus of the positions of the sun at fixed intervals of the daylight hours throughout the year. In winter the sun rises too far south for the first three lines to receive any shadow from the style at all.

THE DIALS AS AZIMUTHAL DIALS

The presence of vertical styles suggests that the dials may have been intended to work from the bearing or azimuth of the sun, that is to say the position of the sun somewhere on a vertical arc running from horizon to zenith. (The azimuth is the angle measured around the horizon from the north point to the foot of the vertical arc.) In the course of a year, the azimuth at any one time of day (except at noon) varies widely with the declination of the sun and therefore a simple dial with a fixed vertical style is of no use as a general time-keeper. It can however indicate the time on one or two particular days in the year and (with lessening accuracy) for a few days earlier and later than those days.

To test this possibility it was necessary to derive the azimuths at which the sun will cause the shadows of the styles to fall on each dial line, by projecting the styles on to the sky as seen from the lines. The measured line angles needed correction for the inclination of the sills (to project them on to a horizontal plan), and then to be referred to true north, allowing for the 25° east-of-south aspect of the chancel.

The azimuths thus derived are to be compared with that of the sun on certain dates and at certain times. Obviously, if enough dates and times were selected for comparison, many matches could be found: therefore attention was restricted to days of importance in the early church (for example, Christmas Day, Lady Day) and to integral hours of apparent solar time. In extracting the declination of the sun for the chosen dates from a modern almanac it was necessary to add 8 days to correct for the difference between the present Gregorian calendar and the Julian calendar in use in medieval times. The comparisons were done first by a graphical method, which showed that some days had one or two coincidences of azimuths and times. These were rejected as being due to chance: the hope was to find a day or days when all or most of the azimuths matched integral hours. Taking the west dial first, the only dates which met this criterion were May 8 and July 22 (Julian calendar), when the sun's declination was +19°. The dial azimuths closely match that of the sun at every hour from 6a.m. to 11a.m. and also at 12.30p.m. Times calculated from the azimuths confirmed these matches.

Details are shown in Table 1 which give the line azimuths, the 'normal time' derived from the graph, the calculated time of gnomon shadow reaching the line, and the difference between the two.

TABLE I
West dial, solar declination +19°

Line azimuth	79°	89	102	115	135	155	193
Nominal time	06^h	07	08	09	10	11	1230
Calculated time	0605	0658	0802	0858	1007	1102	1230
Difference	$+5^m$	-2	+2	-2	+7	+2	0

The first date, May 8, falls within the period of holy days following Easter, but because of the movable dates of Easter Day and the associated holy days through a range of nearly five weeks, it would not have been possible to design the dial for any of them.

The later date, July 22, is the saint's day of St. Mary Magdalene, which, as noted earlier, is the dedication of the church. The west dial therefore indicates every hour from 6a.m. to 11a.m., and 12.30p.m., on the day of the patronal festival.

Referring back to the differences of nominal and indicated times shown in Table 1, the root-mean-square difference is only ±4 minutes and it may be thought that this is unrealistically small. The accuracy of measurement quoted earlier and also any error in the derived chancel aspect would give the expectation of an r.m.s. difference of ±6 to 8 minutes, without making any allowance for the errors of the dial itself. However, even if the overall error is ±10 minutes, there is a 50% chance that any one difference will be 7 minutes or less, and with only a small number of data points the observed error distribution is not unreasonable. It is clear that if the July 22 interpretation is correct, the dial is quite accurately laid out, perhaps within ±5 minutes.

This raises the question of how the dial was made with such accuracy. Direct calculation by spherical trigonometry can in all probability be ruled out. Possibly some geometric method was used, but any such method was obviously not common knowledge, otherwise there would be more dials of this type. The only realistic alternative is that the dial was constructed empirically, by making marks at the desired times on the appropriate date, by reference to some independent time standard. It is unlikely that a village priest would have had access to a mechanical clock in the fifteenth century, but of course the dial may be later in date than the chancel itself. It could be that the dial was made with the aid of a proper 'scientific' sundial, perhaps a portable dial, in which case the date might be 16th century or later. The deduced dial error of ±5 minutes is consistent with the use of a portable dial.

In the case of the east dial, with its rougher construction, the interpretation is more difficult. Assuming that the two lines which do not pass through the foot of the style are intended to be read when the shadow is parallel to the line, some tentative conclusions are possible.

The first four lines have similar angles to those of the west dial and are an equally good fit to the sun's azimuth on 22 July, but the remaining lines have differences of 15 to 25 minutes from the nominal times. There is a possible fit to the sun at declination ±4°, as shown in Table II.

Continued on page 27

THE SHADOW OF RESPECT

CHRISTOPHER ST J H DANIEL

The 21 October 1994 marked the 189th anniversary of the Battle of Trafalgar, one of the most famous sea battles of all time in which Nelson, one of Britain's greatest and most popular heroes, was killed in action.

FIGURE 1: Bust of Nelson by John Flaxman, 1801.
(Photograph courtesy National Maritime Museum)

On the occasion of this particular anniversary, the National Maritime Museum at Greenwich, and the Royal Naval Museum, Portsmouth established the Official Nelson Celebration Committee (ONCC) and announced a programme of commemorative events to celebrate 'The Nelson Decade'. For the next ten years Britain will celebrate the 200th anniversaries of some of the most famous events in British naval history - the great battles fought by Nelson during the French Revolutionary and Napoleonic Wars, culminating in the bicentenary of the Battle of Trafalgar on 21 October 2005.

Admiral of the Fleet, The Lord Lewin, Chairman of the Board of Trustees of the National Maritime Museum, heads the newly formed ONCC which comprises maritime and Nelson specialists from the National Maritime Museum, the Royal Naval Museum at Portsmouth, the Royal Navy (HMS *Victory*), the Nelson Museum at Monmouth, Flagship Portsmouth, Lloyds of London, the Society for Nautical Research, the Nelson Society, and the 1805 Club - a society of high ranking Nelson enthusiasts.

The ONCC has had three main aims: to promote events and exhibitions relating to Nelson and particularly the Battle of Trafalgar; to ensure that commemorative items meet high standards to protect the interests of all participating organisations; to act as an information forum, to minimise overlapping effort and encourage mutual support between institutions.

One of the first major events of The Nelson Decade will be the grand opening on 21 October of a new Nelson gallery at the National Maritime Museum. Using the Admiral's own words to tell his story, the gallery explores his role in the decisive events that shaped British history during this period and his emergence as a national hero.

Viscount Horatio Nelson (1758-1805) was born on 29 September 1758 at Burnham Thorpe in Norfolk. He entered the Navy in 1770 as a midshipman, when he was 12 years old. By the time he was 18 he had served in both the West Indies and the East Indies, as well as in the Arctic. He passed his examinations for the rank of Lieutenant at 19 in 1777 and soon afterwards was back in the West Indies in command of a small vessel, the *Badger*. Later, he received command of a larger vessel, the *Hinchingbrook*.

From 1775 to 1783 Britain was at war with her American colonists who were fighting for their independence. Nelson saw much active service in this theatre of war. In 1778, only a year after becoming a lieutenant, he was made a commander and just a year afterwards, at the age of 21, he was promoted to the rank of captain.

In 1793, just before the outbreak of the war against France, he was given his first big command when he was appointed to HMS *Agamemnon*, a 64-gun second-rate ship-of-the-line which he took out to join the British fleet in the Mediterranean. Here he helped to seize the island of Corsica, but at the siege of Calvi in 1794 he received a wound in his right eye, which later became useless and over which he wore a black patch. In 1797, at the great battle of Cape St Vincent off the south-west coast of Portugal, it was largely Nelson's bravery and skill that ensured victory. Later that year, in an attempt to take Santa Cruz de Tenerife in the Canary Islands, he received a bullet wound in his right elbow, when his arm had to be amputated. This same year he was made a Rear-Admiral 'of the Blue'.

In 1798, having become one of the most distinguished officers in the Navy, Nelson was chosen to command the squadron that was sent to the Mediterranean to discover and stop Napoleon Bonaparte's intentions. However, the French fleet managed to slip out of Toulon, elude the British force and transport Napoleon's army to Egypt where, eventually, Nelson found them at anchor in Aboukir Bay near Alexandria. There followed the famous Battle of the Nile, which was an overwhelming victory for the British, when Nelson was wounded in the forehead. This episode made Nelson a national hero, which was endorsed when, as second-in-command of the expedition that was sent to attack the Danish fleet at Copenhagen in 1801 to prevent it joining forces with the French, Nelson turned the tide of battle into victory. It was during this occasion that Nelson put his telescope to his blind eye and declared that he could not see the signal from the commander-in-chief to break off the engagement. On his return home to England he was again showered with honours and made a Viscount.

On 25 March 1802 the Treaty of Amiens brought a fragile peace that lasted little more than a year, during which time Napoleon rebuilt his fleet and planned to invade

England. In May 1803 Britain and France were back at war. In July of the same year. Admiral Lord Nelson joined HMS *Victory* in the Mediterranean, where he had been sent to keep watch over Toulon, whilst other British forces patrolled the English Channel. Early in 1805 French ships escaped the blockade of Toulon and Rochefort on the west coast of France and sailed for the West Indies. Nelson chased them across the Atlantic and back again and on 21 October 1805 off Cape Trafalgar in southern Spain, he fought his last and most famous battle.

Before the action he summoned all his captains aboard the flagship *Victory* to tell them exactly what he wanted them to do, and then he hoisted his famous signal 'England expects that every man will do his duty'. In a five hour battle 18 French and Spanish ships were taken, whilst the rest fled, only 11 of them reaching the safety of Cadiz to the north. It was a great victory that Nelson and Admiral Collingwood won on that day, but at 1.25pm, at the height of the battle, Nelson was mortally wounded by a French sniper's bullet. He was carried below and died about 4.30pm, after being told the news that he had won a glorious victory.

Nelson's flagship HMS *Victory* was severely damaged and had to be towed Gibraltar to make temporary repairs. After an extensive refit in England she saw service until 1812 when she returned to Portsmouth for another refit, but the end of the Napoleonic Wars in 1815 and the advent of steam propulsion brought her long fighting career to an end. She remained in reserve until 1824 when she became the flagship of the Portsmouth naval command.

The *Victory* had been built in Chatham in the years 1759-1765, and before Trafalgar was twice rebuilt. She was a 104-gun first-rate ship-of-the-line and saw action for the first time in 1778, against the French, who had just entered the War of American Independence on the side of the colonists. Chatham like Portsmouth, has always been closely associated with the Royal Navy, as also with the Royal Marines which is reflected in the town's coat-of-Arms. Likewise, Chatham can lay claim to a strong historical association with Nelson, who walked the streets in the 18th century town long before he became famous. It is to the town's credit, therefore that Chatham has been the first, perhaps, to launch The Nelson Decade, with the unveiling of a unique commemorative vertical sundial in front of the wall of the old post office building on the afternoon of Friday 21 October, 1994. The ceremony was carried out by The Right Worshipful The Mayor of the City of Rochester, Councillor Mrs Ann Marsh at 4.57pm, the time that would have been indicated by a sundial at Chatham at the moment when Nelson died aboard *Victory* off Cape Trafalgar.

The sundial is the 'jewel in the crown' of a 5.5 million pound project to improve the environment of Chatham, to make this old naval town more attractive to its inhabitants

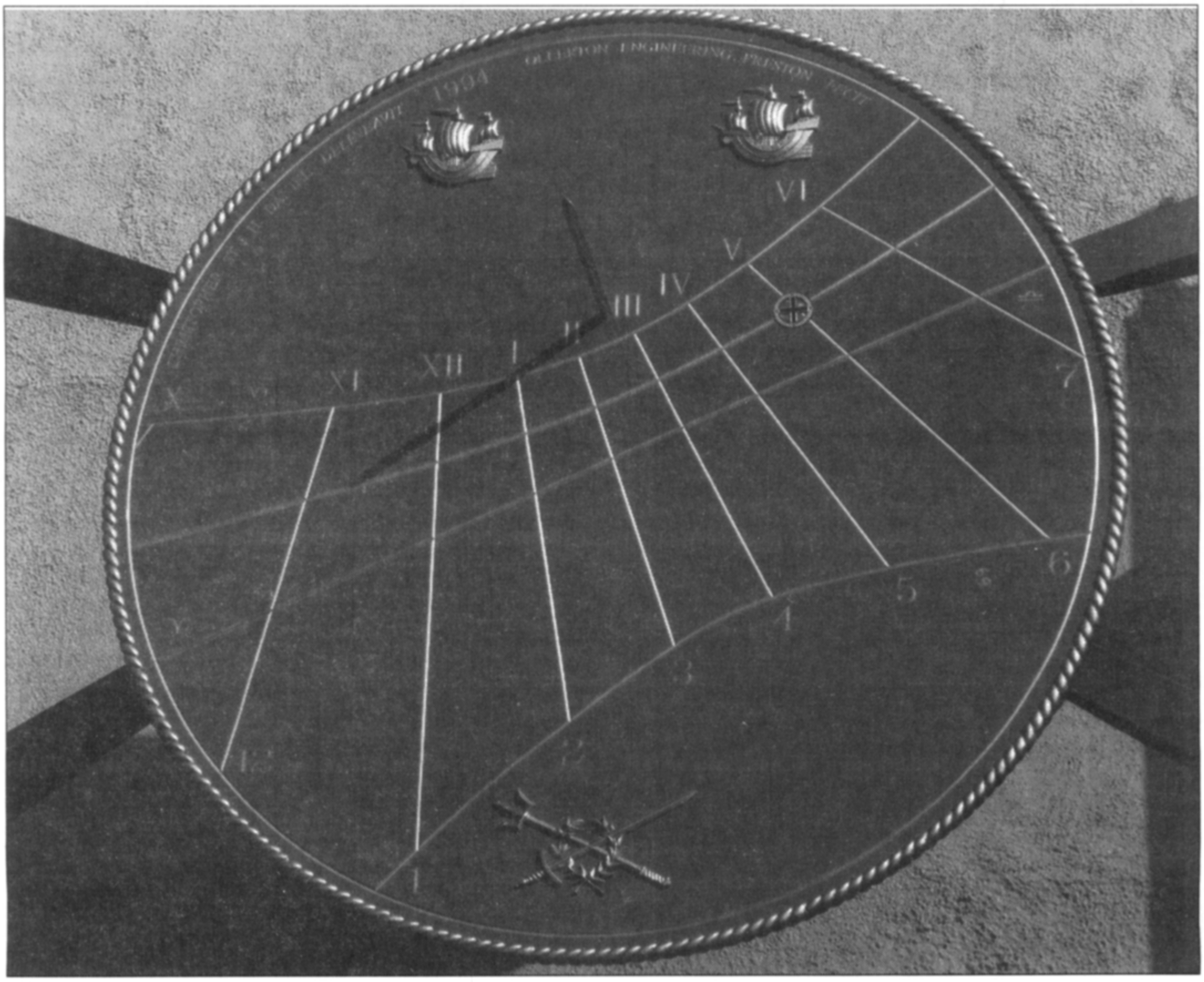


Figure 2: The Sundial

and to its visitors. A pedestrianisation scheme and other improvements to the quality of urban life are expected to provide a complementary appeal to that of the historic dockyard. Implemented by the city of Rochester and under the direction of the London Architects B.D.P. (Building Design Partnership), the main contract has been undertaken by Tarmac Construction, (Civil Engineering Division). The huge steel H-frame, which supports the sundial, and the dial itself were constructed by Ollerton Engineering Services of Preston.

Historically, a sundial is a scientific instrument, the purpose of which is to determine the time from the apparent motion of the sun. In order not to put any strain on the wall of the building, the Chatham sundial is suspended in the vertical plane parallel to the wall. The dial is classed as a *vertical declining* sundial (latitude 51° 23' N longitude 00° 32' E) since the wall declines from the South cardinal point of the compass 33° 45' West.

The design is intended to create a modern sundial in an 18th century naval style, having nautical symbolism to reflect Chatham's historic connection with the Royal Navy and the Royal Marines. This is principally provided through the use of those heraldic achievements in the town's coat-of-arms, namely the two gilded medieval ships, representing the Royal Navy, and the gilded wreathed trident, associated with the Royal Marines. Likewise, the predominant blue ground of the dial-plate, whilst being a traditional sundial colour is also a colour associated with the sea. The naval symbolism is completed in the circular shape of the sundial, bordered by a gilded rope surround which, excluding the use of the naval crown, takes the form of the circular heraldic shield of a capital ship.

In addition to the hour-lines on the dial-face, the sundial is furnished with *declination* lines - the lateral curves crossing the dial-plate - for the *equinoxes*, the *winter solstice*, the *summer solstice*, and for the 21 October

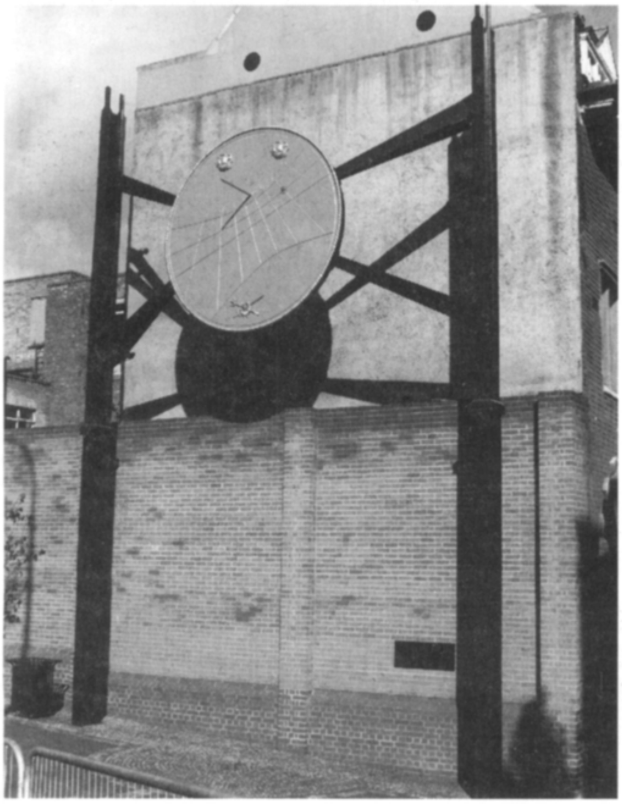


Figure 3: The Sundial supported on its frame

(1805). On this latter arc, the date of the anniversary of the Battle of Trafalgar, there is a small gilded encircled cross, denoting the time of Nelson's death at 4.30pm at Trafalgar at which moment, on that fateful day a sundial in Chatham would have indicated the time to be 4.57pm, as also would have all well-regulated public clocks in the town. This feature on the sundial is intended to be a tribute to Britain's greatest hero and to recall Lord Nelson's close connection with Chatham.

Unlike normal sundials, where the hour of the day may be determined from the shadow of an inclined rod or *gnomon*, in this case the time may be read off by observing the tip of the shadow of an horizontal spike, projecting from the upper centre-line of the dial-plate, in relation to the straight radiating gilded hour-lines. The time so found is called *Local Apparent Solar Time* or, more usually, *Local Apparent Time* (LAT) which is the natural time that our ancestors kept in the days when life moved at a slower pace. Although the Chatham sundial allows for summer time (*Roman* numerals: *winter* time, *Arabic* numerals: *summer* time), to obtain 'clock' time, i.e. *Greenwich Mean Time* (GMT) or *British Summer Time* (BST) it is necessary to apply a small correction to allow for the difference in longitude between Greenwich and Chatham (-2 minutes), and for the *equation of time*. This is a known quantity, resulting from the variation in the earth's orbital speed and the tilt of the earth's axis to the plane of its orbit. The daily correction to be applied may be found in such works as *Whitaker's Almanac*.

The *gnomon's* shadow tip may also be seen to track along the respective lateral lines on the dates of the equinoxes and the solstices. Likewise, on the 21 October each year the shadow tip will track along the gilded arc that represents this historic date. Fourteen minutes before sunset, if the weather is fine and clear, the point of the fading shadow may just be seen to touch the centre of the gilded encircled cross, denoting 4.57 (LAT), the time of Nelson's death. There could hardly be a more fitting tribute to the memory of Britain's greatest naval hero than this silent moment, as the sword-like shadow, as if it were a natural mark of respect, fades with the going down of the sun. Chatham has surely 'set the pace' for The Nelson Decade by the design and construction of this unique commemorative example.

The Chatham sundial was designed by the author, whose works also include the famous 'dolphin' equinoctial mean-time sundial at the National Maritime Museum at Greenwich, to mark the Queen's Silver Jubilee; the Marine Society and Nautical Institute vertical sundial unveiled by Her Majesty the Queen (1979); the four vertical sundials on St Margaret's Church at Westminster (1982); a vertical dial at HM Tower of London (1988); a modern equinoctial armillary sundial at the Savoy Hotel (1989); and a monumental 3-ton York stone slate-faced double-polar mean-time sundial at Otley, in West Yorkshire (1993). He is Chairman of the British Sundial Society.

* * * * *

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THE SUNDIALS OF THE TALMONT

DAVID J. BOULLIN

Expert diallists need not run to their archives to discover if there is something and somewhere that they do not know. Talmont is a small village in the Gironde estuary in the French Department of Charente-Maritimes, about 8 miles south of Royan. It is quite well-known for its fine twelfth century church that stands on the very bank of the Gironde and can be seen for a considerable distance.

I visited the village at the beginning of August 1994, and found an extremely attractive place that is orientated to the interest of tourists; in the winter it must be extremely quiet.

There are only three streets, and within a few minutes I had found a couple of early nineteenth century vertical sundials on the walls of houses. The first is marked in both Roman and Arabic numerals from VIII to VII [pm], with the Arabic numerals superimposed, probably at a later date than the date of construction, which is not given [figure 1, location, a house in the Rue de Port]. The second dial [figure 2, location a house in the Rue de la Ville] bears the date '1980', and is not in such good state as the first, but is almost certainly unaltered since the above date.

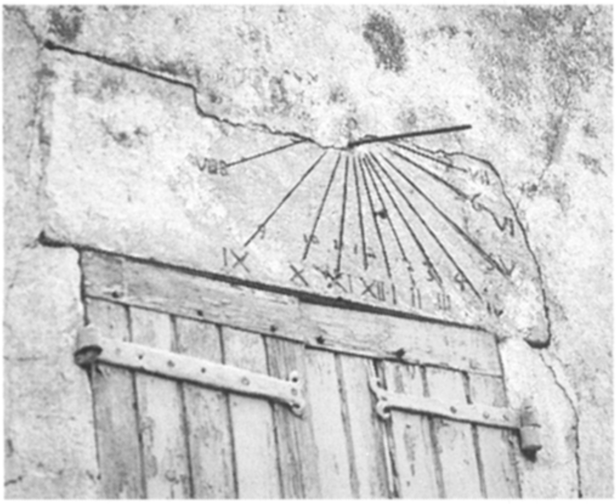

FIGURE 1: Vertical dial on the wall of a house in the Rue du Port, Talmont marked in Roman numeral, probably at a later date than the date of construction, which is not given.

Then came the most unexpected find . . . a sundial shop. This is shown in figure 3; it is a small single-storey building, with a fairly small room within, but a large display of dials inside and outside . . . the later of course all showing the time in the brilliant sunlight under a blue sky. Figure 4 is of a large garden dial embossed with the hours and a simple map of Europe and North Africa. Readers will note that this dial is mounted on a trolley so that it can be wheeled outside for display.

