

The British Sundial Society



BULLETIN

No. 97.4

OCTOBER 1997



Front Cover: Sundial by M. Bernhardt, Bad Soden, Germany
Back Cover: Dial plate of Bernhardt Sundial

(Photos, D. A. Bateman, July 1997)

BULLETIN 97.4 - OCTOBER 1997

CONTENTS

2. EDITORIAL
3. MARKING TIME - *Peter Lamont*
5. ULTIMA NONNA? - *Denis Schneider*
8. THE TURNBULL DIAL - *Desmond Quinn*
10. A MODEL DEPICTING SOME ASTRONOMICAL FEATURES OF STONEHENGE - *H. R. Mills*
11. VOICE FROM THE PAST - *Mike Cowham*
13. ANCIENT SUNDIALS OF IRELAND - *Mario Araldi*
20. CROSSWORD SOLUTION
21. FOLDED-H POLAR DIAL - *John Singleton*
ST. JOHANN'S SUNDIAL - *Mike Cowham*
22. BOOK REVIEWS - *Charles K. Aked*
23. JOURNAL REVIEWS - *Charles K. Aked*
26. SUNDIALS GO GREEN IN NEWCASTLE - *Tony Moss*
27. READERS' LETTERS - *P. Tandy, A. Partridge, M. J. Kenn, A. A. Mills*
31. DIPTYCH SUNDIAL CARDS - *Allan A. Mills*
36. AN ORIGAMI SUN CALENDAR - *John Moir*
38. NOTES FROM THE EDITOR
41. THE ACCURACY OF SUNDIALS - *Erwin H. Overkamp*
47. THE SUNDIALS OF HESSE - *Margaret Stanier*
49. THE 1997 ESSEX SUNDIAL MEETING - *Michael Lowne*
MASS DIAL GROUP: GLOUCESTERSHIRE MEETING - *John Ingram*
50. A 'TIME TRAIL' IN THE CITY OF LEICESTER
51. MORE SUNDIALS OF HESSE, GERMANY - *Photographs by D. A. Bateman*
52. BSS BULLETIN 1997, CONTENTS

BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

ISSN 0958-4315

ISSUE 97.4 - October 1997

EDITORIAL

The October issue of the Bulletin contains something for readers of all interests. There are Sundials Ancient (Ireland) and Modern (a brand new wooden cross-dial). There are notes on How to Make: ('Marking Time') and on How Not To: ('Inaccuracies..') There are suggestions for cardboard cutouts: an H-Dial, Christmas Cards, a Sun Calendar. Encounters with dials in real life (the Turnbull Sundial) and in pictures of Rossetti ('Ultima Nonna?') make happy reading. Reports of meetings in Newcastle-on-Tyne, Gloucester, Essex, and in Germany, bear witness to the vitality of the Society. Contributions have come

from 3 European countries, and there will shortly be one from the Southern Hemisphere. From now onwards, let us be careful to write N, after the 51° 31' when we refer to the latitude of London. Diallists Down Under are sensitive about these things!

Once again the editor warmly thanks writers of articles long or short, and all those who send in contributions. There are some anxieties attached to the job of editing, but the fear of inability to fill the pages is not (so far) one of them.

MARKING TIME

PETER LAMONT

Dialists are generally aware that sundial design of the plane variety amounts ultimately to the determination of shadow angles in relation to sun time. The task of working out the shadow angles from first principles can of course vary from the comparative simplicity of horizontal garden dials to the increasing complexity of wall dials declining East or West and which may in addition also procline or recline.

Ultimately however, whatever the type of dial, the end-result in this age of the computer is a Table on the Screen or Printout showing the shadow angles set against a range of sun hours, but it is not the purpose of this Paper to deal with the calculations involved in that relationship. It will deal instead - as its title implies - with the practical process of marking out the times relating to those shadow angles on the surface of the dial.

As a compulsive designer and constructor of over 70 experimental dials during my years of retirement (many of which turned out ultimately to be reinventions of the wheel!), I have inevitably acquired some practical experience of marking time.

In getting down to the marking out of some of the earlier dials with a protractor, it soon became apparent to me that shadow angles were not the easiest of things to reproduce on the surface of a dial, particularly if fairly close time divisions were involved. Protractors are such small and fiddly things. It would surely be quicker, more convenient and probably more accurate to be able to set out the time divisions along a line with a straightedge scale.

With these considerations in mind, I have been able to devise a reasonably simple method of marking out the time directly along the rectangular borders of the dials. This method, which I think of as the XY method, has been most useful over the years. It is not a substitute for existing computer design programs, but is essentially a semi-standard Add-on to such programs and when it finally reaches the computer screen, it takes the form of an additional column of the time and shadow angle Table.

The essentials of the XY method have been set out on a Diagram (Fig. 1) where a vertical line on the left represents the noon line descending by a distance equal to the designated "scale" from the apex of the gnomon to a horizontal line representing the lower border of the dial. The

second vertical line on the right represents the R.H. border of the dial.