Figure 5 illustrates a range of very much smaller horizontal garden dials that evoked considerable interest amongst the tourists visiting the picturesque village. All are made of what appears to be natural stone with the hours and images embossed or impressed in a variety of colours: primarily red, brown and green. I am unsure that the attractive colouring would survive in the bad weather of the North European climate. Nevertheless, they are all very attractive and priced from about £17 for the smallest up to £60 or more. I probably did not see the entire range. In addition to the horizontal dials the shop also stocks a variety of small dials such as Butterfield dials and ring dials made of bronze-coloured metal.

FIGURE 2: The second vertical dial in Talmont located on a house in the Rue de la Porte de la Ville; it bears the date '1809'.

FIGURE 3: The Talmont sundial shop.

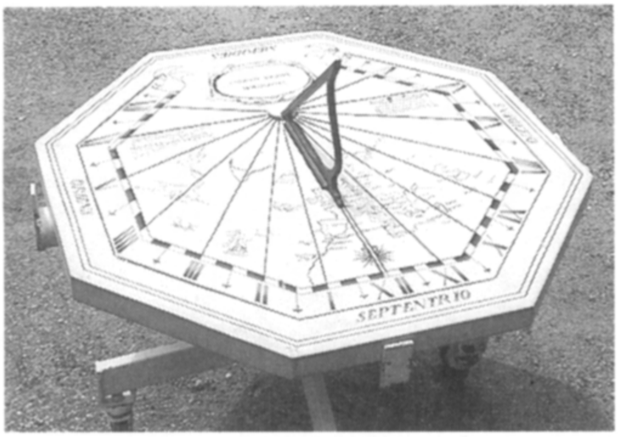

FIGURE 4: A large garden dial embossed with the hours and a simple map of Europe and North Africa. The dial is mounted on a trolley so that it can be wheeled outside for display.

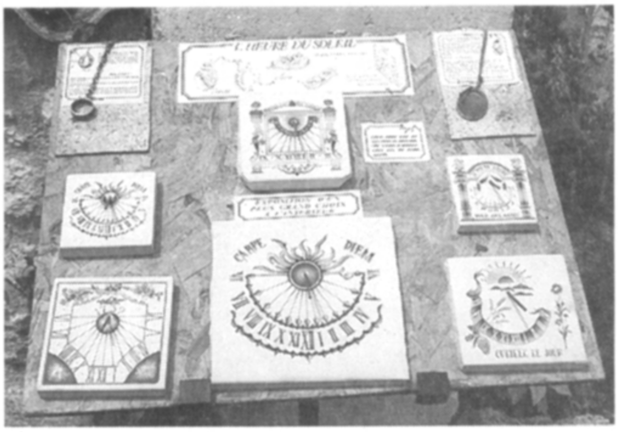

FIGURE 5: A range of small horizontal garden dials made of an apparently natural stone with the hours and images embossed or impressed in a variety of colours: primarily red, brown and green. Prices range from about £17 for the smallest up to £60 or more.

Additionally there was a set of five postcards of dials printed in colour, available for FF20 [about £2.50]. These cards can be turned into vertical or horizontal dials with a small amount of cutting with scissors; clear instructions in French are provided, and they make a most attractive collection which could be assembled during a cold and sunless British winter to provide a practical reminiscence of a small French village and its new and old sundials.

All the sundials including the card dials described are made by 'Artissime', 32 bits Route de Montelimar, F-26110 NYONS, telephone 75-26-03-94.

[Note: the author has no connection with the manufacturers of the sundials described, nor with any other sundial maker.]

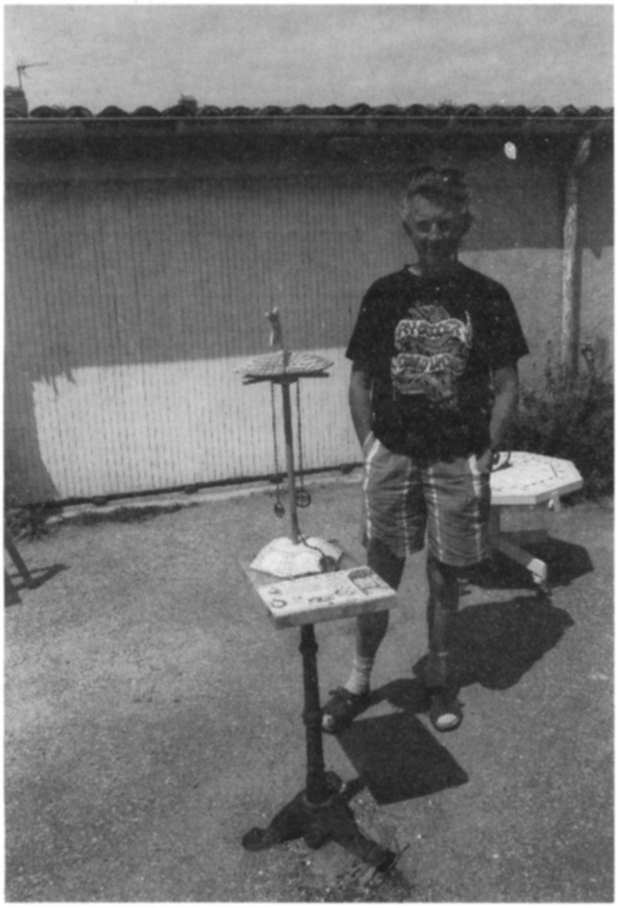

Figure 6

Figure 7

The author and some of the dials on sale in the sundial shop at Talmont *Charente Maritimes*

FOLLOW THE YELLOW BOOK CROWD

JANE WALKER

The Paris visit June 16th - 18th, 1995 was based on the book *Cadrans de Paris* ~~which~~ Peter and I came across on a visit to Paris in 1993, at the time we were unable to see any of the 109 dials listed as our transport was waiting and we were swept back to England before we could embark on a tour. There were detailed maps and enticing descriptions and so, fired with enthusiasm, we returned to Paris later in that year, visited 18 dials in one day and met one of the co-authors, Andrée Gotteland. Mme Gotteland was hesitant about leading a bus load of our members on a tour of Paris dials as she speaks very little English, but she agreed to do so.

The diffuse membership of our society works against organising anything in a hurry and it wasn't until the AGM of 1994 that we were able to judge the response to the idea of a weekend in Paris. In the event, 47 members joined us travelling from as far as Inverness in the North and Dublin in the West.

During the winter, Walter Wells and I worked on the very enjoyable task of translating extracts from *Cadrans Solaires de Paris* to form a booklet in English *Sundials in Paris*. Held aloft, in its cover of 'BSS yellow', it proved a useful 'homing beacon' as we made our way through some of the crowded by-ways of Paris.

Three pick-up points were arranged, the first at Wellington College, Crowthorne, at 6.30am, then in central London and the last at a service station on the M2. Everyone was on time, and the journey passed pleasantly until we reached the outskirts of Paris at 5pm where we found the *circulation tres difficile!* We had picked the same weekend as the Paris airshow (they didn't consult me!) and it took 2 hours to penetrate the *boulevards, rues* and *places* that led to our hotel in the *Rue de Rivoli*. Fortunately our itinerary allowed for a fairly casual approach on Friday evening and by 10pm we were all fed and able to enjoy a late stroll through sunlit squares and streets before turning in.

Saturday morning was fine and warm though cloudy when Mme Gotteland arrived to conduct us through a sundial day starting with a visit to the church of *Saint-Gervaise-Saint Protais* where the oldest dials in Paris (1578) form a pair of verticals on the South Transept. The coach then took us, through what often seemed like a series of passageways rather than streets - certainly they were never intended to take a coach, - to the *Hotel des Ambassadeurs de Hollande* with its 4 painted wall panels, to a modern, fibre optic, dial at the *Jardin des Halles*, and to *Les Invalides* before dropping us off at a self service restaurant in the *Avenue de la Motte Piquet* with 20 dials under our belts before lunch!

The afternoon tour was on foot and started with the meridians of St Sulpice. The group had thinned out a little by this time as not everyone felt up to an afternoon of walking the streets of Paris, but it lost cohesion altogether when our route led us through a fascinating antique market. One find of a horological nature was reported but the price ticket has so many noughts it was hardly worth translating. When our guide reached the steps of St Sulpice and looked round she found herself alone. During the afternoon we 'clocked up' another 14 dials before giving in not because we had exhausted the *cadrans* but because they had exhausted us. Mme Gotteland had given us a thoroughly enjoyable day and although many of the dials are open to the public and can be visited at any time she had arranged for us to see several which would not have been accessible without prior arrangement.

Saturday evening saw us at the *Restaurant Panoramic* where we were joined by Suzanne de Barbat and the president of the *Societe des Cadrans Solaire*, Denis Savoie. This was an enjoyable occasion dining with friends and making inter societal contact in Franglais. The restaurant rose to the occasion with a gateau decorated with a sundial - or perhaps it was a *cadran solaire!*

A plan to visit the *Tour de Montparnasse* was abandoned due to 'driver fatigue' - but it leaves a treat in store for another visit.

Continued on page 39

SUNLIGHT AND SHADOWS
Or, What's The Point of Big Sundials?

ALLAN A. MILLS

Marcel Minnaert, in his 60 years old - but perennially fresh - little book *The Nature of Light and Colour in the Open Air*[1] encourages us to stand in sunlight and closely examine our shadow thrown on the ground. It will be observed to be sharp near our feet but increasingly fuzzy towards the head: the resolution of any shadow cast by the Sun decreases as the shadow length increases. This is, of course, a result of the fact that the Sun (unlike every other star) does not appear as a point source, but rather as a radiant disc of real angular diameter.

UMBRA AND PENUMBRA

The darkest part of a shadow cast by the Sun (or any extended source) is conventionally known as the *umbra*, and the paler part, imperceptibly shading into the region of full illumination, constitutes the *penumbra*.[2] The exact boundary between umbra and penumbra is not specified, but most people will, if pressed, point out a line that appears to them to more or less divide the two areas. There is normally little argument about the time indicated by a garden sundial (this is quite distinct from its accuracy) but the long shadow thrown by a tall pillar or gnomon may well be so indistinct as to bring into question the merit of building a large sundial. Where exactly is the timetelling 'edge' of the index shadow?

The distribution of light within shadows cast by the Sun is therefore of importance when considering the real - as against theoretical - advantages of large instruments built in the past. This sounds like a typical piece of 19th century optics, but no discussion has been traced in the literature. It will therefore be attempted here.

GEOMETRY

The average angular diameter of the solar disc as seen from the Earth is 0.53°, or 32 arcminutes. As a result it is not a source of truly parallel light, but rather of bundles of rays falling within a 1/2° cone. This is illustrated in figure 1.

A horizontal wall or the apex of a roof will gradually occlude more and more of the Sun's disc as it is approached, so that (if viewed through a suitably dense filter) one might see the appearance diagrammed in small circles in figure 1. The Sun will be completely uncovered in the 'geometrical full illumination', completely obscured in the 'geometrical full shadow', and half covered somewhere in between.

Figure 1 also shows that the width W of this zone of varying illumination (I shall call it the 'geometrical penumbra') when received on a surface at right angles to the incident sunlight is given by the expression:

$$
\begin{aligned}
W &= d \times 0.53^\circ \text{ converted into radians} \\
&= d \times 0.0093 \\
&= d / 108
\end{aligned}
$$

At distances around 100mm involved in small equatorial dials the entire geometrical penumbra is therefore of the order of 1mm and is easily ignored, but in larger dials (particularly when projection upon a horizontal or vertical plane is involved) the increasingly indistinct shadow may well cause concern and limit accuracy.

GEOMETRY PLUS BACKGROUND ILLUMINATION

On geometrical considerations alone, the intensity of

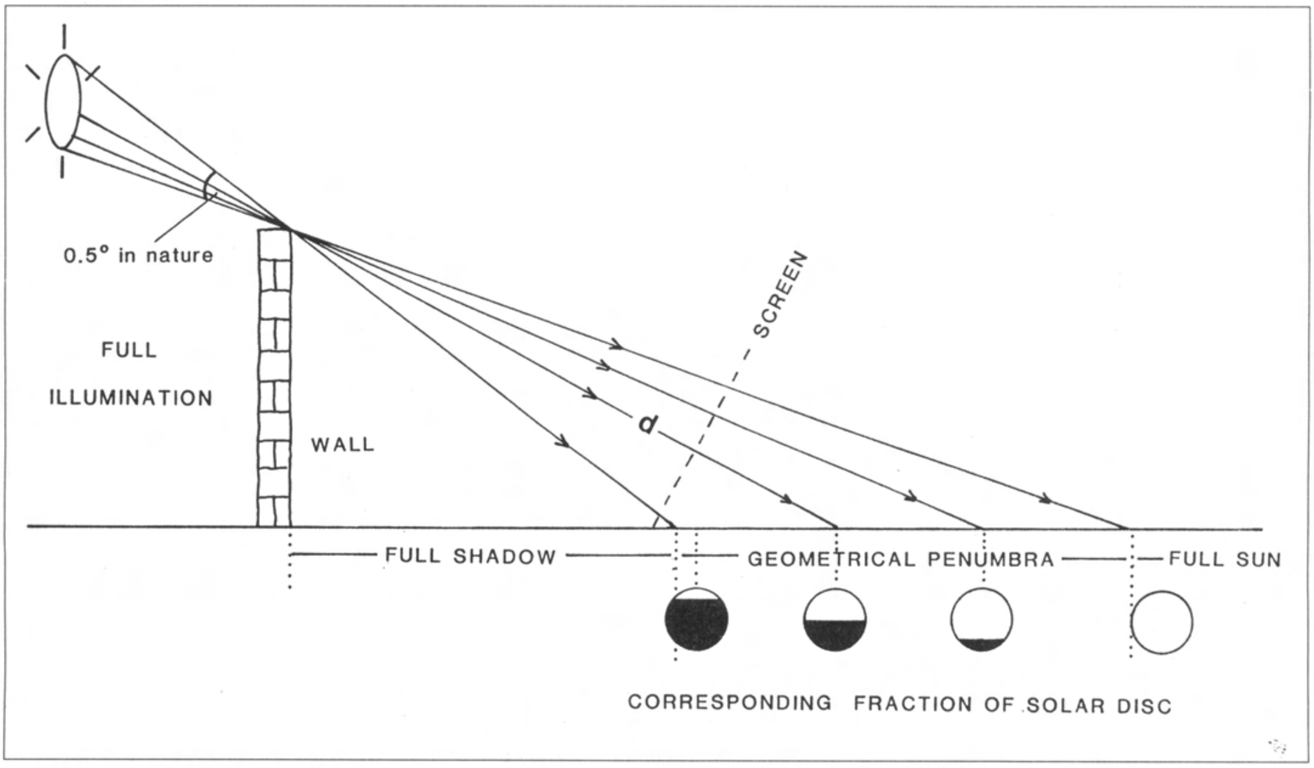

FIGURE 1: Gradual occlusion of the disc of the sun by the upper edge of an opaque barrier (e.g. a wall). Not to scale.

illumination received at any point within the geometrical penumbra will (if we neglect the slight oblatness of the Sun) be measured by the ratio:

$$\frac{\text{Area of exposed segment of a circle}}{\text{Area of the entire circle}}$$

This ratio was calculated at 1 unit intervals for a circle of radius 10 units by using a standard formula of mensuration.[3]

However, account must be taken of the fact that, in any real outdoor situation, scattered daylight from the blue sky,

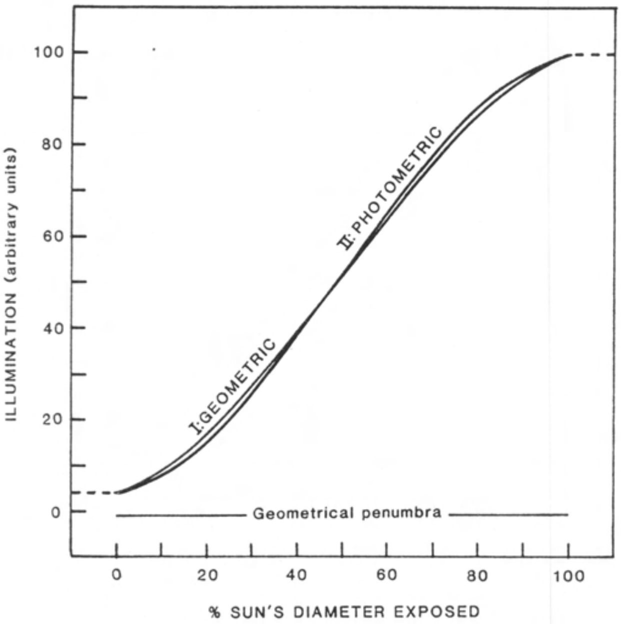

FIGURE 2: Arithmetic plots of illumination vs. distance within the geometrical penumbra, normalized to a maximum of 100 arbitrary units.

white clouds etc. always falls upon the shadowed area. We have no difficulty seeing grass in the shadow of a wall! The ratio between the illumination in full sunshine and that in full shadow as determined with an SEI 'Minilux' photometer. (This instrument is intended to measure light levels in various indoor situations, so the sensitivity had to be reduced by covering the photocell with three thicknesses of paper.) A ratio of 25:1 between the two readings was obtained: *i.e.* the light falling upon the shadowed area was 4% of that illuminating the sunlit area. This measurement was made on an Autumn day with scattered cumulus clouds, and is thought to represent a typical figure.

A constant was therefore added to every term in the tabulation of geometrical areas so that the new totals, when nomalized, extended from 4% to 100%, representing full shade to full sunlight. The result is plotted as curve I in figure 2. It is a sigmoid shape, as would be expected from the symmetrical nature of the geometry involved.

Bands due to Fresnel diffraction at the straight edge of a shadow-casting obstacle play no part in the formation of ordinary shadows: even if the Sun were a point source they would be only a few millimetres wide at distances measured in metres.[4]

LIMB DARKENING

However, the Sun's disc is not uniformly bright: almost every introductory textbook of astronomy includes a photograph demonstrating its 'limb darkening'. This decrease in intensity towards the edge is a result of the radiation emanating from the photosphere being obliged to traverse increasing thickness of the absorbing solar 'atmosphere'. Experimental measurements of the quantitative diminution of intensity with solar radius are available.[5] These were used to obtain the mean emissivity of zones of the Sun as a fraction of unity at the centre, and then combined with the corresponding geometrical areas to give curve II in figure 2. It is slightly steeper than the unmodified curve I.

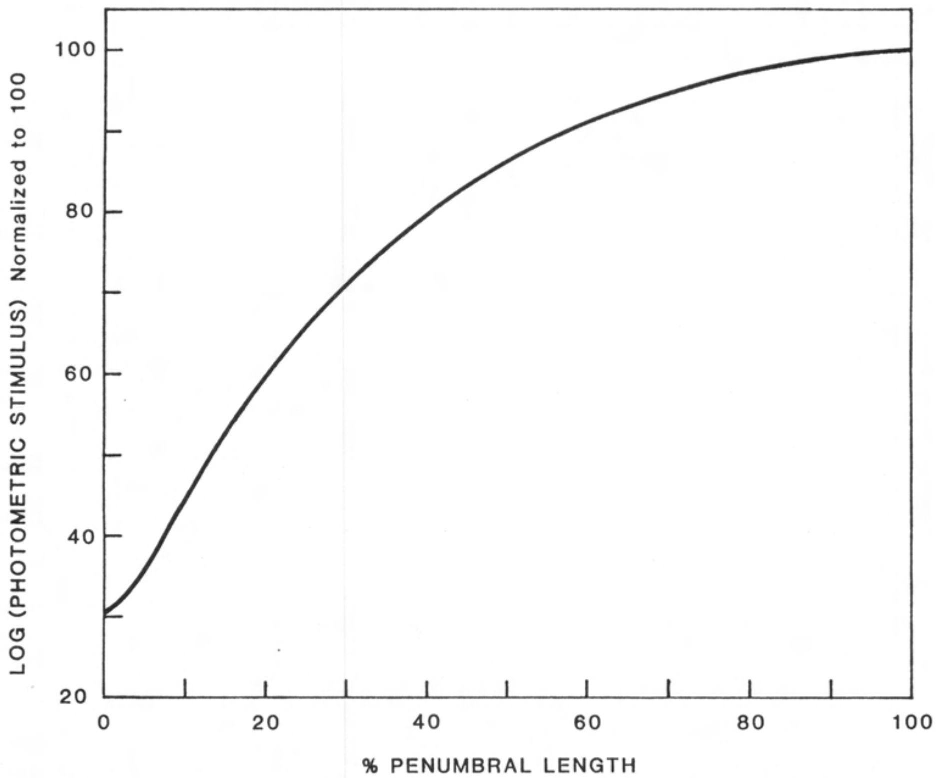

FIGURE 3: Plot of log (stimulus) vs. distance within the geometrical penumbra, normalized to a maximum of 100 arbitrary units.

A photometer with a pinhole aperture traversed through the geometrical penumbra would be expected to give an output signal approximating this 'photometric' curve. In practice, to achieve accuracy the advance of the entire shadow with time would have to be nullified. This is the purpose of a heliostat.[6] Again the exact curve will vary with conditions: intensity of background light, presence of haze near the Sun, etc, etc.

VISUAL PERCEPTION: LOGARITHMIC RESPONSE

It might initially be expected that the eye would discern the point of greatest slope on the photometric curve as the 'edge of the shadow'. This occurs at 50% of the length of the geometrical penumbra, where the sun is half covered, but this point falls within a broad region (30 - 70%) that is almost linear, and so of nearly identical gradient. Natural shadows seem to be more closely defined than this.

The pioneering experimental psychologist Gustav Fechner (1801-1887) demonstrated that, in common with our other senses, the eye/brain system exhibits an approximately logarithmic response: 'Fechner's Law' states that *the sensation varies as the logarithm of the stimulus*.[7] The numerical results giving curve II were therefore converted into logarithms to the base 10, normalized to 100%, and plotted as figure 3.

A very different curve emerged. It fell slowly from 100% illumination, but gradually increased in slope to reach a maximum gradient between 15 and 5% of the geometrical penumbral extent. The slope then diminished between 5% and zero, the latter representing the beginning of the full geometrical shadow. Presumably a photometer adapted to give a logarithmic response would give this form of curve, but only direct experiment will show if the human eye/brain 'sees' an edge in the region of maximum gradient.

VISUAL PERCEPTION: MACH BANDS

When a young man, the versatile physicist Ernst Mach (1838-1916; best known as the originator of the 'Mach number') placed a piece of white card alongside a piece of grey card, and uniformly illuminated the combination in a sunlit place well away from any shadows. He noticed that a dark band appeared to be present in the grey zone near the boundary, with a brighter white band just over the border into the white area. These contrast effects have therefore come to be known as Mach bands.[1,8] They have no real physical existence, and so are not detected by a photometer, but may be an evolutionary response of the brain to help 'sharpen up' the edges of objects in the visual field.[9]

Being a purely subjective illusion, it is not possible to enter Mach bands quantitatively in figure 3. Presumably they could help sharpen any perceived edge towards the dark end of the geometrical penumbra, but the transition into full illumination at the opposite end is so gradual that contrast bands are neither expected nor perceived. In this respect one of Minnaert's diagrams[10] appears to be in error.

EXPERIMENTAL INVESTIGATIONS

Theoretical predictions should always be checked against experimental results. To do this, the simple device shown in figure 4 was constructed. It consisted of a plano-convex lens of 100cm focal length (*i.e.* 1 dioptre) taped over a 10mm aperture in a rectangle of card. On the centre line below the lens was another hole covered by a piece of black paper, in which was pricked a 1.5mm diameter pinhole.

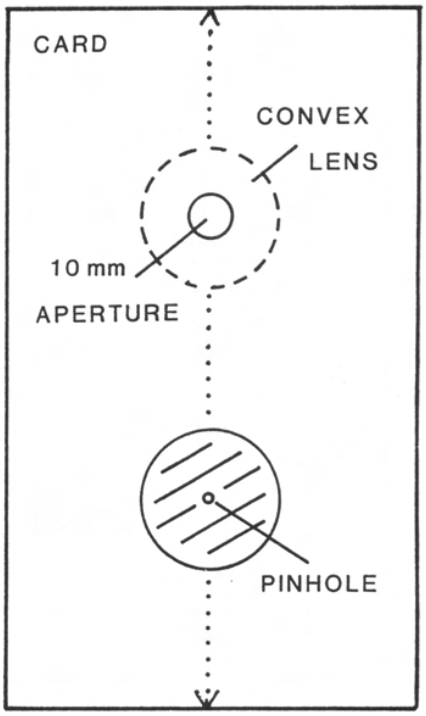

FIGURE 4: Card bearing a convex lens (500-1000mm focal length; 10mm aperture) and a pinhole, with their centres on the same vertical line.

The shadow thrown by a corner of the house was received upon a white board set normal to the incident light and about 7 metres from the relevant portion of the vertical edge. By introducing the mounted lens from the side, and adjusting its distance from the screen, it was found possible to produce a sharp image of the shadow-casting edge of the wall. This was superimposed upon a slightly out-of-focus image of the Sun. A small movement inwards reversed the situation. By moving the lens-card from side to side it was possible to set the marked central line over any part of the geometrical penumbra, and observe the area of the Sun that was responsible for the illumination at that point (Figure 5). It was found that:

a) The unassisted eye perceived an 'optimum shadow edge' that could be defined to within 3 or 4mm. A number of observers agreed with the placing within this margin. (It is this fuzzy region that is sometimes referred to as the penumbra.)

b) The beginning of the geometrical penumbra was marked by the image of the wall just beginning to cut into the image of the disc of the Sun. This was at a distance of about 60mm from the shadow edge noted above, but no change in the illumination on the screen was perceptible to the unassisted eye.

c) The bisected sun was not represented in any particular way within the geometrical penumbra, so the eye is indeed not reacting to the maximum gradient of the photometric curve.

d) The perceived edge of the 'optimum shadow' corresponded to a point where just a little of the sun remained uncovered. The measurements included in

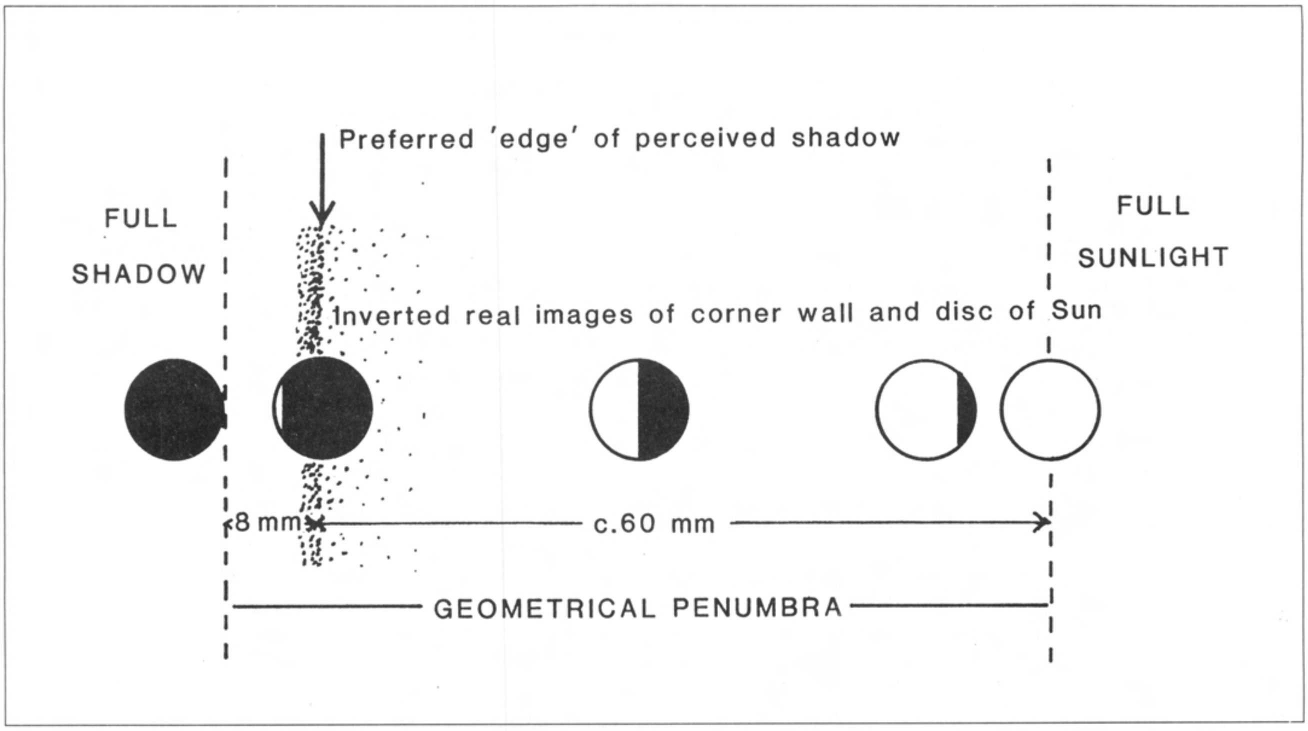

FIGURE 5: Apparent visual edge of the shadow cast by a vertical corner wall 7m away, with the observed fraction of the Sun's disc responsible for the illumination at given points within the associated geometrical penumbra.

figure 5 are subjective and very approximate because of the overall motion, but correspond to about 12% of the Sun's diameter being uncovered. This is in satisfactory agreement with the logarithmic response curve of figure 3, but should obviously be checked with the heliostat.

e) The image of the Sun did not entirely 'wink out' until about 8mm further into the perceived shadow beyond the chosen 'edge'.

f) The images produced by the pinhole were much the same, but were characteristically slightly fuzzy and of much lower intensity. The bright segment produced by the exposed portion of the solar disc was easiest to see, and appeared to 'wink out' at a point practically coincident with the perceived 'optimum shadow edge'. This wink-out point could be located to better than a millimetre, but as it was moving all the time it was easiest to note the instant in time when it crossed a pre-existing mark.

LARGE SUNDIALS

We are now in a position to examine the timetelling ability of big sundials. On a purely geometrical basis the width of a division representing one unit of time increases linearly with distance from the gnomon, but so too does the width of the geometrical penumbra. This would mean that large instruments have no advantage whatsoever! Fortunately things are not quite so bad as this, for we have seen that various factors enable us to perceive a reasonably definite 'edge' to the shadow cast by a distant wall. This is not the same as resolving a narrow cylindrical gnomon or a pointed index: a television aerial projecting from the roof of my house is not discernible at all above the shadow of the apex thrown upon the lawn. For the same reason a flying bird casts no shadow.[11]

Nevertheless, people have not infrequently invested considerable trouble and expense in the construction of large sundials embodying 'sharp' gnomons of some sort or another. Modern examples tend to be monuments[12] or architectural features,[13] and are not primarily intended as accurate time-tellers. But this was not the case in the past, particularly for structures built before the application of telescopic sights and the spread of the mechanical clock. These instruments were clearly made large so that the scale would be long, and smaller divisions of angle (equivalent to smaller divisions of time) could be engraved upon it. Well known examples are the 'Dial of Augustus' in Rome,[14,15] and the huge equatorial dial built at Jaipur in India by Maharaja Jai Singh in the 1720s (Refs. 16-20 and figure 6). The radius from the appropriate edge of the solid sloping wall constituting the gnomon to the curved scale is about 15 metres, so the shadow will in theory move close to 1mm per second. However, the geometrical penumbra will be 14cm wide. Although a curved staircase provides access to the scale divisions, I doubt if it would be possible to define the perceived edge of the shadow to better than ±2cm, equivalent to ±20 seconds of time. This is an order of magnitude poorer than might be expected by considering only the size of the structure, and definitely would not satisfy Jai Singh's desire for accurate timekeeping and the production of improved astronomical tables. (He was a knowledgeable astronomer in his own right, and built other observatories at Delhi, Ujjain and Benares.[17]) Could there have been some method of improving definition within the shadow that has been forgotten over the centuries?

THE 'SHADOW SHARPENER'

The lens card used to explore the distribution of light within the penumbra gave a clue, for it was found perfectly possible to project a sharp image of the above-mentioned rooftop TV aerial in silhouette against the disc of the Sun. The pinhole did the same, although less clearly and at a lower intensity.

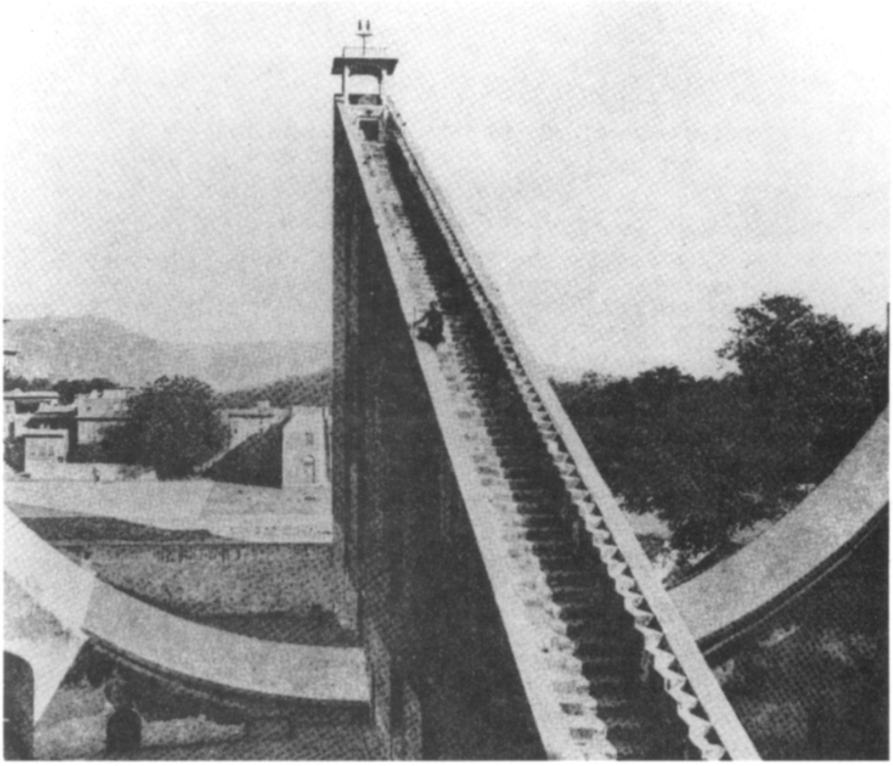

FIGURE 6: The great equatorial sundial (*Samrat Yantra*) of Jai Singh at Jaipur, India. (After Cousins[18])

It should be noted that, strictly, these images are not 'sharpened-up' versions of the *shadow* of the aerial: they are simply inverted real images of the back-lit object itself. Nevertheless, in conjunction with the image of the solar disc, they accurately indicate the direction of an imaginary line joining any shadow-casting element ('gnomon' or 'stile') with the centre (or either limb) of the sun - and this is exactly what is required for timekeeping purposes.

Spectacle lenses would surely have been available to Jai Singh (with their high value to weight ratio they are an excellent item for trade) so that a board with a lens mounted in it could have been constructed. This accessory would have enabled the true edge of the massive masonry gnomon to be defined clearly enough on the scale for it to be set on the solar limb or across its diameter - whatever had been chosen when constructing the instrument. The astronomer-in-charge could then determine time to within seconds. In the absence of a lens a pinhole would do, most easily by noting the point on the scale where the residual solar image 'winked out'. If contemporary documents exist, they might contain some otherwise enigmatic reference to auxiliary apparatus of this nature.

FIGURE 7: The 'Tower of Chou Kung' at Gaocheng, some 50 miles SE of Luoyang, north-central China. (After Needham[20].) The horizontal iron bar constituting the gnomon had not been restored when this photograph was taken.

However, it is not necessary to await such research, for fortunately one document that has come down to us from medieval China does mention such a device. The 'Tower of Chou Kung' was built around A.D. 1276 in north-central China to determine the days of the solstices as accurately as possible for calendrical and divinatory purposes.[20] It still exists (Figure 7) and is essentially a giant noon mark with a graduated meridian scale, the gnomon being a horizontal iron bar set 32 feet above the scale. The level construction of the latter was checked against built-in water troughs, so this was obviously a high quality instrument designed to cope with the slow variation in the Sun's declination around the solstices. An indistinct or non-existent shadow of the bar-gnomon would be useless, but fortunately a contemporary document - the *Yuan Shih* - contains an account of what seems to have been a new invention at the time. Needham (ref.20, p.229) translates the relevant passage as follows:

> "The shadow definer (*'ying-fu'*) is made of a leaf of copper 2" wide and 4" long, in the middle of which is pierced a pin-hole. It has a square supporting framework, and is mounted on a pivot so that it can be turned at any angle, such as high to the north and low to the south (*i.e.* at right

angles to the incident shadow-edge). The instrument is moved back and forth until it reaches the middle of the (shadow of the) cross-bar, which is not too well defined, and when the pin-hole is first seen to meet the light, one receives an image no bigger than a rice grain in which the cross-beam can be noted indistinctly in the middle. On the old methods, using the simple summit of the gnomon, what was projected was the upper edge of the solar disc. But with this method one can obtain, by means of the cross-bar, the rays from the centre of the disc without any error . . ."

The bar-gnomon was missing when Needham was preparing the text, and this led him to postulate an incorrect usage, but a replacement has now been fitted. An account of a visit, with subsequent re-enactment of the use of a 'shadow definer', has recently been published by Krupp.[21]

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Continued from page 15

TWO UNUSUAL MASS DIALS IN DORSET

TABLE II
East dial, solar declination +4°

Line azimuth	78°	88	100	115	140	157	160	188
Nominal time	-	06^h	07	08	10	11	11	1230
Calculated time	-	0603	0704	0815	0955	1051	1101	1223
Difference	-	$+3^m$	+4	+15	-5	-9	+1	-7

Although the r.m.s. difference is quite small ±8 minutes, the match is not entirely satisfactory. There is no match to the first line (the sun rises too far south to cast a shadow on this line), and there is no dial line corresponding to 9a.m. Either of the two close lines (157° and 160°) might indicate 11a.m.

Two holy days correspond to a solar declination of +4°, March 25 (Lady Day) and September 8 (festival day of St Mary the Virgin). Subject to the above reservations, the dial might represent either.

SUMMARY AND CONCLUSIONS

The existence of these dials is intriguing and if not unique, they are certainly very rare. No local or church historian has thought fit to discuss them or their possible significance.

The line analysis has shown that the dials may just possibly be intended for use as mass dials drawn on near-horizontal surfaces, a naive attempt because the errors would be very large. It is also possible that they are transitional between mass dials (with their presumed horizontal gnomons) and scientific dials.

The preferred explanation however is that they are azimuthal dials designed to show the time on certain specific holy or festival days. It is possibly significant that there are two dials, one 'better' than the other, which could suggest development and improvement of an initial idea. Without any written history or record it is not possible to do more than speculate. Now that the dials are in the record, we hope that further discussion and evidence may shed more light on these instruments.

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MASS (PRODUCTION) DIALS

A. F. BAIGENT

I was very interested in reading "Fundials" by John Lester in the October 1995 BSS Bulletin. For many years my wife has run sales in aid of the RSPCA, and originally I made bird boxes, bat boxes, and similar items for her to sell. Although I did not expect the price to cover the true cost, I did hope to cover the cost of the wood. As this seldom happened, I then looked for a different means of providing things to sell and decided upon a horizontal sundial.

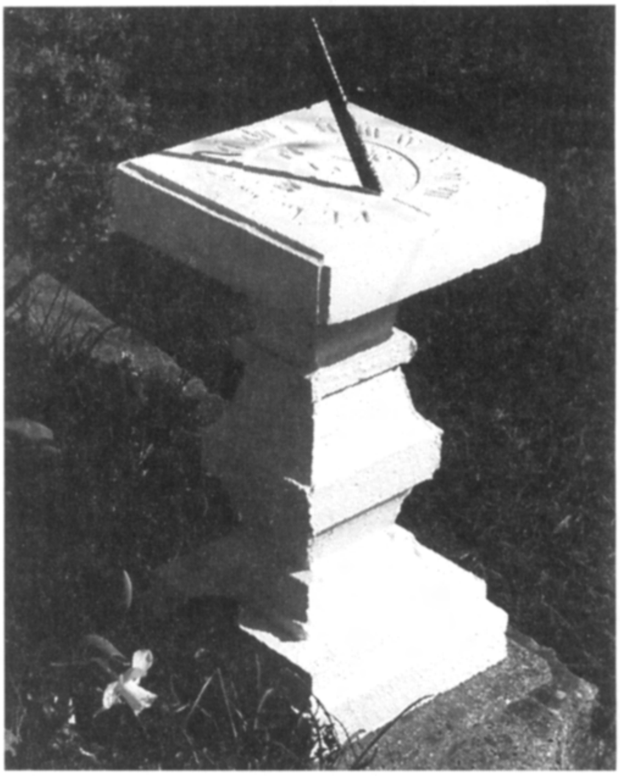
My aims were:

1. The dial should be cheap to make.
2. It should take under an hour to make each dial.
3. The dial should be as accurate as possible, not just an ornament.
4. It should have appeal for both "non-sundial" enthusiasts and for keen gardeners.
5. The sundial should be durable and weather resistant.

With these aims in mind, I decided upon concrete and steel as my main materials for the manufacture, which, in the quantities required for each dial, should cost no more than 25 pence.

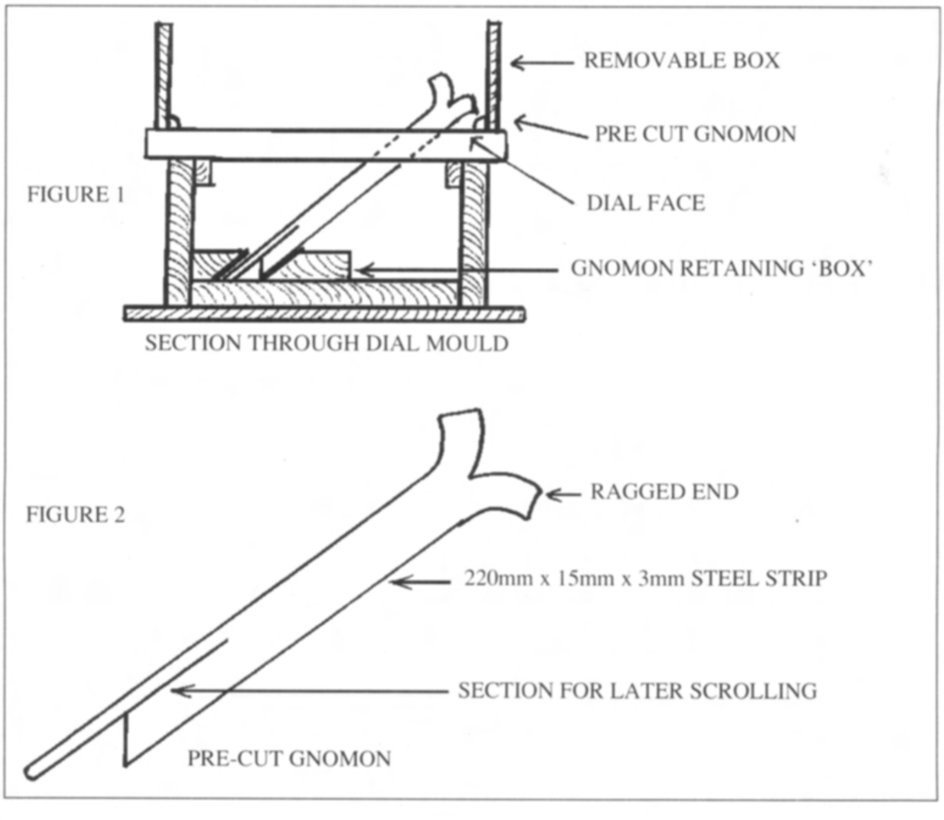
A temporary mould was constructed using formica covered wood as a base on which to cast the face. A piece of plastic downpipe was heated, flattened, and from the resulting sheet, letters and numerals were shaped. These were pinned to the formica face in the correct laterally inverted positions. The ends of the hourlines were indicated by round-headed escutcheon pins placed in a disc of formica, and another to give compass directions.

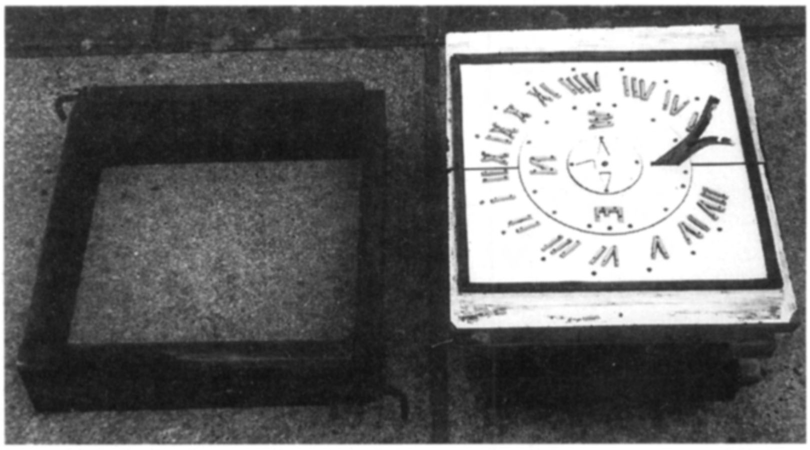
A slit was cut into the mould face to allow the steel gnomon to pass through at an angle of 52°. The exposed end of the gnomon was supported in a "box" in the mould support - see Figure 1. A rim of square section was fixed around the surface, with a removable box fitted round the assembly to hold a 75mm depth of concrete.



Completed Dial

The material for the gnomons was obtained from the steel strips of old folding pushchairs, ragged at one end to ensure a good grip in the concrete, and the free and shaped for later scrolling, see Figure 2.





Removable Box and Mould Dial Face

Before casting commenced, the mould was painted with old engine oil to act as a release agent and the gnomon placed in position. The filling was a 3:1 mix of sharp sand and cement, mixed thoroughly and rather wetter than normally desirable for ordinary work, tamped well into the box section. The concrete was then left to harden for about three days before being turned out of the mould to cure for a few weeks. The dial was then coated with white masonry paint, which helps to cover up any minor blemishes in the concrete surface and makes the dial water resistant. The gnomon was then scrolled and painted black.

I was so pleased with the performance of my "temporary" mould that its status was raised to that of permanent, and it has helped in the making of over 100 dials, the sales of which have raised about £500 for the RSPCA over the last fifteen years.

...Whilst most of my dials are to be seen in local gardens, some have travelled to Scotland and Wales, and one even to Australia. When I see them set up in friends' gardens, I wonder sometimes why I spent so much time with concern for accuracy of indication, for most are set anywhere but true North/South, and many have been positioned in full shade!

WHERE IS THE SUN?

GORDON E. TAYLOR

There must be a number of members like myself who have been consulted on the best way of orientating a sundial. A rough idea can be obtained from an ordinary magnetic compass providing that (1) there are no large metallic objects nearby and (2) that the deviation of the needle from true north has been determined for the date and the place in question. In general building plans cannot be relied on for the alignment of walls for the erection of vertical dials.

It is obviously much more accurate to use the position of the Sun. Ideally one observes it on the meridian but this is often frustrated by cloud, particularly in this country. This was certainly my experience when setting up the Seven Dials sundial in Covent Garden in 1989. I observed the Sun on any azimuth that was available, firstly on the ground for the benefit of the builders, and later at the top of the monument when the stone block bearing the dials had to set in position. To facilitate the calculations I wrote a computer program which gives the azimuth of the Sun for any place on the Earth's surface and for any date and time. The mathematical formulae used to calculate the position of the Sun are valid for the years A.D. 1900-2100 to an accuracy of about 0.01 degrees. The program will run on any IBM-compatible computer and is now available to any member from the Editor - just ask for the package SUNAZALT.

The output gives for any place, for any date-time or range of date-times, the azimuth and altitude of the Sun to a precision of 0.1 degrees. The time of transit is given, together with an indication of whether it occurs before or after the requested time. Also tabulated is the Sun's right ascension, declination and local hour angle. The time may be input to the nearest minute, or even to the nearest second, if required. An example of the output is given below:-

LONG. (W) 2.500 LAT. 51.300

U.T.						AZIMUTH	ALTITUDE	TRANSIT			R.A.		Dec.	L.H.A.
y	m	d	h	m	s	o	o	h	m		h	m	o	o
1996	3	20	6	30	0	92.5	1.9	12	17.4	a	23	59.8	-0.03	-86.87
1996	3	20	7	0	0	98.3	6.6	12	17.4	a	23	59.8	-0.02	-79.37
1996	3	20	7	30	0	104.3	11.2	12	17.4	a	23	59.9	-0.01	-71.87
1996	3	20	8	0	0	110.5	15.7	12	17.4	a	0	0.0	-0.00	-64.36
1996	3	20	8	30	0	117.0	20.0	12	17.4	a	0	0.1	0.01	-56.86
1996	3	20	9	0	0	123.8	24.0	12	17.4	a	0	0.1	0.02	-49.36
1996	3	20	9	30	0	131.0	27.8	12	17.4	a	0	0.2	0.02	-41.86
1996	3	20	10	0	0	138.8	31.1	12	17.4	a	0	0.3	0.03	-34.36
1996	3	20	10	30	0	147.0	33.9	12	17.4	a	0	0.4	0.04	-26.86
1996	3	20	11	0	0	155.8	36.2	12	17.4	a	0	0.5	0.05	-19.36
1996	3	20	11	30	0	164.9	37.8	12	17.4	a	0	0.5	0.06	-11.85
1996	3	20	12	0	0	174.4	38.6	12	17.4	a	0	0.6	0.07	-4.35
1996	3	20	12	30	0	184.0	38.7	12	17.4	b	0	0.7	0.07	3.15
1996	3	20	13	0	0	193.6	38.0	12	17.4	b	0	0.8	0.08	10.65

PORTABLE RING SUNDIAL

BY COLIN J. THORNE

"PLANS FOR CLOCKMAKERS"

Sundials must be designed for the latitude on which they are to be used, although some types can be adjusted for different latitudes. The ring dial is a non-adjustable type and tells the time from the sun's altitude, not its azimuth or hour-angle.

First you must compile a table of the sun's altitudes for the hours of the day on certain dates of the year. The first dates of the Zodiac months are used because they relate to the sun's annual cycle, calendar months are arbitrary in this respect.

You need to know your latitude. If you do not already know it you will find it in the margin of any good map or atlas. The nearest whole degree is sufficiently accurate for this little dial.

The equation for determining the sun's altitude is:-

$$\sin A = \sin D \sin L + \cos D \cos L \cos H$$

where A = the sun's altitude
D = the sun's declination, see table below.
H = the sun's hour-angle; equal to 15° for each full hour either side of noon. E.g. for 11am and 1pm H = 15°, for 10am and 2pm H = 30°, etc.
L = your latitude

The sun's declination is its altitude relative to the plane of the celestial equator as follows (to nearest ½°; Northern hemisphere):-

Aries	♈	March 21	0°
Taurus	♉	April 20	11½°
Gemini	♊	May 22	20½°
Cancer	♋	June 21	23½°
Leo	♌	July 21	20½°
Virgo	♍	August 23	11½°
Libra	♎	September 23	0°
Scorpio	♏	October 23	-11°
Sagittarius	♐	November 22	-20°
Capricorn	♑	December 22	-23½°
Aquarius	♒	January 21	-20°
Pisces	♓	February 20	-11°

NOTE: For the Southern hemisphere the positive and negative signs are transposed, i.e. the April to August figures are negative (minus) and the October to February figures are positive.

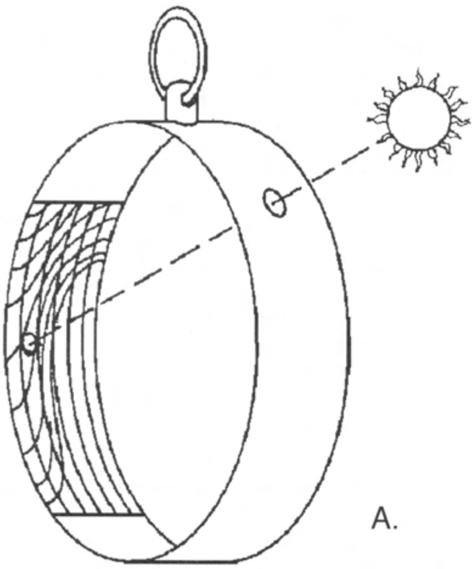
The table below shows the sun's altitudes for the hours of the day on the above dates for the latitude of 51° North (Southern England).

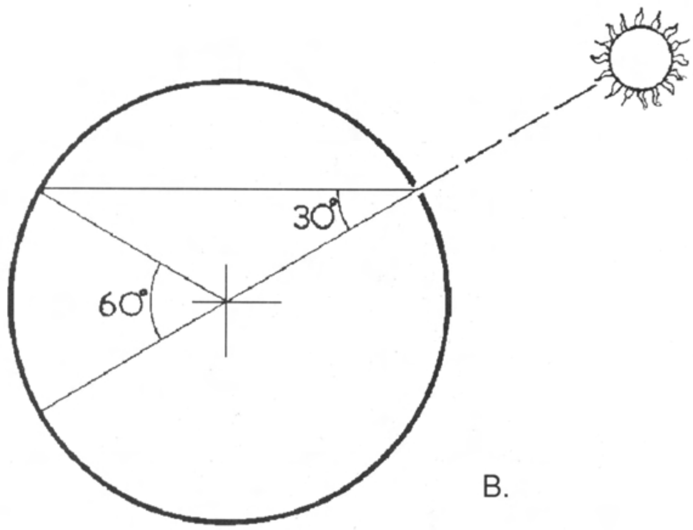
Lat. 51° N	♋ Jun 21	♊♌ May 22 Jul 21	♉♍ Apr 20 Aug 23	♈♎ Mar 21 Sep 23	♓♏ Feb 20 Oct 23	♒♐ Jan 21 Nov 22	♑ Dec 22
Noon	62.4	59.4	50.5	39	27.8	19	15.6
II-I	60	57.2	48.6	37.4	26.4	17.8	14.4
IO-2	54	51.4	43.6	33	22.6	14.3	11
9-3	45.8	43.5	36.2	26.4	16.6	8.8	5.7
8-4	36.7	34.5	27.6	18.3	9.1	1.7	-
7-5	27.3	25.1	18.3	9.4	0.5	-	
6	18	15.7	8.9	0	-		
5-7	9.2	6.8	-				
4-8	1.1	-					

Using a "scientific" pocket calculator or a book of sine tables complete the table below for your latitude.

	♋ Jun 21	♊♌ May 22 Jul 21	♉♍ Apr 20 Aug 23	♈♎ Mar 21 Sep 23	♓♏ Feb 20 Oct 23	♒♐ Jan 21 Nov 22	♑ Dec 22
Noon							
II-I							
IO-2							
9-3							
8-4							
7-5							
6							
5-7							
4-8							

THE PRINCIPLE OF THE RING DIAL





A. The dial is suspended with the gnomon hole facing the sun to cast a spot of light on the scale on the opposite inner surface of the ring, from which the time is read. The vertical columns represent the months and the diagonal lines the hours.

B. An angle subtended at the centre of a circle is twice that subtended at the circumference. Therefore, if the sun's altitude is 30° it will measure 60° of arc on the opposite side of the circle to the gnomon hole.

It therefore follows that if we make the inner circumference of the circle to be 180mm (360°/2) then each degree of altitude will equal 1mm on the scale.

The scale consists of 6 vertical columns, each representing two "complementary" months, e.g. Aries and Virgo, and a series of diagonal lines, each representing two "complimentary" hours, e.g. 9am and 3pm. As the sun's altitudes from December 22 to June 21 are a mirror image of those from June 21 to December 22 the hour scale can be "folded over" and only 6 monthly columns are required. This makes a more open and easily read scale.

"SUNDIAL TIME"

The sun does not tell Mean Time (clock time) but "Local Apparent Time". For each degree of longitude West of the local time meridian, from Greenwich, the sun is 4 minutes "slow" and for each degree East is 4 minutes "fast". The sun also varies in its timekeeping rate throughout the year, sometimes "losing and sometimes "gaining". This is known as the "Equation of Time". The monogram below indicates this "equation" throughout the year.

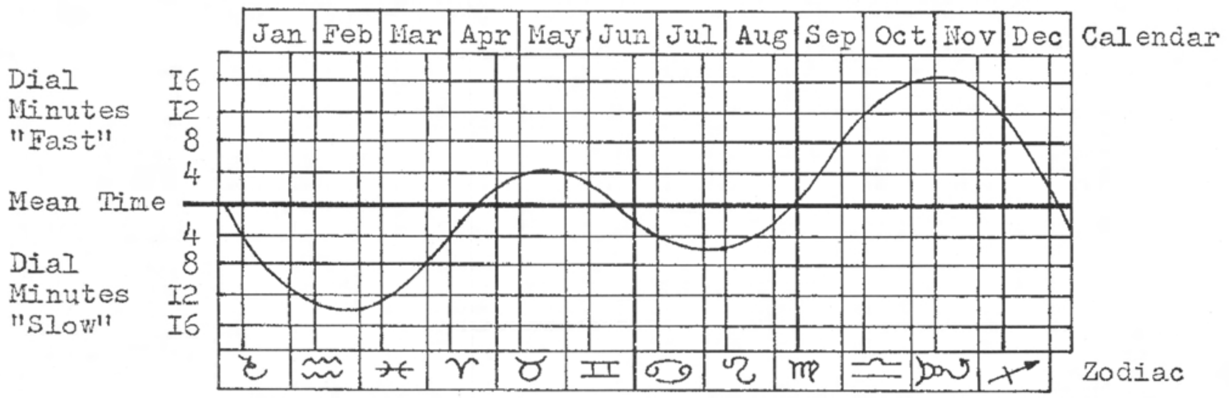
The equation of time and longitude corrections are expressed as a positive figure when the sun is "fast" or for longitude East and as a negative figure when the sun is "slow" or for longitude West. The equation + longitude correction is added to Mean Time to give Local Apparent Time and, conversely, subtracted from the time indicated by the sundial to give Mean Time. Allow for "Summer Time" if applicable.

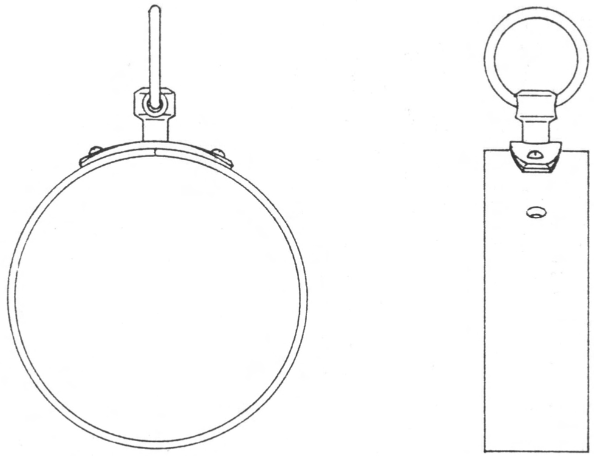
A sundial designed for a given latitude will tell true Local Apparent Time at any point around the globe on that latitude.

CONSTRUCTION NOTES

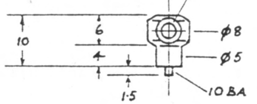
The ring is engraved "in the flat" before bending and silver soldering. Use soft brass or well annealed brass to facilitate easy bending around a former. Mark and centre punch the gnomon hole on what will be the outside surface of the ring but do not drill until after bending and soldering. Soft brass does not engrave easily with cutting tools. Use an "electric pencil" engraving tool with a straight-edge as a guide. It is worth making a thin plywood pattern as a guide for each of the curved hour lines, allowing for the radius of the engraver stylus. Draw numbers and Zodiac signs with a pencil as a guide and engrave over freehand. If you have not used the engraving tool before, practice on a piece of scrap brass first. Move the tool slowly and firmly and do not be tempted to go over a line a second time.

THE EQUATION OF TIME

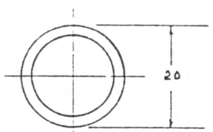




GENERAL ARRANGEMENT.

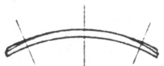


PENDANT. MATL BRASS.

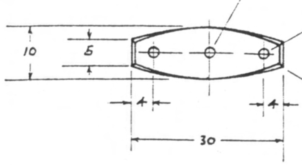


BOW. MATL Ø2 BRASS ROD

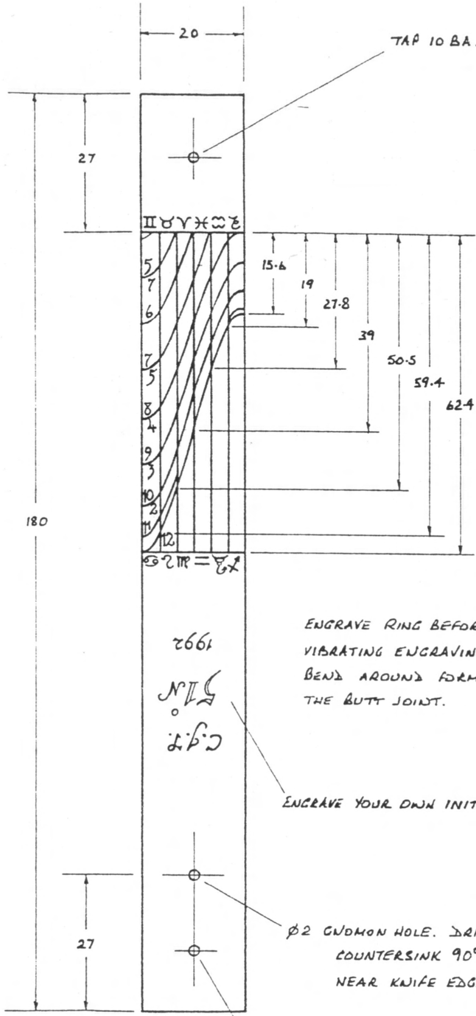
BEND AROUND FORMER. FIT THROUGH PENDANT & SILVER SOLDER BUTT JOINT.



PENDANT PLATE. MATL 1·5MM SOFT BRASS



SCREW PENDANT INTO PLATE & SECURE WITH SOFT SOLDER.
SECURE PLATE TO RING WITH 2 OFF 10 BA STEEL ROUND HEAD SCREWS.



TAP 10 BA. LOCATE FROM PENDANT PLATE AFTER FORMING RING.

HOUR LINES DRAWN ARE FOR LATITUDE 51° NORTH AS AN EXAMPLE. MEASUREMENTS GIVEN ARE FOR NOON LINE ONLY. SEE TABLE ON PAGE 2 OF SHEET 27/2-1 FOR MEASUREMENTS FOR OTHER HOUR LINES FOR THIS LATITUDE. (THE MEASUREMENTS IN MM. ARE EQUAL TO THE ALTITUDE IN DEGREES)

THE 11a.m - 1p.m. HOUR LINE IS PARTLY OMITTED TO AVOID OVERCROWDING THE SCALE.

YOU MAY PREFER TO ENGRAVE ONLY THE p.m. HOUR NUMBERS ALSO TO AVOID OVERCROWDING.

ENGRAVE RING BEFORE BENDING, USING AN "ELECTRIC PENCIL" VIBRATING ENGRAVING TOOL.
BEND AROUND FORMER TO FORM RING & SILVER SOLDER THE BUTT JOINT.

ENGRAVE YOUR OWN INITIALS, LATITUDE & DATE.

Ø2 GNOMON HOLE. DRILL AFTER FORMING RING. COUNTERSINK 90° INCLUDED ON OUTSIDE TO LEAVE NEAR KNIFE EDGE TO HOLE ON INNER SURFACE OF RING.

TAP 10 BA. LOCATE FROM PENDANT PLATE.

RING.

MATL. 1·5mm SOFT BRASS SHEET

RING SUNDIAL.	
C.J. Thorne LBHI ©	
plans for clockmakers	
date 2/8/95	drg no 27/2-2

THE STORY OF THE GUERNSEY LIBERATION MONUMENT

At the 1995 BSS Conference, a very interesting lecture was given by Mr. David Le Conte in respect of the monument erected to celebrate the occasion of the Island's liberation from the yoke of the occupying German Force. As the Editor did not receive a manuscript of this lecture, the following account is taken from the official leaflet.

BASIC OUTLINE: The Liberation Monument was planned as the focus of the major celebrations commemorating the Fiftieth Anniversary of the Liberation of the Channel Islands, and in particular Guernsey, on 9th May 1945. It was envisaged as "A marriage of Art and Science" to provide a lasting commemoration of Guernsey's long awaited liberation.

The Liberation Monument was designed by Eric Snell, and erected by the States Liberation Day Committee. Calculations of the shadow path of the tip of the obelisk acting as the sun shadow marker on the 9th May were carried by Mr. David Le Conte on behalf of the Astronomy Section of La Societé Guernesiaise. The heavy cost of the Monument was defrayed by public subscription.

Further information on the Liberation Monument was published in *Billet d'Etat XVII*, 1994; and a full report on the shadow path and related date is lodged at the Greffe.

For an artist's impression of this unique dial (yes - unique), see Figure 1.

TEXT FROM PAMPHLET:
Three thousand years ago Neolithic man erected stone monuments on the island of Guernsey, placing them as precisely as they could, using the best technology available at the time. Some of these stones can still be seen standing today, reminders of those ancient peoples.

These prehistoric monoliths were the inspiration for Guernsey artist Eric Snell, who was commissioned by the State of Guernsey to design a fitting memorial worthy of commemorating the Island's Liberation from the Second World War Occupation on the 9th May, 1945. (Editor - was it really so long ago?). The Liberation Monument is precisely placed, using electronic age technology to mark out accurately the path of the shadow of the tip of the obelisk on 9th May, 1995 (the day of the public unveiling of the Monument).

The obelisk is made up of fifty layers of Guernsey granite, one for each year of liberation and as each is 10 cm thick, this makes a total of 5 metres to the tip of the obelisk (16·39 ft or 5·4365 yds to those still unmodified from Imperial units). Each layer thus represents one year of freedom since liberation, the top layers are sheared away to represent the five years of occupation endured by the islanders. The seating and platform are constructed from off-white French granite which increases the contrast of the shadow cast by the obelisk.

Inscriptions placed on the seating record the major events of the 9th May 1945, the surrender of the German Occupying Force at 07.15 am, the landing of the British Liberation Force at 08.00, and the unfurling of the Union Jack at 10.15 am to signal the end of the German occupation.

Also recorded are the memorable words of Sir Winston Churchill:

"Our dear Channel Islands are also to be freed today".

At the East end of the seating the words "Thanks be to God" are inscribed in English and Guernsey French.

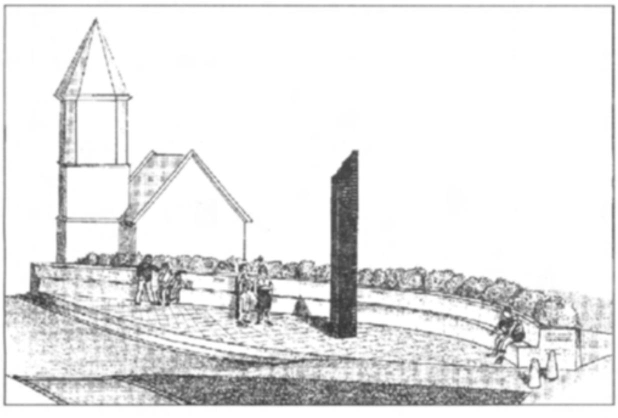
The Liberation Monument is in a location near the old Weighbridge Clock Tower at St. Peter Port Harbour where in this area that the Islanders met the English liberating forces on 9th May, 1945 and rejoiced at their newly won freedom from their German oppressors. It now provides a pleasant place in which to sit in the sun as it faces due south precisely.

The monument is designed to be positioned within one-hundredth of a degree precision and this gives a precision of time indication to a few seconds in time. The accuracy varies with the year because of the effect of the solar year being about 365¼ days, and of course will change slightly over the years through settlement, weathering, and astronomical variations. Nevertheless it should be reasonably accurate for the years it remains in existence.

It will be obvious to BSS members that this is the supreme example of a dedicated sundial - so special that it serves its true purpose on one day of the year only.

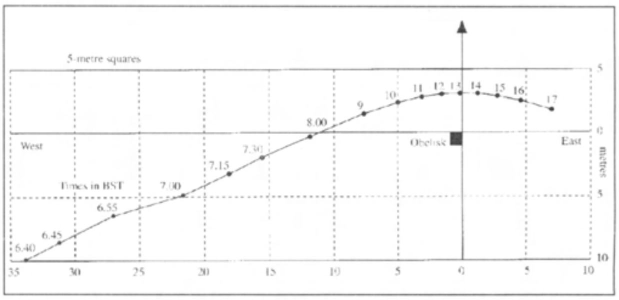
Figure 2 shows the path of the shadow of the tip of the obelisk on 9th May of each year. The apparent kink in the curve is the result of the shadow moving for its early movement on the base of the seating and on to the riser behind the seating itself at about 6.55-7.00 am, and the indications cease about 5 pm because the seating comes to an end by then. The kink would have been better placed at 7.15 am to mark the transition from German to English rule. Note that the shadow moves almost 50 metres in its day-long journey.

The Editor would like to express his admiration at the apparent simplicity which achieves a functional and artistic excellence which serves the purpose it was erected for in a truly moving way. Only those who served in the last war, and/or suffered under the Germans, can understand the true meaning of this unique dialling symbol of freedom.



Artist's impression

The design of the Liberation Monument is unique to Guernsey. Although not strictly a sundial, it records the passage of the Sun on one special day each year.



The path of the tip of the shadow on the 9th May.
The bend in the curve between 6.55 am and 7.00 pm is where the shadow moves from the base to the seating.

REFRACTIVE SUNDIALS

ALLAN A. MILLS

Refractive sundials are those instruments where the whole or part of the gnomon and dial are immersed in a liquid, generally water. The refractive index of this medium will affect the direction of the transmitted ray (or shadow), and so may change the indicated time as compared with the normal 'in air' situation. The refractive index μ of vacuum is defined as being unity, and at 1.0003 that of air may for most purposes be considered the same, but water has an index of 1.333: it is considerably more refractive. The 'bending' so produced is very apparent when a straight straw in a tumbler of water is viewed from the side.

The type example of the refractive sundial is commonly taken to be the 'Dial of Ahaz' mentioned in the Bible in II Kings, Ch.20, vs. 8-11. In this account, the prophet Isaiah is credited with impressing King Hezekiah by 'turning back the shadow in the Dial of Ahaz by 10°'. Later commentators assumed that a hemispherical scaphe dial was involved, and wondered if Isaiah could have accomplished such a feat by filling the bowl with water. (Although water is nowhere mentioned in the Biblical account, and Hezekiah would have to be a remarkably unobservant and gullible monarch not to notice the addition!) Be this as it may, the positive benefit was to draw the attention of a number of competent mediæval philosophers to the problem of quantitatively predicting the amount of bending experienced by light rays entering transparent liquids and solids at any angle. Nowadays, sixth formers rattle off 'Snel's law':

$$\mu = \frac{\sin i}{\sin r}$$

where i is the angle of incidence and r the angle of refraction, both with respect to the normal to the surface. However, they rarely realise that this deceptively simple relationship defeated Ptolemy, Bacon, Witelo and Kepler: Willebrord Snel[1] of Leiden did not define it until 1621. Before that date an answer could only be obtained by experiment.

It will also be remembered that, before the spread of the mechanical clock in the 14th and 15th centuries, all sundials kept 'seasonal' rather than our modern 'equal' (equinoctial) hours. The Bowl of Ahaz problem may therefore be generalized into asking what would be the effect of immersing ancient or modern forms of sundial in water, or indeed any liquid of known refractive index. Nowadays, by applying Snel's relationship to the formulae defining seasonal and equinoctial dials, it is practicable to calculate the effect very accurately, and to employ experimental tests simply to confirm these theoretical dial patterns.

This work has been carried out for scaphe and planar horizontal dials calibrated according to both hour systems, and confirmed by filling appropriate models with water.[2,3] As would be expected from the nature of refraction, the 'underwater' dials are much contracted by comparison with their usual 'in air' equivalents. In the former, the maximum allowable angle of refraction of 48.6° associated with the Sun on the horizon gives rise to a refracted circle parallelling the rim of a scaphe, and defines the upper border of the subaqueous dial pattern.

Figure 1 shows an aerial view of a hemispherical scaphe dial graduated in seasonal hours for a latitude of 52.5°N - a convenient mid-England figure. The full lines define the hour grid in air; the dashed lines its sub-aqueous equivalent. The shadow of the tip of the vertical gnomon indicates the time to be halfway through the 9th hour on a day around the equinox. When the undisturbed bowl is filled with water (Figure 2) the shadow correctly points to the same time-of-day on the dashed grid. However, if one imagines only the full-line pattern to be provided, then the indicated time is about half-way through the 8th hour. The shadow has indeed 'gone backwards' by 15°! Nearer to the midday line (the boundary between the 6th and 7th hours) the tip of the shadow recedes less and less, until at noon exactly it changes only in altitude. In the morning it goes forward when water is added. Therefore, although Isaiah *could* theoretically have worked his 'miracle' by the watery expedient postulated in mediæval times, to fulfil Hezekiah's chosen direction of displacement he would have had to be careful to do the demonstration at an appropriate point in the afternoon!

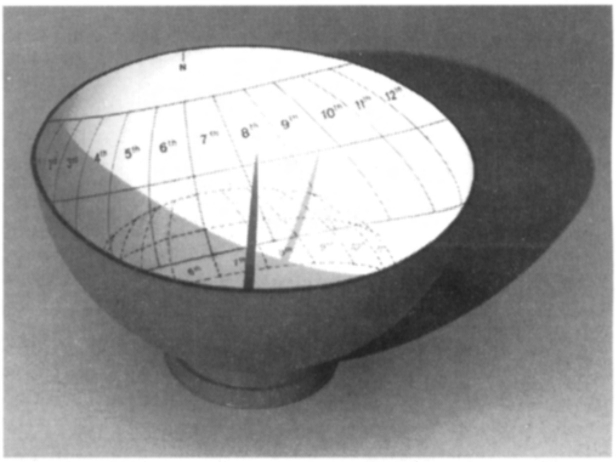


Figure 1: Oblique view of a seasonal-hour hemispherical scaphe, showing the shadow cast by its vertical gnomon in air.

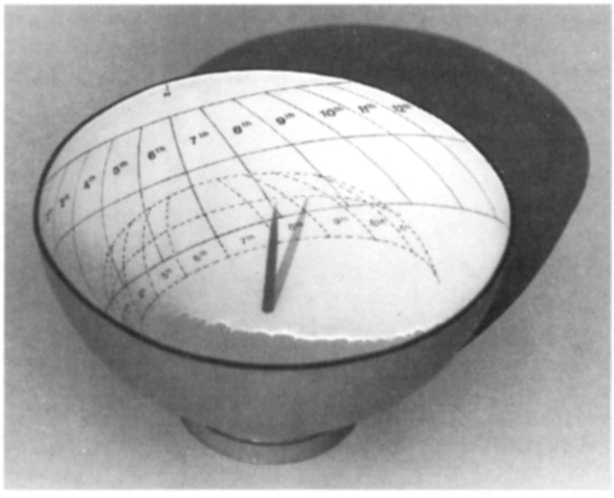


Figure 2: The scaphe dial of Figure 1 filled with water, but otherwise undisturbed.

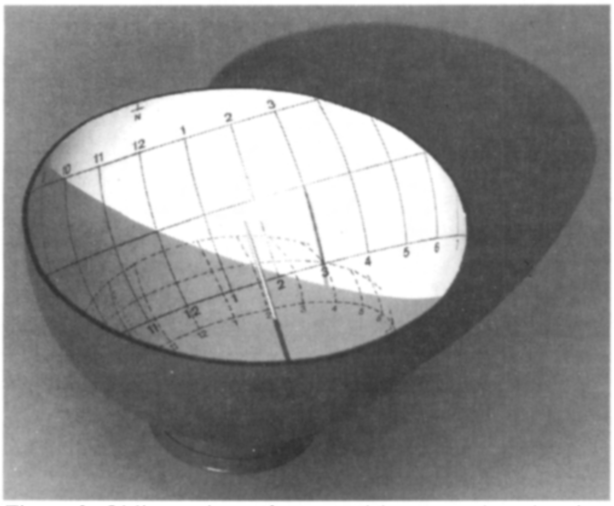


Figure 3: Oblique view of an equal-hour scaphe, showing the shadow cast by its sloping gnomon in air.

Figure 3 shows a bowl calibrated in equal hours. Note the gnomon sloping upwards at the latitude angle so as the be directed at the northern celestial pole. Its point is coincident with the centre of the rim plane. As before, the full lines indicate the usual sub-aerial pattern, the dashed lines its sub-aqueous equivalent. Figure 4 shows how 3pm recedes to 2.15pm when the bowl is filled to the brim with water. Only the tip of the shadow is operative: the usual property of the length of the gnomon being coincident with the hour lines is lost.

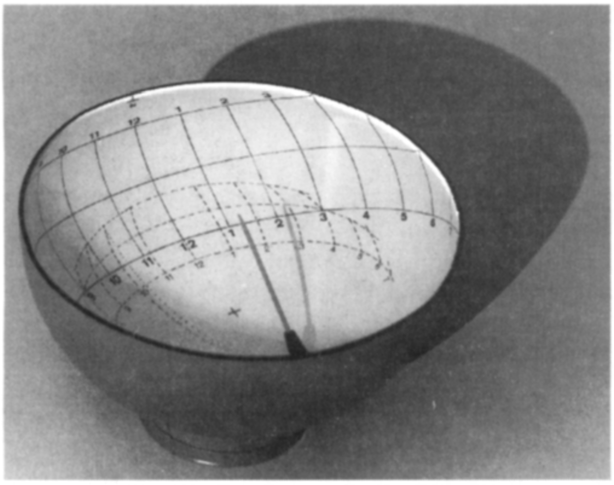


Figure 4: The scaphe of Figure 3 filled with water.

A few rare and valuable historical dials demonstrate the same phenomenon. Figure 5 illustrates a scaphe made by the Nuremberg instrument maker Georg Hartmann and bearing the date 1547. Its latitude angle is 41°41' - that of Rome. The numeration shows it to be graduated in equal hours, but the characteristic depression of the upper border of the grid to parallel the rim indicates a refracted pattern. The bowl would have to be completely filled with water for the tip of the shadow to indicate the correct time. A date of 1547 well precedes Snel's 1621 publication of the correct form of the law of refraction, so presumably this calibration was made by experiment against a 'dry' bowl graduated in the usual way. This refractive sundial is now in the Museo de Santa Cruz at Toledo, but there is no matching standard scaphe for the latitude of Rome. An ordinary Hartmann scaphe, dated 1539, is in the Museum of Science at Oxford, but it is for a latitude of 48° (Nuremberg).

Figure 5: Refractive equal-hour scaphe by Georg Hartmann of Nuremberg, dated 1547. Courtesy of the Museo de Santa Cruz de Toledo, Spain. Inventory No.286.

A beautiful golden dial by Christoph Schissler the Elder, made in Augsberg in 1578, is illustrated in Figure 6. Now a treasured possession of the American Philosophical Society at Philadelphia, it has unfortunately lost the sculptural figure of Atlas that once supported the shallow concave dish that bears the dial, and has been subjected to various erroneous reconstructions of the gnomon. The latter takes the form of a tensioned thread supported by the staff held by a turbanned figure positioned on the rim of the bowl. A complex pattern engraved within the dish appears to represent a sub-aqueous grid. Elucidating this, and

Figure 6: Horizontal refractive sundial by Christoph Schissler, 1578. By courtesy of the American Philosophical Society, via Owen Gingerich.

Continued on page 49

THE ASTROLABE

RENÉ R.-J. ROHR, FRANCE

Astrolabes are astonishing creations, at first sight, one might wonder if they were intended for some mysterious use when examining these in museums or collections, but their curious decorative beauty will long be remembered - see Figures 1 and 2. Framed on a velvet background, they possibly evoke the dreams of a Thousand and One Nights. Uninitiated persons cannot possibly realise that they are facing an astronomic nomogram born more than two thousand years ago, and having been for many centuries the most popular instrument in observatories and mosques.

Astronomy is a science as old as the hills. The moon imposed itself as one of the first elements of primitive time-measurement, and those who observed it could not help looking also at the starry firmament. Astrology is also an ancient practice, beginning in Mesopotamia and Egypt, descending down to the present day, with monuments and documents bearing witness to its millennial activity. But it was Greece and its Alexandrian School that attempted to give the subject a more scientific foundation.

The spherical form of the earth was known in the time of Apolonius and Archimedes, and so the idea of the astrolabe began to make occasional mention in manuscripts, but no description seems to exist of the design with a drawing to accompany it. The Greeks possibly tried to fit a sphere, representing the earth, with a kind of loose spherical shell acting as an image of the starry heavens; the two being rotatable on a common axis, the polar axis of the earth. This would have been an embryonic astrolabe, preserving the angles existing on the two spherical surfaces. Astrolabes of this form may have existed in Antiquity, possibly they existed in the time of Alphonse X. One example of eastern Islamic origin, dated 1480 AD, is the only surviving example known, and is in the possession of the Museum of the History of Science, Oxford.

But this instrument was too clumsy for transport or easy handling. The old astronomers, however, never abandoned their dream of a planispheric instrument. But today no one, in fact, knows who the mathematician was who found the key to its realisation. The problem resolves itself into finding a mode of projection of the stars on a plane whilst preserving the angles. In a letter from a certain Sinesios (5th century), there is the mention of astrolabes, and for the first time in recorded history, of the stereographic projection in connection with Hipparchus, who lived in 150 BC, and was the first scientist to achieve the measurement of important distances - even the dimensions of the earth.

His reputation, and the aforesaid letter, entitle him to be regarded as the father of the theory of stereographic projection and of the first useful astrolabe. It must be remembered that this projection preserves the angles unchanged so that a projected circle will become a circle again, and the centre of projection is located on the surface of the sphere and the resulting view is seen on a plane at right angles with the diameter issuing from the projection centre. One may recall too, that the demonstration of these facts is not mentioned in the mainly planimetric "Elements", composed by Euclid some 150 years earlier.

The most brilliant part in the history of the astrolabe began with the Arabs when they became the heirs to Greek science. Their instruments attained perfection, mainly in the centres of Persia and Spain, from whence the first instruments appeared in the Western Christian world only in the times of Hermanus Contractus and the Pope Sylvester II, (Gerbert of Aquitaine in 999 AD), former monk and a student of a Moorish University in Spain.

Their design of astrolabe remained unchanged throughout the Middle Ages and has retained its popularity down to our own time as the classical or stereographic astrolabe, to mark the difference with more recent inventions such as the astrolabes of Roias, de la Hire, al-Tusi, Profatum. Oughtred or Allen, and the so-called "mariner's" astrolabe, which is in fact a misnamed protractor. Unspecified astrolabes always mean the classical form.

The astrolabe consists in the first place of the so-called *Mater* (Figure 3), a kind of round brass box having a clinch called the *Throne*, in which a ring is placed to hold the instrument suspended when in use. The rim of the mater is graduated in 2 x 12 hours, subdivided in minutes. The empty space of the mater is the container for one or more round plates, the *Tympanum* (Figure 4) with no rim, but pierced in its centre and engraved with the projections of the horizon, the Zenith, the lines of equal altitude (called *Almucantars*), the azimuth lines, all drawn for one latitude, with the Equator and Circles of Solstices. Tradition requires that in the northern hemisphere, the projection for these coordinates to have the South pole for centre, with the result that the number of stars represented will be increased; whereas for an exterior astrolabe clock for this hemisphere, the north pole is taken in order to give a better representation of the daily course of the sun. The space below the horizon line contains the lines for unequal hours occasionally, but mainly in Mediterranean countries, in place of the 11 unequal hours, the 9-23 *ab occasu* (Italian), or the 1-125 *ab-hortu* (Babylonian) hours are used there. It is to be noted that the sun rises in the East, so that East is marked in this part and West on the right.

Next to the tympanum lies the so-called *Rete*, being the first plate to be rotated when the instrument is in use. It is a kind of fretted network centred around the north pole, showing the positions of a number of the principal stars, with their names adjacent on pointers. An important element of the rete is the orbit of the sun, with the ecliptic circle divided in the signs on which it can be set, marking a date, the second rotatable item on this side of the instrument is the *Rule*, marking a diameter of the rete. On those astrolabes to be used in the southern hemisphere, the stars and general orientations need to be changed in consequence.

The complete front view of the astrolabe, with its mysterious signs and drawings, has more than once been called a golden gem, or the jewel in astronomy or mathematics, and is the treasure in many museums (see Figure 6).

The rear side, with only one alidade, turning and giving the indications of dates and degrees in the graduations around the circular rim, is less decorative, yet it is of no less importance than the elements to be seen on the front. The filling up of the empty inner spaces of the circular scales varies widely according to the choice of the maker. The common use is the division of the surface into four quadrants by a horizontal and vertical diameter. That on the

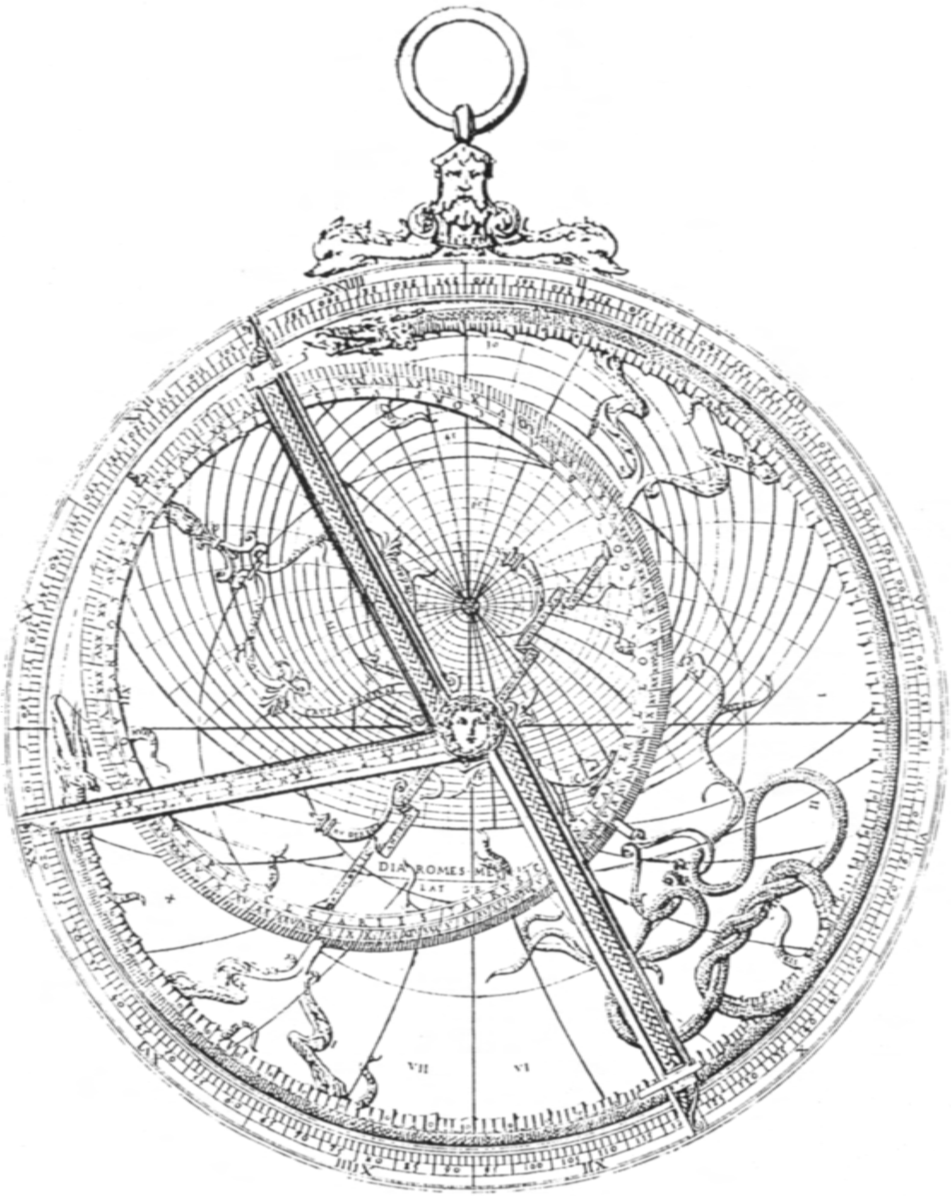


FIGURE 1: Front of one of the finest astrolabes known. Made by *Vincenso Danti*, circa 1490.

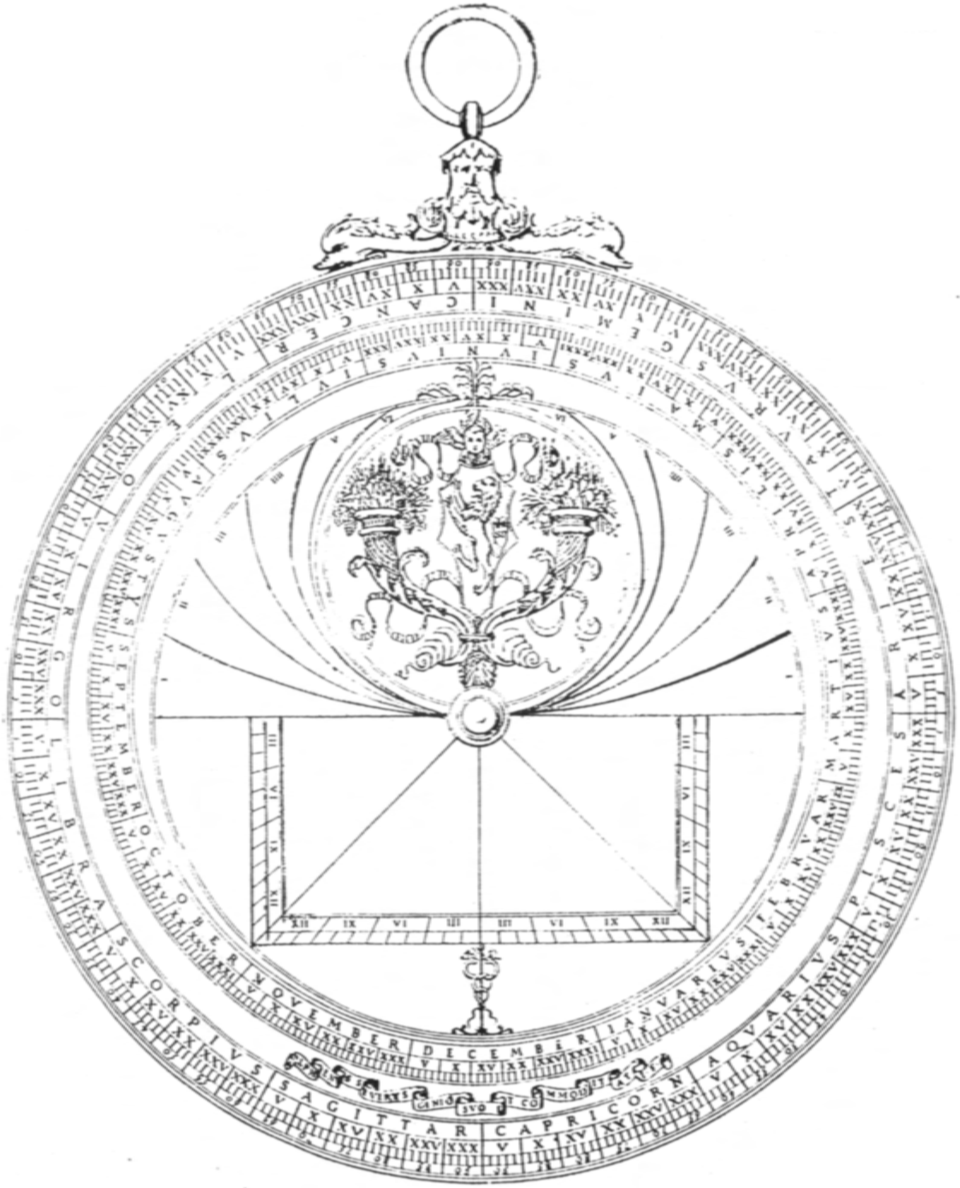


FIGURE 2: Rear view of the astrolabe shown in Figure 1.

FIGURE 3: The *Mater*, a shallow round box with a slightly elevated, graduated rim.

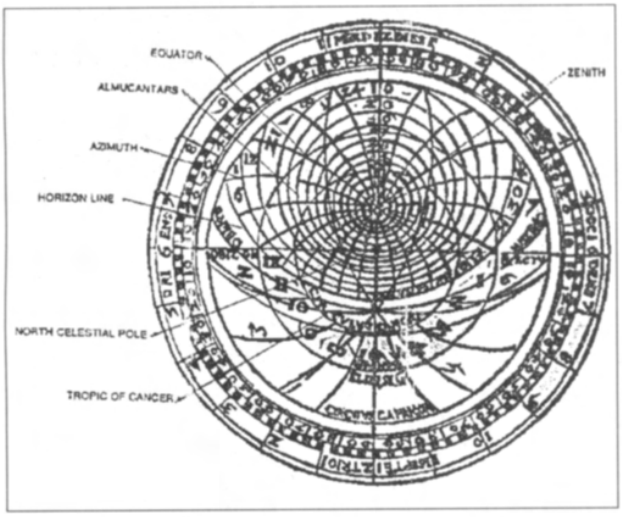


FIGURE 4: The *Tympan*, a disc carrying various kinds of information, interchangeable for use at different latitudes.

upper right holds 6 arcs for converting normal equal hours into unequal ones by means of the zodiac signs drawn on half the alidade. This can be extended in the same way in the left upper quadrant, which can be used for trigonometric indications as well as many more items. One often finds there, with Arabic instruments, the nomogram giving for one or more places the seasonal altitude of the sun when its azimuth coincides with the Qibla.

Lastly there is the important alidade (Figure 8), with its two sights.

As to the different uses of the astrolabe, there is the story of an Arab of old who boasted that he knew at least a thousand . . .

In fact, the astrolabe is a kind of nomographic means, or

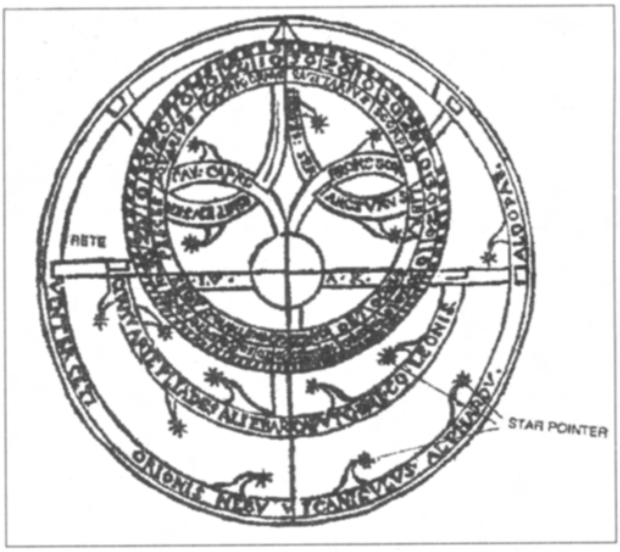


FIGURE 5: The *Rete*, a fretted network bearing the position of important stars and their names.

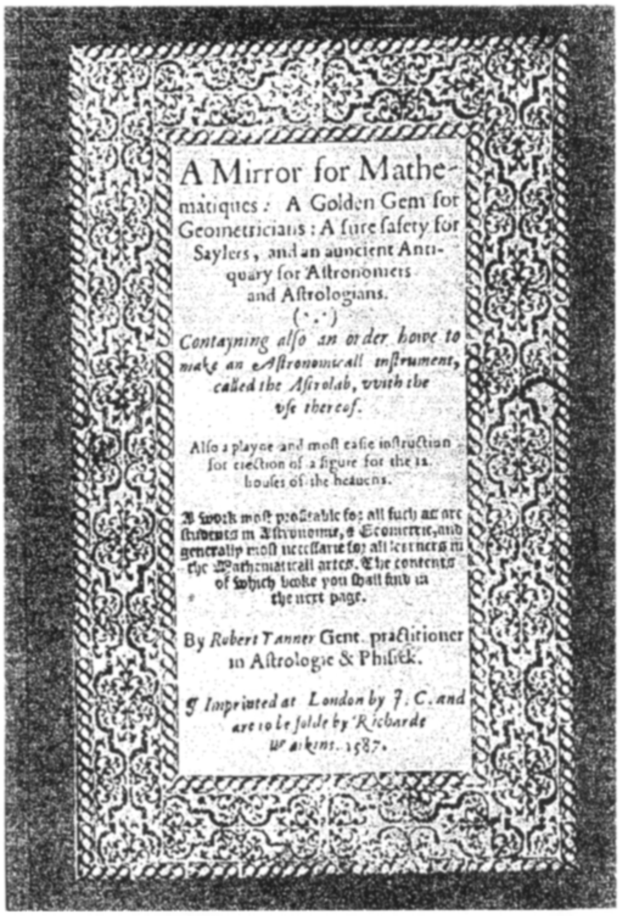
even computer giving the true local time from the altitude of the sun or some other celestial body. Using the sun, the solution is given by setting the rule on the date given by the signs of the zodiac. But as the rule is the stereographic projection of a meridian, it then gives the position of the sun in the zodiac. If one now turns the rete, together with the rule, in other words, the starred heaven and puts the position of the sun on the observed almucantar, the astrolabe shows the actual projection of the stars and the sun. The rule, as the meridian of the sun, gives the time on the hour scale engraved on the rim. At night a star serves the same purpose, its point on the rete is turned on the observed almucantar, and the rule previously set on the date in the zodiac will give the time sought on the rim. In both cases the observer takes the correct arm of the almucantar - i.e. rising or setting.

Moreover the side of the rule, or another rule can be graduated, the point of this rule, at the moment of contact,is noted and the rule or rete turned to right and left: the limits of the day will be seen when the points of the sun on the ecliptic, the rotation of the rete, and the altitude of the stars are judiciously used.

The right quadrant on the rear of the instrument has almost always the inner quarter of the circle divided into 6 equal parts. Arcs of circles tangent to the horizontal diameter in the centre join the points dividing the parts; the sighting alidade, when graduated with dates, gives the length of the unequal hours. These circles are often repeated in the left quadrant where often these are various diagrams relating to varying hours.

It must be added that more and various possibilities have been used, of which some have astrological intentions, etc. The previously mentioned Arab (of the 1,000 uses) perhaps did not over-exaggerate, for there are many applications in Islam, where diagrams give, for a number of places, the altitude of the sun in the moments when its azimuth is that of Mecca.

The origin of much of the present knowledge goes back into the antiquity of ancient Greece, whilst many of the important parts of its evolution occurred in the Arabic Middle Ages - and more facts from the lasting, never-failing interest in the astrolabe as a unique realization of human ingenuity, justify the superlative given by Robert Tanner, many years ago, of "Golden Gem".



A Mirror for Mathematiques: A Golden Gem for Geometricians: A sure safety for Saylers, and an auncient Antiquary for Astronomers and Astrologians.

(·.·)

Contayning also an order howe to make an Astronomicall instrument, called the Astrolab, with the use thereof.

Also a playne and most easie instruction for erection of a figure for the 12. houses of the heavens.

A work most profitable for all such as are students in Astronomie, & Geometrie, and generally most necessarie for all learners in the Mathematicall artes. The contents of which booke you shall find in the next page.

By *Robert Tanner* Gent. practitioner in Astrologie & Phisick.

Imprinted at London by J. C. and are to be solde by Richarde Watkins. 1587.

FIGURE 6: The cover of Robert Tanner's book (1507), praising the astrolabe as the *Golden Gem.*

FIGURE 7: The rear side of an astrolabe (from Tanner's book).

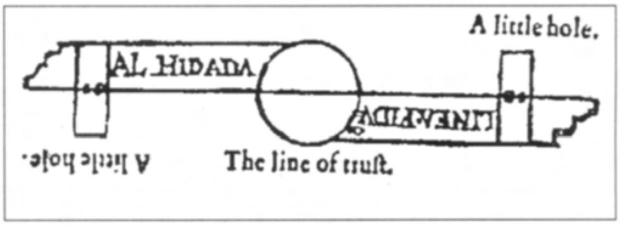


FIGURE 8: The *Alidade*, rotating on the rear side of the astrolabe.

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Continued from page 21

FOLLOW THE YELLOW BOOK CROWD

Sunday's visit to the *Observatoire de Paris*, was a highlight of the weekend. After several months of corresponding in rusty French, I had understood that we were to see only the Grisini meridians but we were whirled from ground floor to roof level of this treasure house with non-stop commentary, in English, by the indefatigable Suzanne de Barbat who has worked at the *Observatoire* since 1953 and now holds a senior position. Our only regret was that we couldn't stay longer on that occasion and several members are hoping to make another visit in the future.

The coach then took us on to *Montmartre* and the white marble church of *Sacre Coeur* where we spent an hour being tourists before boarding the coach for home. From the many kind letters I have received, everyone enjoyed the trip and we should have no difficulty in filling the coach if anyone knows of another city full of sundials.

I have not given details of the dials we visited but the booklet *Sundials in Paris*, with map, is available to members who may find themselves at a loose end in the French capital or who would prefer to read about them from the comfort of an armchair. Price £2.50 from me at 31 Longdown Road, Sandhurst, Camberley, Surrey, GU17 8QG. *Cadrans Solaires de Paris* is unfortunately out of print. Please make cheques out to the British Sundial Society.

BSS AWARD SCHEME FOR SUNDIALS

BSS OPEN COMPETITION - AWARDS FOR FIXED DIALS 1995

INTRODUCTION

To remind members of the details of the BSS Award Scheme for Sundials created and erected in Great Britain, initiated in 1994, brief details are repeated here:

The British Sundial Society has announced a new Open Competition for sundials erected in the UK in the last 5 years.

The British Sundial Society was founded in March 1989 by a small group of enthusiasts. It has grown rapidly. It now has nearly 500 members, and produces a quarterly journal of 52 A4 pages which many much larger societies might envy. The Editor remarks "Its amazing that after 3,000 years, there is anything new to say on sundials at all" but he has material already for the next 3 issues!

Despite their great antiquity, sundials are still not as common here as in other countries. The Society has promoted the Awards in order to encourage good design and manufacture of dials, to stimulate the commissioning of new dials, and to spread knowledge of the science and art of dialling.

Piers Nicholson, who is running the Awards says "Sundials are a meeting point of the "two cultures" - a successful sundial has to be mathematically accurate, to be of a pleasing design, and to be well made". All three factors will be taken into account by the Award judges appointed by the British Sundial Society.

Entries for the awards from designers, makers, or manufacturers of fixed dials erected in the UK since 1989 will be accepted up to 21st March 1995. There are three categories for Awards: for horizontal dials, for vertical dials, and for other dials. The Awards will be announced on 21st September 1995. Application forms are available from David Young, Secretary, British Sundial Society, 112 Whitehall Road, London, E4 6DW (Tel: 0181-529 4880).

Winners in each category will receive a certificate, a plaque to be fixed in a prominent position near the sundial, and a cheque for £250.

The Awards are supported by the Sun Alliance insurance group.

THE PANEL

The panel of judges appointed by the BSS Council in April 1995 consisted of Professor Alan Smith as Chairman of the Awards Sub-Committee, with the Chairman of the BSS, Christopher St. J. H. Daniel and Douglas A. Bateman. All of these have had considerable experience in the design and making of sundials.

REPORT OF THE PANEL OF JUDGES

The following report was submitted by the Chairman of the Awards Panel, Professor Alan Smith:

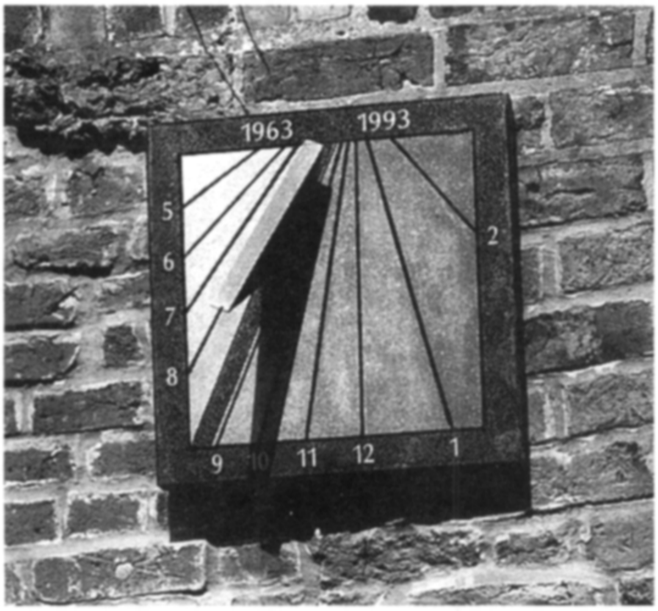
Response to the first BSS competition for the design of fixed sundials was more than encouraging, and some eighteen dials were entered by twelve individuals. Some entrants were *professional manufacturers* of dials, some were *designers* whose ideas were carried out by craftsmen or industrial manufacturers, some were designers who were also *makers* but who relied on others to do the necessary calibrations, some were designers, makers and calibrators whose dials, therefore, were entirely their own creation. Entries were also valid (according to the entry conditions) from *owners*, all of which added further complexity. To try to rationalise this matter, therefore, the judges made their decisions based entirely on the *quality and excellence* of the dials themselves, without attempting to apportion responsibility to either designer, maker or calibrator, though some clarification of this situation must ultimately be sorted out.

After working through the documentation and photographs a 'short list' was prepared, and all the dials on that list were visited and examined 'in the flesh'. A problem which faced the judges was the distinction which clearly existed between what one might think of as 'traditional' dials and those which had a 'modern' or 'innovative' character. Should a traditional dial which is extremely well made, therefore, be rejected in favour of one which attempts to bring a new approach to an ancient form? How does one judge between a standard horizontal brass dial, very well made, sound in structure and clearly and accurately calibrated but not particularly visually exciting, and a modern dial in coloured perspex on a concrete office block, combining a back-lit clock which shows the relationship between conventional clock time and sundial time, controlled by a photo-electric cell which switches on the lighting when clouds come over, and at night? This is an example of the *extreme* nature of the problem of 'traditional' versus 'modern', but it is exactly what the judges had to face, and over which there was much debate.

To reach a unanimous decision the judges relied entirely on their assessment of the quality of workmanship which the dials showed, the suitability of purpose, the quality of lettering, dial furniture and decorative additions, the calibration calculations, the siting of the dial and the integration of the whole to form a unified, satisfying composition. Thus some dials were rejected on grounds such as fragility of the gnomon, over-decoration of the gnomon causing confused shadows, unsatisfactory or inappropriate mounting, lack of quality in the detail of finish, and so forth. Honesty, integrity and fine workmanship were the hall-marks of the successful entries, and although some of these aspects might (and did!) give rise to subjective judgements, especially in terms of *taste and fashion*, your panel of judges worked very hard indeed to arrive at a balanced and fair appraisal.

Four dials were COMMENDED on the basis of the above mentioned criteria, but only one MAJOR AWARD was given. From the beginning of the exercise the judges were as one in their assessment about this particular entry, i.e. that it demonstrated a modern approach to a traditional design, an appropriateness of materials to the building on which it is mounted, a handsome quality of carving and gilding of the numerals and other lettering in a well-proportioned space, a decorative but restrained gnomon with a clearly defined shadow, a suitably dignified status befitting the commemorative nature of the work, a subtle statement of the shadow position at the solstices and, finally, an admirable presentation of the documentation containing the history, design, purpose, selection of materials and completion of the dial. Although considered the best of the entries it must be said that there were several other submissions of great merit which have been suitably commended, and an overall standard was reached which augurs well for contemporary sundial design.

Inasmuch as this was the first competition organised by the BSS for making awards for the design and manufacture of fixed sundials, numerous problems arose as the judges began their work. It was the nature of these problems which suggested that some revision of the 'rules and conditions' and 'criteria for judging' might be necessary before the next award scheme is proposed in three years' time. This was in many ways a natural outcome of a first attempt to organise a competition of this kind, and it is hoped that such problems as there are will be resolved the next time round.

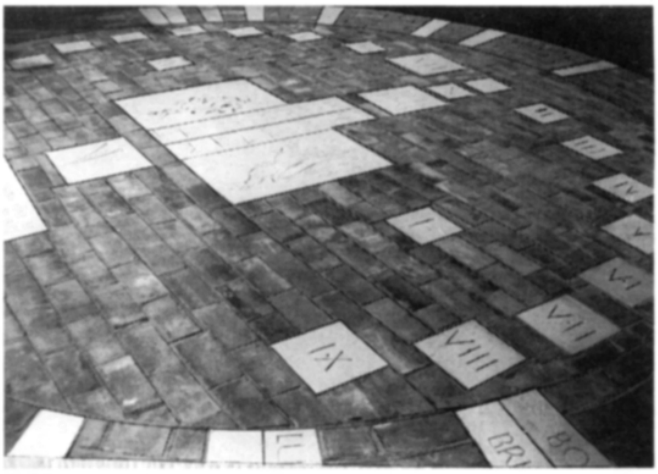


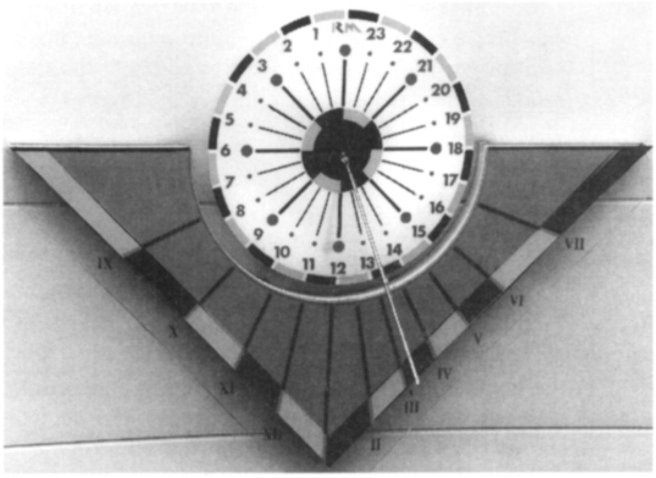
Vertical Declining Dial at Ashbourne, Derbyshire

A dial commemorating a wedding anniversary, installed in a private garden. The dial declines 40°E and is made of coloured concrete by a sculptor who specialises in this material. The colour, from light yellow at 5.00 am is graded to deep red at 2.00 pm, giving a natural visual progression of the passing day; the yellow numerals are let into the dark border. The whole simple design blends very happily with the brick wall on which it is mounted.

Analemmatic Dial set in the pavement at Penshurst Place, Kent.

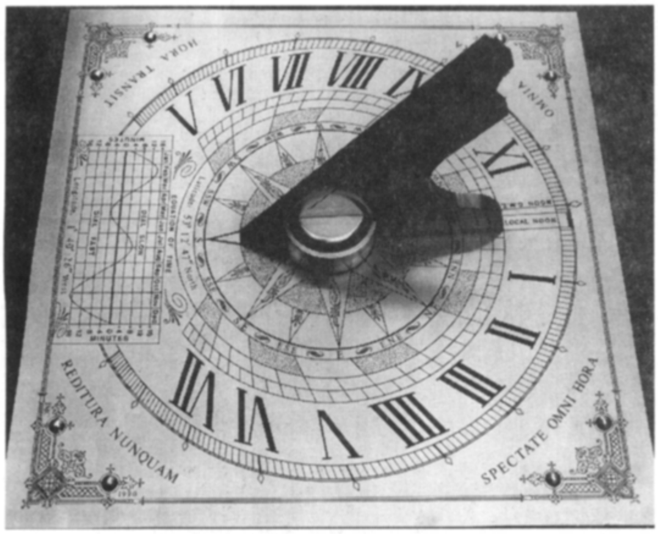
The red brick used at Penshurst Place, for the buildings and garden wall, provided a natural setting for this analemmatic dial sited in an adventure playground. The date scale and hour markers were made and carved in hard-wearing York stone to contrast with the brick pavement, and designed to withstand the effects of many feet. Heraldic symbols of the De L'Isle family are incorporated, and because the dial would be seen by many overseas visitors the names and directions of several locations are marked with plaques on the outer edges. The dial complements other dials at the site.





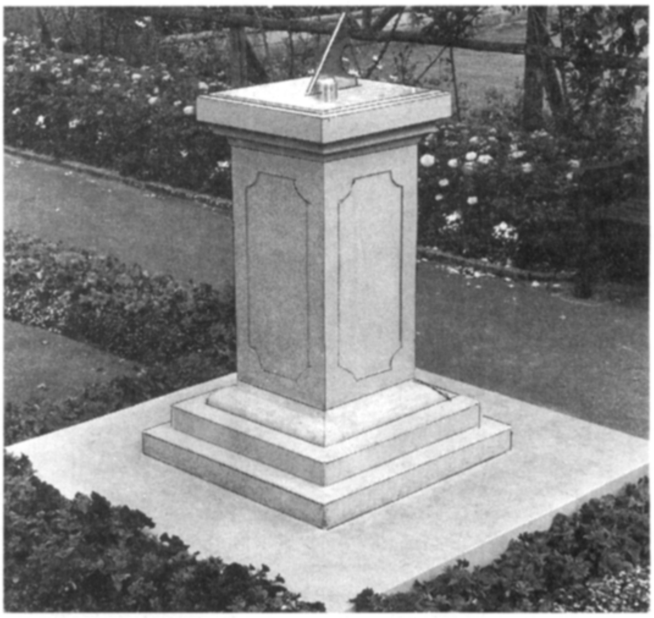
Vertical Declining Dial on an office building at Abingdon, Oxfordshire.

This is an interesting experiment in combining a clock with a sundial. The clock is back-lit and its one hand is positioned behind an opal acrylic face, moving anti-clockwise to coincide with the sundial shadow. The gnomon is in clear acrylic which looks silver in the sunlight. Internal lighting is automatically switched on at night and during cloudy weather by a light-sensitive switch. The acrylic dial on a powdered, coated aluminium backing has weathered well since its erection in July, 1992.



Horizontal Dial at Bakewell, Derbyshire

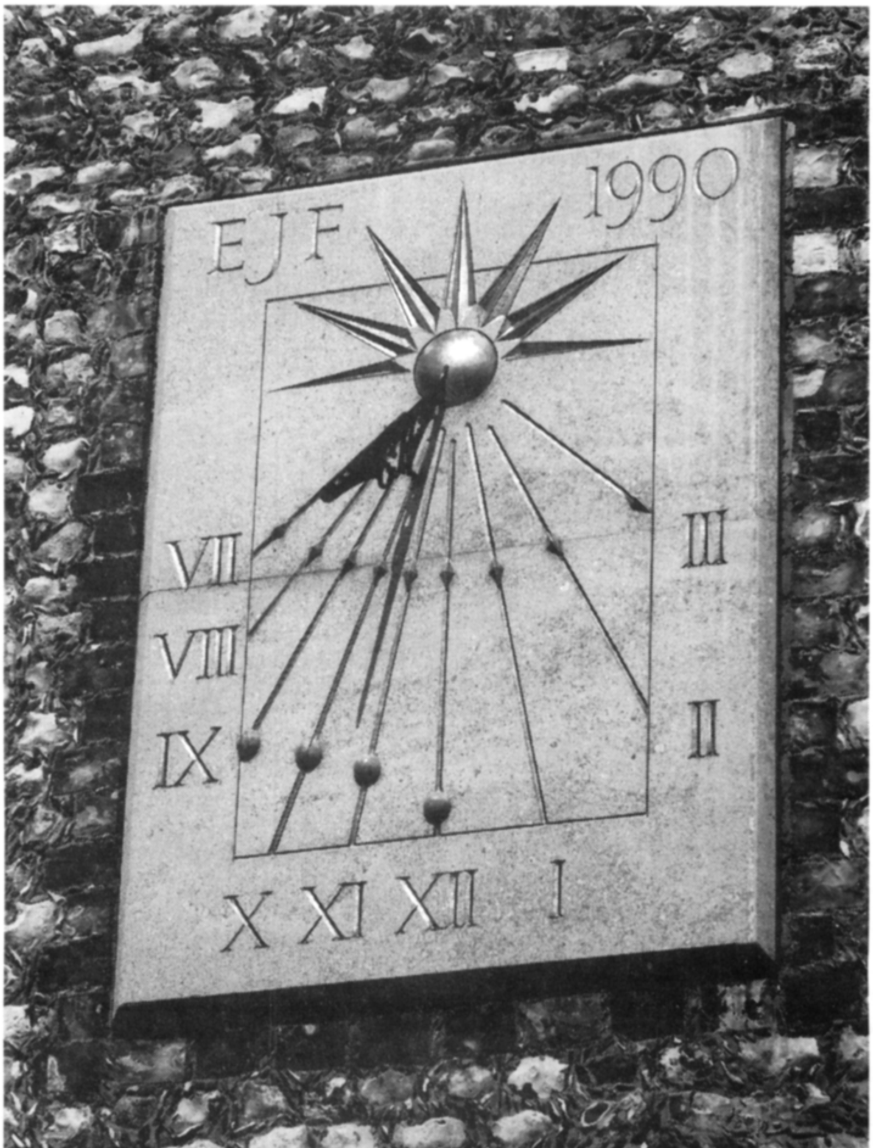
A conventional horizontal dial mounted on a handsome stone plinth in public gardens at Bakewell. It was designed and erected, at public expense, as a memorial to a popular and well-known Bakewell citizen who died in 1988. The dial is made of brass and is exceptionally well calibrated in 5 minute intervals, incorporating an equation of time graph, commemorative motto, compass rose, details of latitude, and is correct to GMT. The gnomon appears to be unique in that it indicates, on its edges, the position of Polaris.



The Winner

SALLY HERSH

Sculptor and Lettercutter



* *Vertical Dial at West Dean College near Chichester, West Sussex.*

A very handsome vertical dial which combines the best of modern craftsmanship and design with a traditional dial form. Made of Ancaster Weatherbed stone, the carved liens and numerals are gilded and the winter and summer solstice positions are indicated by coloured porcelain markers (blue for winter, red for summer), the sun's declination being shown by a pointed nodus on the gnomon, which itself is made of black anodised aluminium to prevent staining. This elegant dial is mounted on the dark flint wall of West Dean College and commemorates the gift of West Dean House by Edward James as an educational foundation.

* A complete article about this dial appears elsewhere with this Bulletin.

BOOK REVIEWS

CLOCKWISE AROUND WALES - A Horological Miscellany. Several authors, edited by Paul Parker. 21 Figures, in which 8 colour plates are included, pp. 112. Published by Vale Books, Denbigh, Clwyd, 1995. ISBN 0 9522617 1 5. Thin card covers with two colour illustrations. Price £12.50.

This little book is a pot pourri of horological bits and pieces, the kind that one can pick up, start reading at any point, and immediately be interested. It is a real book for the bedtime reader who wishes to cast off the cares of the day and have a little light entertainment before departing for the land of Nod. It is an excellent example of how to present vignettes of the horological scenes of yesterday in a very human way.

Whilst the book is directed mainly at the mechanical clock enthusiast, and particularly those dwelling in the land of the Bard, it nevertheless contains enough of dialling to make it worth acquiring by the bibliophile members of the BSS.

On page 32, for example, is a short section by the British Sundial Society Chairman, Mr. Christopher St. J. H. Daniel entitled "Three Multiple Sundials - A Borderline Case", with illustrations of the multiple dial at Mannington Hall and the much better known example of Moccas Court in the Wye Valley.

And again, commencing page 52, is a three-page description of the stained glass sundial at Tredegar House, Newport, Gwent - the only one known in Wales. This is beautifully illustrated in a colour plate on page 43. This section also give information on the stained glass window dials of Henry Gyles of York, that made by him in Gray's Court, York, is illustrated on page 42. Mr. Daniel is, of course, the world authority on stained glass dials.

"Slate Sundials of the Gower Peninsula" on page 64 is another contribution by our worthy Chairman. Turning over the pages and reaching page 77, a colour print of the sundial in Rhosili churchyard appears. A more evocative illustration of the harmony of an old sundial with its environment could not be imagined, it appears to have grown there.

Finally, from a diallist's point of view, starting on page 82, is an outline by the BSS Chairman of the *remarkable* sun and moon dial of Isaac Morris at Plastirion, about a mile from Pwllheli. Figure 20 shows the dial in great detail. It may be unique for Wales, but the principle has been used elsewhere, although nothing like as beautifully delineated. Morris's dial is a superb example of craftsmanship.

For the account of this last item alone, this book is worth acquiring. The only snag is the price - £12.50, this works out at 11p per page for the complete horologist, and about 60p per page for a part-time horologist such as the diallist. Ah well, we must all pay for our pleasures. Those with a poetical leaning will appreciate the various snippets of versification spread throughout the pages. A map of Wales with the old boundaries shown is also given, essential when dealing with clockmaking in Wales.

Very brief details of our Chairman are set out on page 107.

All in all a very pleasant book and well recommended. As a former clock and watch enthusiast, the reviewer does not agree with some of the statements made about clocks, fortunately these are of no consequence whatever to the diallist.

The book is quite different to the usual horological book which is unashamedly technical and as dry as dust to the uninitiated. For once, and not before time, someone has breathed humanity into horological words.

* * * * *

HORDOZHATÓ NAPORÁK. Edited by Lajos Bartha. Twenty B & W illustrations in the text, with 4 colour illustrations on each page of the paper cover. 68 pages. Published by two Hungarian Museums - the Iparmüvészeti and Kiscelli, November 1995. ISBN 963 046050 5.

This is a splendid catalogue prepared by our Hungarian friend Lajos Bartha and is an extensive outline of portable sundials selected from Hungarian collections, and in particular with two exhibitions showing these to the public. The first exhibition was - "Time-Measurement" at the Museum of Applied Arts, 4th August to 24th September, 1995; and "My Measure is the Sky" at the Budapest Kiscelli Museum, 12th September to 12th November, 1995.

Lajos Bartha has made the catalogue accessible to English readers by his translation of the Hungarian titles, and also has included a short section outlining the data in the catalogue.

The whole gamut of portable dials is surveyed, plus Compendiums, Nocturnals, Perpetual and Lunar Calendars, European Astrolabes, and Clocks incorporating Sundials.

An interesting section is the listing of sundial makers and corporations. These are from all parts of Europe and not confined to those in Hungary. The BSS Bulletin receives a number of mentions in the reference section.

Mr. Bartha is to be congratulated for arranging these splendid sundial exhibitions in the present difficult social and financial conditions in Hungary. Only a true enthusiast would be able to overcome the overwhelming difficulties caused by the fall of Communism.

The method of obtaining copies of this essential catalogue is not known to the reviewer, possibly the Society's bookseller (Rogers Turner Books, Greenwich) will be making arrangements for these to be made available for purchase by BSS members.

As an aside, the reviewer is still wondering how the computer checking dictionary accepted the title of the catalogue without the slightest quibble, it means "Portable Dials" with the sub-title of "Selected from Hungarian Collections".

* * * * *

ANNALS OF SCIENCE

On pages 75-84 of volume 53, published in 1996, is an erudite article by our well-known contributor, Dr. Allan A. Mills, Head of the Astronomy Group, University of Leicester. It is entitled "Altitude Sundials for Seasonal and Equal Hours". The summary of the article is given here in full:

> Altitude dials do not require knowledge of the N-S direction to quantify time in terms of either seasonal or equal hours. Methods for determining the corresponding dials patterns are reviewed and accurately computed data for a latitude of 51°N presented as horizontal, vertical, rectangular and pillar dials in both timekeeping systems.

The outline commences with an introduction to the constraints set in designing and using an altitude dial, followed by Part 2 which is a description of the methods for generating dial patterns, which is, of course, far more complicated than those for equal-hour azimuth sundials. It is also of interest in noting the true use of the maligned Torquetum which converted heavenly observations into altazimuth coordinates.

Part 3 of the article is concerned with Equal-hour altitude dials for horizontal, vertical, rectangular coordinates, pillar and other derivatives. The appropriate delineations are clearly illustrated in three figures and one illustration.

Section 4 deals in the same way for seasonal-hour sundials, which of course were the precursors of the later equal-hour sundials which came into use to reconcile the division of the day by solar means and that given by the newly introduced mechanical clock in the late thirteenth century which divided the day into twenty-four regular intervals of time.

Had it been simple to follow solar time with a mechanical clock (and it was not achieved for about four centuries), we might still be using the seasonal hours even today, for the difficulties and imperfections of a system are tolerated when they are totally familiar. For example our old coinage system of pounds, shillings and pence, or the old Imperial weights and measures; they were illogical to modern minds, and cumbersome in use, but to those familiar to them, no difficulties were experienced at all.

The author, well known for his didactic skills, has presented here an account of outstanding clarity. Yet present-day knowledge, aided by the facility of computing, only leads the modern diallist to an increasing respect for the ancient diallists who produced accurate delineations without any such aids. Truly they were men of genius.

READERS LETTERS

HERMITAGE MUSEUM

In Bulletin 95.3 Book Review section, it was stated that Patricia H. Atwood of the Time Museum, Illinois, USA, had translated the catalogue prepared by Dr. V. Iu. Matveyev of the dials in the Hermitage Museum, St. Petersburg (formerly Leningrad). This was incorrect, Ms. Atwood has translated an article by Matveyev, not the catalogue and she has also sent a letter explaining why it cannot appear in the BSS Bulletin, as follows:

> I would be happy to give permission to use my little translation in the BSS Bulletin, however I do not have the authority to do so. The author of the article must give his permission, and I fear that it will be virtually impossible to elicit a reply from Dr. Matveyev due not only to the general difficulties of communication with St. Petersburg, but also to the challenging nature of his duties as Chief Curator of the Hermitage.
>
> Please feel free to circulate my translation informally to anyone you think may be interested, however I regretfully must ask that you not publish it in BSS Bulletin without the author's permission.

PATRICIA H. ATWOOD
U.S.A.

* * * * *

PETER NICHOLSON

A friend and I share a common interest in the architect, carpenter, surveyor, practical builder and mathematician Peter Nicholson (1765-1844). In 1833 a book written by him, called *A Treatise on Dialling, comprising the delineation of sun dials in every position* . . . was printed at Newcastle, so we are aware that he had an interest in dialling.

Recently my friend came across an article on Peter Nicholson in the *Haddingtonshire Courier* of 30 March 1860, which includes the following comment:

"At Morpeth he produced his work on *Dialling*, the publication of which led to a dispute between him and Dr. Lardner."

Can readers of the Bulletin let me know if they know where details of such a dispute might be found? Did Lardner also publish something on dialling? Dionysius Lardner (1793-1859) was an Irish scientific writer, elected Professor at London University in 1827, and editor of *Lardner's Cabinet Cyclopaedia* amongst other works.

Any information about Peter Nicholson would be most welcome, especially if any member wishes to dispose of any books by him.

PETER RANSOM

EDITOR: I communicated to Mr. Ransom the following information taken from my Magnum Opus of dialling references, the numbers refer to the entry in my listing.

688 NICHOLSON, Peter. *A Treatise of Dialling* . . . Newcastle, 1833

Peter Nicholson (1765-1846) was principally an architect but opened up a number of schools in the provinces and in London, besides giving private lessons. The article in *Ree's Cyclopaedia* "Proportional Compasses and Projections" was contributed by him.

577 LARDNER, Dionysius. *Common Things Explained.* Although the section on dialling is very short and the subject is dismissed by Lardner, the section on time is very useful. The book is not continuously paged, the numbers in the index refer to the paragraphs.

* * * * *

ANGLO-SAXON SUNDIALS

I am interested in the origins of Anglo-Saxon sundials and enjoyed reading your article on the Bewcastle Cross in Bulletins 95 1/2.

I think it likely that this cross is, or was when complete, a Celtic Ring Cross, erected to bear witness to a general faith in Christianity and possibly to serve a subsidiary purpose of marking a precinct of a monestary. There are many Celtic Ring Crosses still extant, but none of them, as far as I am aware, carry sundials. I agree with your thoughts about the date of the Bewcastle sundial, which is distinctly disputable.

We might ask, why were Anglo-Saxon sundials made and what was their purpose?

We know, or we think we know, it was decreed by the Pope at the beginning of the seventh century, that prayers should be said at fixed times throughout the day, as earlier laid down in St. Benedict's Rule, and these seven fixed times became known, because of canon law, as the canonical hours.

Apart from the natural phenomena of daybreak and sunrise, and sunset and nightfall, the remaining three canonical hours, which we take to have been mid morning, noon and mid afternoon, would for their determination require some kind of measuring device, such as a sundial.

In Italy in the early seventh century, the ancient Graeco-Roman spherical sundials would have been well known. Such dials elegantly mapped out the twelve seasonal hours from sunrise to sunset throughout the year, indicating the hour by the tip of the shadow of the gnomon. Determination of the third, sixth and ninth hours would have been straight-forward.

It seems likely that the Christian missionaries from Rome to England in the seventh century, and pilgrims returning to Ireland, would have brought with them details of the hemispherical dials. But neither England or Ireland possessed the skills needed to design or construct them.

Viewed from the front, the hemispherical dial looks like a protractor on a plane surface. Could it be that dial makers in England and Ireland thought, in ignorance, that the characteristic Anglo-Saxon dial on a plane surface would give the same information as a hemispherical dial? We know that it does not, since the hour angle, as shown by the shadow of the edge of the horizontal gnomon, is not constant throughout the year.

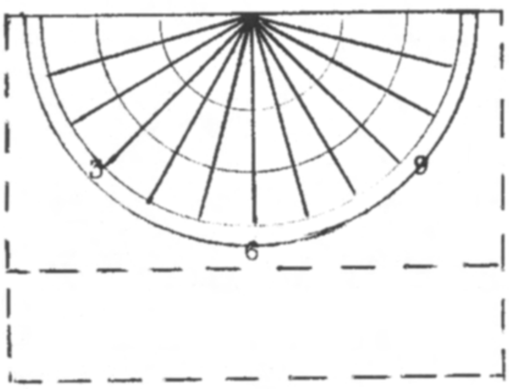
The early Anglo-Saxon dial was probably intended to show the canonical hours of Terce, Sext and None. We do not know whether these dials were brought to England by missionaries from Ireland, or taken to Ireland by missionaries returning from England. There is in north Wales, in a churchyard on the mainland near Anglesea, a Celtic dial exactly like the one found at Iniscaltra in Ireland.

The Celtic pillar dial found in Ireland are very similar to Anglo-Saxon dials, except for the termination at the ends of the hour lines. These terminations may be the Celtic Ring Cross equivalent to the Roman Cross, both of which are Christian symbols.

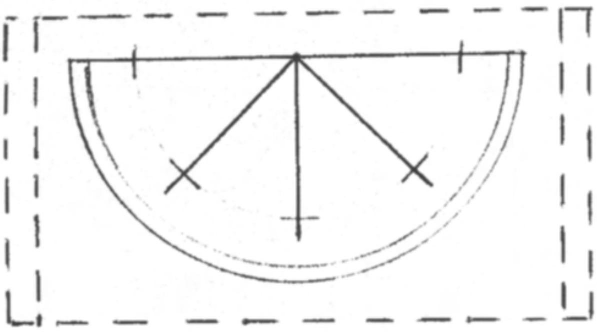
It may be that Anglo-Saxon dials were not intended to show the hour of the day at all, but were Christian adaptations of the pagan practice of sun worship. Symbolising for the newly converted, by the daily rotation of the shadow of the gnomon, the inexorable passage of time and the divine control of the brevity of life.

Ignorant superstition might thus explain the missing gnomon on those few Anglo-Saxon dials which survived the wholesale destruction during the later Danish invasions.

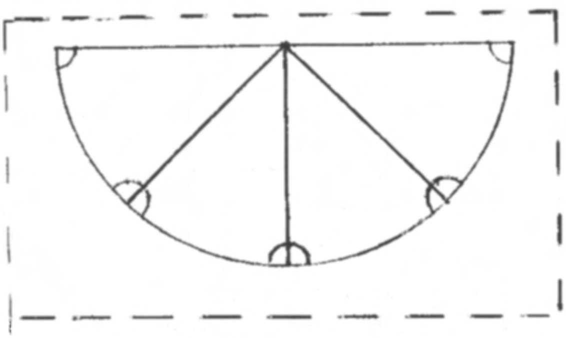
DAVID SCOTT



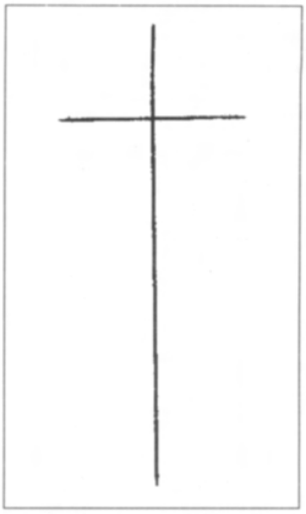
Graeco-Roman Hemispherical Sundial



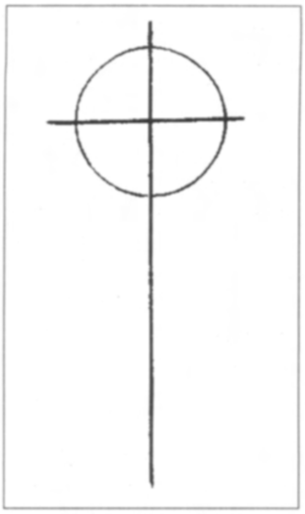
Anglo-Saxon Sundial



Irish Pillar Sundial



Roman Cross



Celtic Ring Cross

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THE CANTERBURY DIAL

What a pleasure to read Peter Drinkwater's 'Comments upon the Canterbury Pendant' despite its idiosyncrasies of spelling and nomenclature. I should like to here to endorse its conclusions. The Canterbury dial is a religious instrument, its purpose is to locate the moments of the Christian rituals. What interested the user of such a dial was not locating a moment in an arbitrary numbered grid of hours such as, in the western world, we have imposed on day and night since the Renaissance, but knowing when a certain proportion of the day had elapsed. In an unequal hour system such proportions can be represented by numbers (the third hour signifies half the period between sunrise and noon, the ninth, half the period between noon and sunset). The numbers of an equal hour system however can only represent such periods symbolically and this difference, I would suggest, lies at the root of much modern misunderstanding of early Medieval dials.

In this context I should like also to endorse Karlheim Schaldach's suggestion that the purpose of early Medieval vertical dials north of the Alps was more symbolic than practical. To find the two functions entwined is not, I think, alien to the mind-set of men in the 8th to 11th centuries, and if vertical dials could serve only as approximative time-indicators (though considered as indicators of proportions of time rather than of specific hours they emerge rather better), they may still have been useful as equinox markers. At all events (and with this subject we are very much in the realm of the hypothetical) I am very glad, and re-assured, to find the ideas of Mesrs Drinkwater and Schaldach convergent with the tentative conclusions that I have been developing while preparing the early Medieval chapter of the non-technical, social history of sun dials on which I am presently engaged.

It may further be of interest to readers to know that a second dial of the Canterbury type survives. It is now in the Historical Instruments Collection of the Adler Planetarium, Chicago. This instrument was publicly exhibited in Amsterdam in 1990 and is illustrated and briefly described in the catalogue of the exhibition, *Time* (ed. A.J. Turner), The Hague, 1990 p.95 no.169. The following description and comments on the new sun-dial are quoted from my forthcoming history mentioned above.

'This second sun-dial is made of bog-oak and bone and is slightly larger than the Canterbury example. Its overall height is 78mm (month plate 49.5mm + cap and suspension piece 28.5mm) and there is a taper from 27mm at the bottom of the month plate to 25.5mm at its top. The whole instrument is about 6mm thick. Unlike the Canterbury dial, the bog-oak dial is entirely without ornament apart from the bell-shaped form of the cap carrying the suspension eye and the three concentric rings scribed around the gnomon holes at the top of each month scale.

Although clearly functioning in exactly the same way as the Canterbury dial, and having the same ecclesiastical functions as that, this new dial is equally clearly not a copy of that from Canterbury. Apart from the obvious differences of the materials and decoration, the London/Chicago dials does not exhibit an error in the month name placings found on the summer face of the Canterbury dial which reads April, June, May/August, July, September instead of April, May, June/July, August, September. Moreover, although close in style and evidently in the same tradition, the lettering of the London/Chicago dial is somewhat less rigid and upright than that of the Canterbury dial. The left-hand minim of the M is more curved and flowing, the R is more open as are the G and the S, although both are less well formed than those on the Canterbury dial. Cumulatively, the difference in the lettering and the form of the cap of the London/Chicago dial suggest that it is later in date than that of Canterbury although by how much remains a matter for conjecture.

Whatever the date of the London/Chicago dial, it is important for freeing the Canterbury example from its isolation. It shows that similar, though more modest dials of this type were made, and this suggests in turn, that they may have been widely known and used by educated monastic and regular clergy throughout the Middle Ages. If so, then it is probably the Canterbury dial that is exceptional in being made of precious metals, and it may be that the errors that it shows arise from the fact that it was made by a gold- or silversmith unfamiliar with the production of such an everyday object. Where such dials might have originated however remains a mystery.'

A. J. TURNER
Le Mesnil-le-Roi

DROITWICH SUNDIAL

The Droitwich War Memorial dating from the First World War is in a prominent position in the town centre and is surmounted by a horizontal sundial. The supporting stone base was vandalised early in 1995 and the Mayor organised a fund to enable repairs to be completed in time for the VJ Day Anniversary celebrations during the summer.

The Dial had not been damaged by the vandals, but Peter Lamont, a member of the Society, had noticed some time ago that the Dial was entirely unsuitable for the Latitude of Droitwich as the gnomon inclined upwards at an angle of 30 degrees only (more suitable perhaps for Cairo), though a subsequent computer check revealed that the Dial markings were substantially correct for the locality. The Dial did not bear a makers name and local enquiries did not throw any light on the reason for the incorrect gnomon, so it is thought that this must have been added at some stage during the past 70 years following damage or vandalism to the original gnomon. A further check also revealed that the dial was misaligned by approximately 11 degrees in an anti-clockwise direction.

He drew attention to the Mayor to the defects of the dial and volunteered to redesign the gnomon and supervise its installation and realignment on the new stone base which was then being prepared. The Mayor agreed and the redesigned gnomon was duly manufactured and installed in time for the VJ Day celebrations. To discourage possible future vandalism the opportunity was taken of providing a gnomon of robust construction with a V shaped leading edge which was also made rather shorter than usual; a sad commentary perhaps on the degree of respect for the war-dead at the end of the twentieth century.

PETER LAMONT

Droitwich War Memorial Sundial after fitting of new gnomon, 1995.

* * * * *

COMPUTER PROGRAMME

Could I ask for some help with understanding the calculations that are set out on page 45 of Bulletin No. 95.2? I have tried to calculate the declination for the days of the year as shown in Formula 1 as:

$$-\sin 23{\cdot}4^\circ \times \cos(T + 2\sin T)$$

and I am not getting the correct answers. Is there an error in this formula? I want to make an analemma for my sundial and wish to use the equation set out on the bottom of page 47, which requires this calculation to enable the operation to be correct.

Can you also send me the listing of the Basic program that you refer to on page 48 of that issue? I would be interested in any elementary books that detail how to construct a vertical declining dial with analemmas. Can you recommend one?

P.D.G. TOMPKINS

EDITOR: Mr. Tompkins was sent a listing of the program. The equation was not set out very well on page 45 of Bulletin 95.2 because the degree symbol was omitted and this makes the equation look ambiguous. Has anyone else experienced difficulties? Neither could he think of an elementary book dealing with a vertical declining dial with analemmas. Is there no limit to the punishment to which a diallist will submit himself? Or does this merely mean a vertical declining dial with one analemma at the noon line?

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NOTE: A number of Reader's letters have had to left over until the next issue of the Bulletin because of lack of space. Apologies to those who have been disappointed - it is first come, first served.

* * * * *

A LIKELY STORY

On the evening of 22nd April, 1995 in a public house not far from Grantley Hall, two coach drivers were getting drunk and it was not costing them a penny because they had a story to tell.

It had been an awful day, cold and raining. Steady, heavy, drenching rain. Their story, if it was to be believed, was that they had taken over 80 geriatrics on a forty mile round trip to see a sundial!

It sounded a bit farfetched, and of course ~~on~~ no one really believed them, but it was a good story and worth a pint on a wet Saturday night in the Yorkshire Dales.

Note: To the drivers, anyone over forty years of age is a geriatric.

A.J. ADAMS

EDITOR: See end of page 4 for an account of this epic journey of misplaced enthusiasm. It was the first occasion of rain on a BSS sundial safari.

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MAGNETIC COMPASS

We are Australian members of the BSS and enjoy your Bulletin for the information and ideas they provide.

We are at present trying to develop a simple modern portable sundial. Incorporated in the sundial is a small insert compass. We are having trouble tracking down an appropriate low-cost compass that works!

The ones we have found so far have either failed us completely or are plastic and ugly. What we want is at least 12mm diameter by 6mm deep and simple (and cheap). Alternatively just the compass internal workings would be useful as we could assemble them in the sundial and paint the points of the compass ourselves.

If anyone can help us please write to: John and Jenny Bourne, 21 Evans Street, MORUAY 2537, AUSTRALIA. Tel: (044) 744252 Fax: (044) 744284.

Finally I would like to use these pages to thank all the people who responded to my letters and talked to me about sundials when I visited Britain last year. Colonel and Mrs. McVean in particular made us very welcome. I would also like to apologise to Professor M. Jayson and his wife. I intended to visit but fell foul of public telephones and the M6 late on a Friday night.

JENNIFER BOURNE
Australia

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NORTH DECLINING SUNDIALS

Peter Meadows' article on North declining dials was interesting but he overlooks the fact that while a South dial cannot show a shadow above the horizontal (the horizon gets in the way), a North dial can show a shadow below its "inverted" gnomon due to the sun's declination.

Peter's dial declines at 15° 42' East, and a quiet half hour with my calculator showed that, at the Summer Solstice, the sun will not go "behind the wall" until just after 8.30 am L.A.T., and will start to cast a shadow from the West just before 6 pm. I have drawn a diagram of Peter's dial with these extra hours added. Although the sun will set at about 8.20 pm at the Solstices, I have added the 8.30 pm line to match the 8.30 am mark and balance the layout of the furniture.

Peter's diagram of hour line limits as drawn (Figure 1) would only apply to dials declining in the Polar plane, as it does not take account of the sun's declination, changes in which will also change its azimuth for a given hour angle. I studied Peter's nomogram for several minutes and at one point doubted whether one could be satisfactorily constructed for vertical dials. Obviously, the only way to find out was to drawn one. I found that it all fell into place quite naturally with a nice gentle curve at the point where the wall eclipses the sun. In fact I was so taken up with the idea that I constructed one for South decliners also. One might think that this would simply be the middle shaded portions of the North dial nomogram, but a little thought indicates that any South facing dial will receive its maximum hours of sunlight at the Equinoxes. Copies of both nomograms are shown here.

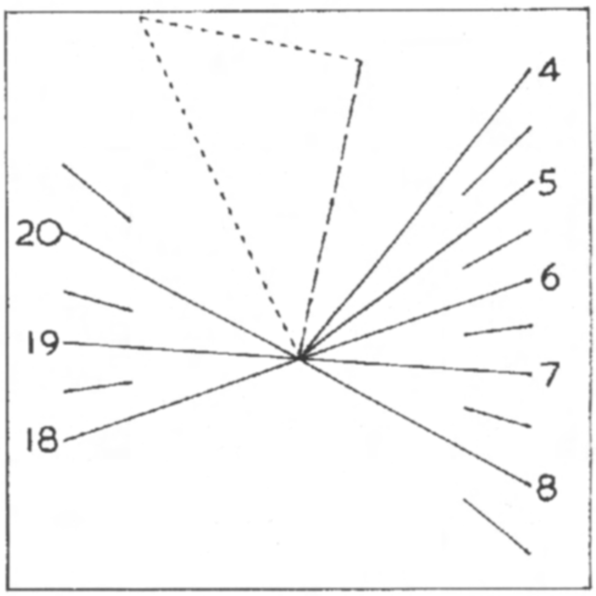


FIGURE 1: Dial for Latitude 51°43'N.
North Declining East 15°42'.

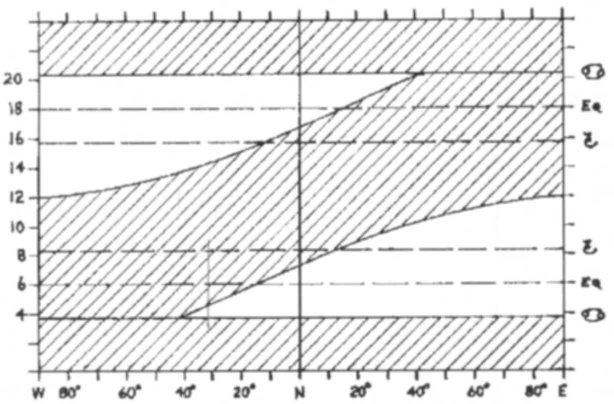


FIGURE 2: Hour line limits for vertical North declining dials at lat. 51 N. (Maximum hours of sunlight at the Summer Solstice.)

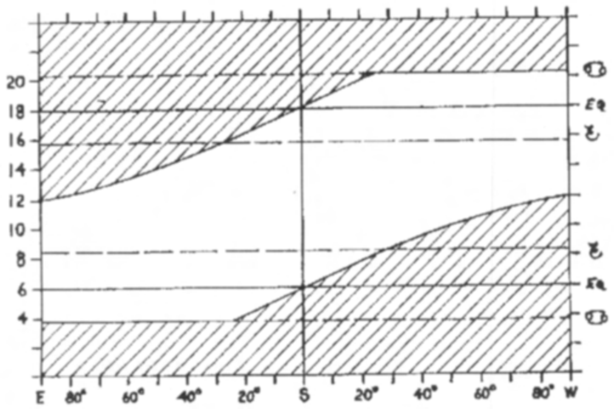
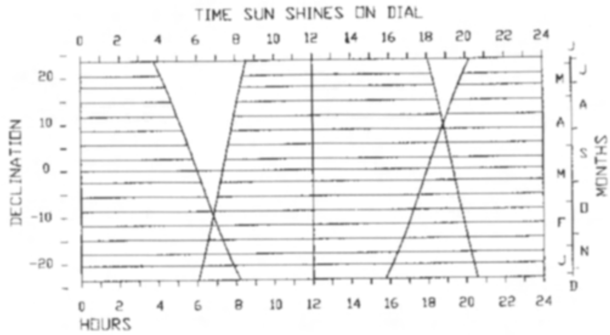
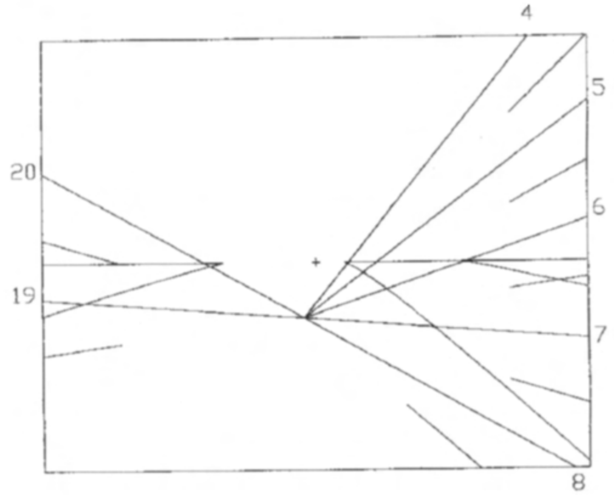


FIGURE 3: Hour line limits for South declining dials at 51° North. (Maximum hours of sunlight at the Equinoxes.)

Please do not think I am trying to belittle Peter's article, far from it. He simply overlooked the effect caused by the sun's declination. I am grateful to him, it got my grey cells working! Although at the time I had not yet read H.R. Mill's article, "Keeping Track of the Sun", I am pleased to say (perhaps relieved would be a better word!) that, give or take the 5-10 minutes accuracy to which any small nomogram can be read, they do match his graph of the sun's azimuth-hour angle, on page 38 of the Bulletin.

COLIN THORNE
Barnstaple





NORTH DECLINING VERTICAL DIALS

In the BSS Bulletin 95.3, pages 33, 34, Mr. Meadows writes about north-declining vertical dials. Indeed these dials have limited hour lines, but not so far limited as Mr. Meadows writes. ...In the beginning is written that a north dial will only have hour lines between sunrise and 6 am together with between 6 pm and sunset. But for the latitude of 51° 43' these limits are between sunrise and 7.20 am and between 4.40 pm and sunset. The limits are not 6 am and 6 pm.

Also the example in the article which declines 15° 42' east will have more hour lines. For a certain plane I calculate the limiting hours with the help of a graph. For the dial mentioned in the Bulletin the limiting hours are between sunrise and 8.34 am and between 6.04 pm and sunset. The dial thus will show more hour lines and will be as you see in the drawing.

F.J. DE VRIES
Netherlands

Continued from page 35

REFRACTIVE SUNDIALS

finding the correct lower point of attachment for the string gnomon, have intrigued Owen Gingerich and Philip Sadler for some years.[3]

All the above sundials belong to the directional (azimuthal) family, but it will be realized that the other great family of sundials - altitude dials - may also be transformed into refracted versions. These are conveniently termed 'chalice dials', and some very beautiful examples featured in an article in Bulletin 95.3, October, 1995, pp. 19-26.

NOTES AND REFERENCES

1. This is the name and spelling quoted by the authorative *Dictionary of Scientific Biography*, (Edited C.C. Gillispie, Scribners N.Y. 1975, Vol. 12). However when writing (mostly mathematical) texts in Latin, he himself employed the form "Snellius", so it is common to find the ratio of sines termed "Snell's Law".
2. A.A. Mills, The 'Dial of Ahaz' and Refractive Sundials in General. Part I: Scaphe Dials. *Bulletin of the Scientific Instrument Society* 1995 No.44 pp.21-24.
3. A.A. Mills, The 'Dial of Ahaz' and Refractive Sundials in General. Part II: Horizontal Planar Dials. *Bulletin of the Scientific Instrument Society* 1995 No.45 pp.25-27.
4. P.M. Sadler, An Ancient Time Machine: The Dial of Ahaz. *American Journal of Physics* 1995 **63** (3) 211-216.

SUNDIAL MOTTOES

CHARLES K. AKED

A writer on dialling dismissed the mottoes on sundials as "trite" and ruining what would be otherwise excellent examples of dialling, comparing them with the descent from true artistic values by Millais in his painting "Bubbles". Truly one man's meat is another man's poison, for personally I enjoy "Bubbles" as a friend of infancy, and sundial mottoes are often an apposite comment upon the view of the sundial looking at the observer. Since these have been used by dial makers since time immemorial, they must have been of some value to be able to continue in existence to this day.

Sundials are often included in the comments and plays by the ancient writers. Everyone knows of the doggerel written by Plautus in the second century B.C:

The gods confound the man who first found out
How to distinguish hours - confound him, too,
Who in this place set up a sun-dial
To cut and hack my days so wretchedly
Into small pieces! When I was a boy,
My belly was my sun-dial - one more sure,
Truer, and more exact than any of them.
This dial told me when 'twas proper time
To go to dinner, when I had ought to eat;
But nowadays, why even when I have,
I can't fall to unless the sun gives me leave,
The town's so full of these confounded dials,
The greatest part of its inhabitants,
Shrunk up with hunger, creep along the streets.

Of course the early sundials were singularly unornamented with words except to record that so-and-so had made this munificent gift of a dial for the benefit of the public at large, an early form of advertising which made sure that each person who consulted the dial was aware by whose generosity he was enabled to go about his daily business. Many early Greek dials do not even bother to number the hour lines, rather like a modern clock dial which bears only batons to mark the hours. Long usage makes it possible to deduce the time without the numerals meant to make it easy to read the time. The writer once made this observation to the wife of a prominent horologist, who said that she could not possibly do without the figures to tell the time. I pointed out that there were no figures on her watch dial, she had not noticed this after wearing her watch for over three years. In a similar way, ancient people must have been able to read the dials without numeration, in fact possibly the numerals might have meant nothing to the average person of the proletariat.

Thus the placing of mottoes on sundials would have meant little to those other than educated person (this may still be the case today), and often the subtlety of the meaning is lost unless one is familiar with the language of the motto. An hilarious joke in English does not quite hit the mark when delivered in French or German; and vice-versa. By the time we modern readers have painfully translated the Latin or Greek inscription on a dial, any chance of appreciating its significance has long gone.

One might think, with the preponderance of Latin tags on dials, that these had come down through the millenniums: this view would be erroneous since most of the usual Latin mottoes are of European origin, accounted for by the universal use of Latin to disseminate knowledge. It was the favoured language of the scientist, astronomer and agronomist, so many of their terms are still in use with us today. In the Middle Ages the majority of dialling tracts were written in Latin, indeed such early writers as the mathematician Oughtred wrote all his dialling tracts in Latin and these remained so until many decades later when others transposed them into English for the less learned. Sir Christopher Wren wrote his thoughts on dialling in Latin, including anagrams to date the work ad establish priority.

Mottoes were considered worthy of note from the beginning of what might be termed the scientific age of dialling when diallists were able to calculate the lines instead of having to use geometrical methods. *Helio-tropes or New Posies for Sundials* written by John Parmenter in 1625 deals with sundial sayings exclusively, hardly commenting upon the dials themselves except in passing. The whole of this work was published in BSS Bulletin No. 89.2, November 1989. Thus also John Wells in his book, *Sciographia . . .* published in 1636, includes suitable arrangements of words, whilst Charles Leadbetter in his *Mechanick Dialling . . .* includes no less than sixty examples described in the subtitle to the book as "To which are added a choice collection of Mottoes in Latin and English", London, 1737.

The search by Mrs Alfred Gatty, as Margaret Gatty called herself as author of *The Book of Sun-Dials*, published London, 1872, in respect of sundials, was limited to mottoes and their place in social history. Her friend James Nasmith recommended that she leave the dry part alone (i.e. the technical side), "for it has been done many times before". So Margaret dealt with the moral and poetical part of sundials almost exclusively, fortunately because in her preface she commits the blunder of ascribing the Queens' College, Cambridge sundial to Sir Isaac Newton, stating that he himself had erected it. Evidently the technical side was not within her powers. Nevertheless there is a lot of useful information in her Introduction.

In all events, Margaret compiled one of the best-known books on sundials, faithfully recording all those she saw herself and those sent by correspondents. Each motto is translated from the foreign language where applicable, and generally a short piece in explanation. Alas, a lot of these dials have vanished for ever, and would be completely unknown but for her indefatigable efforts. There are 377 mottoes listed by her in the main record, and she illustrates a selection of these at the end of the book, first published in 1872. In "Further Notes" she does yield to the temptation of describing some remarkable sundials that have no inscription. As Margaret says: " . . . and though no inelegance of form or poverty of material can render a beautiful motto insignificant, it is a fact that some of the finest and most costly dials are without mottoes". It says much about the subject then that the sundial at Bewcastle was unknown to Margaret Gatty in spite of mentioning the examples at Kirkdale and Edstone, these of course do have some words on the dials. The later ubiquitous mass dials spurned all words and symbols, because of this and the complete lack of mention in any records, they remain the most enigmatic dialling relics of ancient times.

There is no doubt that anyone who wishes to acquire a knowledge of the sayings on sundials must make a start with Margaret Gatty's great work. The last edition, enlarged and re-edited by H. F.K. Eden and Eleanor Lloyd, published in 1900, is a much more sophisticated book and the first two hundred pages encroach upon the preserves that Mrs Gatty herself avoided. However page 203 moves on to a much enlarged list of mottoes, giving details of 1682 mottoes, whilst also included is a 12 page scientific treatment of sundial construction by J. Wigham Richardson. This edition must be obtained by any discerning diallist.

In 1902, Alice Morse Earle published her book, Sundials and Roses of Yesterday, a quite different format to that of Mrs Gatty, in which the mottoes are merely an adjunct.

The later books on sundial mottoes are rather feeble, for example *A Book of Sundial Mottoes* compiled by Alfred H Hyatt in 1903, with a foreword by A.M. The Mottoes cover 113 pages and they are placed in no particular order, nor is any detail included as to where the mottoes were found, nor is there a single illustration of a sundial except on the book cover. The only justification for printing it would appear to be the small size of the book and of course a much lower price. Another small book is *The Book of Old Sundials* by Alfred Rawlings which appeared in 1914, although the drawings of famous sundials were drawn 21 years earlier by Warrington Hogg. Again the mottoes are listed in no particular order and with very little added detail. In this book there is an excellent chapter on the theme of the sundial motto which epitomizes its role in adding the final touch to a sundial. It is the finest exposition of the role of the sundial motto that the writer has come across.

Ye Sundial Booke by T. Geoffrey W. Henslow, 1935, is a large book of 422 pages. He must have been a would-be poet because he generated 600 verses to accompany the line drawings of the sundials he included. The illustrations are quite fanciful but plausible, the writer, in spite of having visited Kirkdale many times, found himself looking for the details shown in Henslow's book. Like Hyatt's earlier book, the drawings in Henslow's book were drawn much earlier, in this case by Miss D. Hartley, many of the drawings being dated 1912. Evidently they were not commissioned by Henslow because he would have been a schoolboy at the time the drawings were made. In spite of all the versifying, not one single motto is included in the main treatment, the unwary reader glancing through the book might be deluded into thinking the verses below were actually on the dials. Many of the interesting dials shown are not identified, a pity considering the effort which must have gone into compiling the work. However there is a chapter in the book devoted to famous men and the sundial with notes on mottoes. In considering the multitude of mottoes, Henslow avoided the huge task of listing them by stating he does not wish to weary his reader with these, recognizing that Gatty had already pre-empted him in this respect of dialling. Many of his remarks shows how much he owes to reading her treatise, although he does not mention her by name. However, if anyone is looking for a sundial motto, Henslow included a 14-page listing of his own mottoes, all two-liners in English.

One of the little-known books dealing with sundial mottoes was that written by the Reverend John S. Hill, Minister of Mure Church, Irvine, Ayrshire, Scotland. It was written for boys and girls attending Sunday School, their parents and their teachers. There are thirty-six short chapters in the form of homilies, each commencing with an appropriate sundial motto. Each essay interweaves the meaning of a sundial saying with moralistic excerpts from the Bible and mentions of famous people.

It commences with a poem which starts off very well:

THE SUNDIAL

In a quaint old-fashioned garden,
Near the fountain on the lawn,
There's an ancient sundial standing
Crumbling, old, and worn . . .

Alas the metre goes awry after this point and the initial flow is lost.

Like many books connected with time, this contains no mention of the date of its publication, but on reading the text in Chapter 12, where several resolutions are made for 1929, and mention is made of the BBC reorganising its twenty wireless stations, we can assume it was in that year in spite of it being so very old-fashioned in its approach. Evidently the minister had access to a copy of Mrs. Gatty, for there are traces of her findings in the book, especially in the last section "Twelve Wise Sayings" which collates twelve sundial mottoes which disseminate wisdom. But it was always a difficult act to follow Mrs. Gatty, the high priestess of sundial mottoes.

Enough has been written here to show that there has been a large interest in these sundial texts and that at one time they were considered an important addition to a plain sundial. The mottoes were often exhibited in the same vein as aphorisms delivered from the pulpit, exhorting the immediate visitor to cast off sloth and cultivate punctuality, or adopting a high moral tone. In the case of Latin tags, it is doubtful if readers of any bygone age were any better at deciphering these than present day discoverers of the decaying texts. Often the writer has had to turn to Gatty to remove the obscurity of ancient words, for modern linguists often cannot appreciate the subtlety. As one Latin teacher explained to the writer when asked to translate a few words, "I can't, it is old-fashioned Latin". The majority of us will never be able to appreciate the original flavour of the saying, for like a joke that has to be explained, something is lost in the translation, especially if it is hesitatingly delivered.

Somewhere in the world there must be those who still collect sundial mottoes, it may be a better pursuit than collecting train numbers. Thanks to those enthusiasts in the past, many of these have been preserved when their stone records have crumbled into the dust. Perhaps, even today, there is another Margaret Gatty preparing a new and even better treatise.

Reading Edmund Gunter's book recently - *His Majestie's Dials in Whitehall Garden*, published in 1624, the writer thought how strange it was that the book had survived the centuries although a frail item, whereas the five-ton block of stone forming the sundial did not last the century out. It might have done rather better had it been inscribed with an admonitory message, warning drunken revellers not to use it as a urinal, although this could hardly have been classed as a motto. Similarly mottoes are often the last surviving remnants of long lost dials, which otherwise would be completely forgotten.

SWORDS INTO PLOUGHSHARES

MICHAEL HICKMAN

You cost me £22 - I wonder what you cost some poor aviator?

You sit on my desk clean and static and you are there as a technical curiosity, or perhaps my latest toy. But were you once vibrating badly and surrounded by noise, by smoke, by fear? Did you go over Berlin in a Lancaster one night more than fifty years ago? Over the Ruhr in a Stirling? Did some wretched frightened navigator try to set you correctly to find out what his course really was because the magnetic compass had been hit by the last burst from a Messerschmitt night-fighter? Did he try desperately to remember what he'd been told about how to use you? Did he try perhaps more desperately to find through the cloud and the smoke a suitable star that he could identify?

Did he have by him that lovely list of names of the navigational stars? Alpheratz? Schedar? Aldebaran? Dubhe? Altair? Fomalhaut? Whoever named the navigational stars, an early Arab astronomer perhaps, had an ear for musical sounds, whose beauty would match the beauty of the stars themselves.

But beauty didn't come into the navigator's reckoning, did it? How did he identify the stars, I wonder? If I get it wrong it doesn't matter. It's a blow to my pride perhaps, but nothing worse. If the navigator got it wrong then the result was almost certainly disaster.

But the navigator who used my astro-compass didn't get it wrong. Or if he did there was no disaster. My compass is sitting on my desk, rather than lying somewhere under German soil or perhaps operating in a recycled state in the latest Volkswagen.

My compass may not have flown over Germany. Perhaps it has been over the Atlantic in a Sunderland flying boat on long anti-submarine patrols where the navigator's worst enemy may have been boredom, not flak or night-fighters.

Again it may not have flown in action at all. It may have been only on training flights in which embryo navigators learned their trade, all the while regretting that they were not to be pilots, or else thinking of the girl they were to meet that night. I hope that they did meet that night.

Perhaps the compass never went anywhere but sat unwanted and unused in some vast RAF store. But looking at its box I don't think that was what happened. The box bears honourable scars and greasy fingermarks; from a fitter perhaps swearing as he took the compass out to a Lancaster one cold damp Yorkshire night prior to a raid.

I think that I would like my compass to have been in a bomber over Berlin. Now I am using it as a sundial and its most deadly effect is to enable me to bore everyone about it. But if it had been over Berlin and is now a sundial in Dorchester then that really would be a sword into a ploughshare wouldn't it? I'd like that - and I hope that those departed young navigators would have liked that too.

BSS SUNDIAL COMPUTER PROGRAM

Members wishing to acquire the BSS computer program disk are requested to send their orders (with a cheque for £8.50 made out to the BSS) to the General Secretary, Mr. David Young. The Editor regrets he is unable to supply these any longer because of health problems. See rear inside cover for Mr. Young's address.

USEFUL ADDRESSES

Mr. Charles K. Aked 54 Swan Road WEST DRAYTON Middlesex UB7 7JZ	[Editor] Tel: 01895 445332	Mrs. Anne Somerville Mendota Middlewood Road HIGHER POYNTON Cheshire SK12 1TX	[Library, Archival Records & Sales] Tel: 01625 872943
Mr. Graham Aldred 4 Sheardhall Avenue Disley STOCKPORT Cheshire SK12 2DE	[Council Member]	Mr. Robert B. Sylvester Barncroft Grizebeck KIRKBY-IN-FURNESS Cumbria LA17 7XJ	[Membership] Tel: 01229 889716
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Mr. Alan Smith 21 Parr Fold Avenue WORSLEY Manchester M28 7HD	[Northern Liaison] Tel: 0161 790 3391		

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