The first sloping line from the apex represents the angle S of the shadow cast by the gnomon (as taken from the computer Table) representing (say) 2 hours. This and other times could each be plotted by protractor, but it would be equally feasible to multiply the scale by the tangent of S and plot the result (X) along the lower border from its intersection with the noon line.

The advantage might not seem very significant for a single plot, but if an additional column representing ($X = \text{Scale} \times \tan S$) is added to the Shadow Angle Table on the computer, a plot of all the X 's corresponding to the successive times can then be made along the lower border in a single operation with a graduated straightedge.

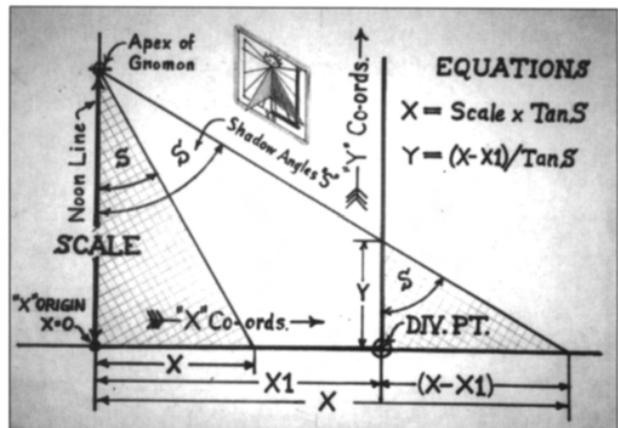


Fig. 1 Diagram of XY Method

The expression $X = \text{Scale} \times \tan S$ completes the mathematical basis of the first part of the Add-on, but an inspection of the second sloping line towards the R.H.S. of Fig. 1 will show that as the hours from noon increase (say beyond 3 hours or so) so do the shadow angles and the values of X . Indeed these will reach infinity as the shadow angle reaches 90 degrees.

A limit must therefore be set on the length of the lower border. This can be achieved within the program by making the first choice of the time marked at the division point an empirical one. A Yes/No Option in the program positioned immediately below the resulting X /shadow angle Table will enable the time at the division point to be adjusted successively in 10 minute steps until satisfactory proportions of that side of the dial have been achieved.

The time scale beyond the division point will now continue upwards on the vertical border. Simple geometry on the small shadow angle triangle at the R.H.S. of Fig. 1 gives the vertical time co-ordinate as $(Y = (X - X1)/\tan S)$ where X is as defined above for the lower border and X1 is the value of X at the division point.

A second Table on the computer with the Y co-ordinates plotted alongside the shadow angles completes the information required for the design and plotting of this side of the Dial in accordance with the XY Add-on method.

The three essential Inputs required for the application of the method are:

1. The Scale (distance from the apex of the gnomon to the lower (horizontal) border).
2. The required subdivisions of Time on Dial (1hr, 1/2hr, 15min or 10min).
3. The Division Point (freely adjustable) - in 10min units of time.

In its application to horizontal or south-facing vertical dials, only one pair of Tables is required for X and Y respectively as the two sides of the dial are identical mirror images, but in E or W declining dials where the two sides are different, a pair of Tables is first completed for the "acute" side (towards which the gnomon inclines) and is followed by a second pair for the "obtuse" side by the automatic reversal of the sign of the angle of decline. See Fig. 2 for a typical example.

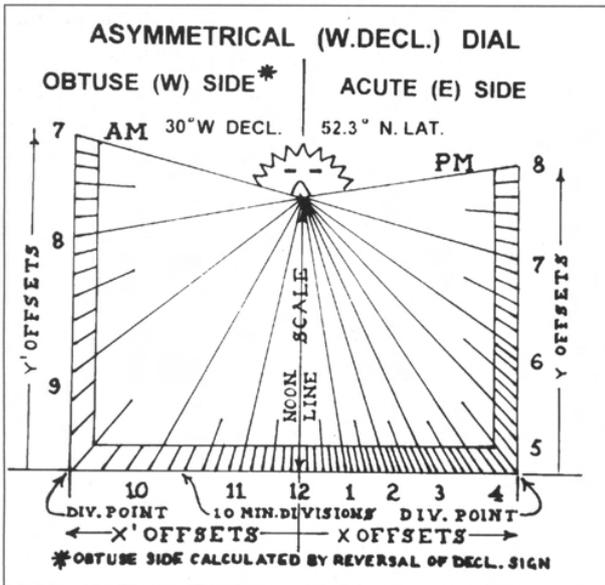


Fig. 2 Offsets for west declining vertical dial

The application of the method to south facing dials is in no way affected by the effects of procline or recline provided that the usual adjustments to the latitude are made by the straightforward addition or subtraction of the degree of tilt.

The problems of applying the method to declining dials which also proclined or reclined proved to be far from simple owing to the three-dimensional complexity of the gnomon's meeting the dial face at a sloping angle affecting both components. I decided to make a test model of this, partly because I wished to make a dial of this type for the sloping balcony rails above my own front door, and partly for my own reassurance on the calculations. The model was constructed for a West decline of 30 deg. and a procline of 20 deg. and is illustrated in Figs. 3(a,b&c).

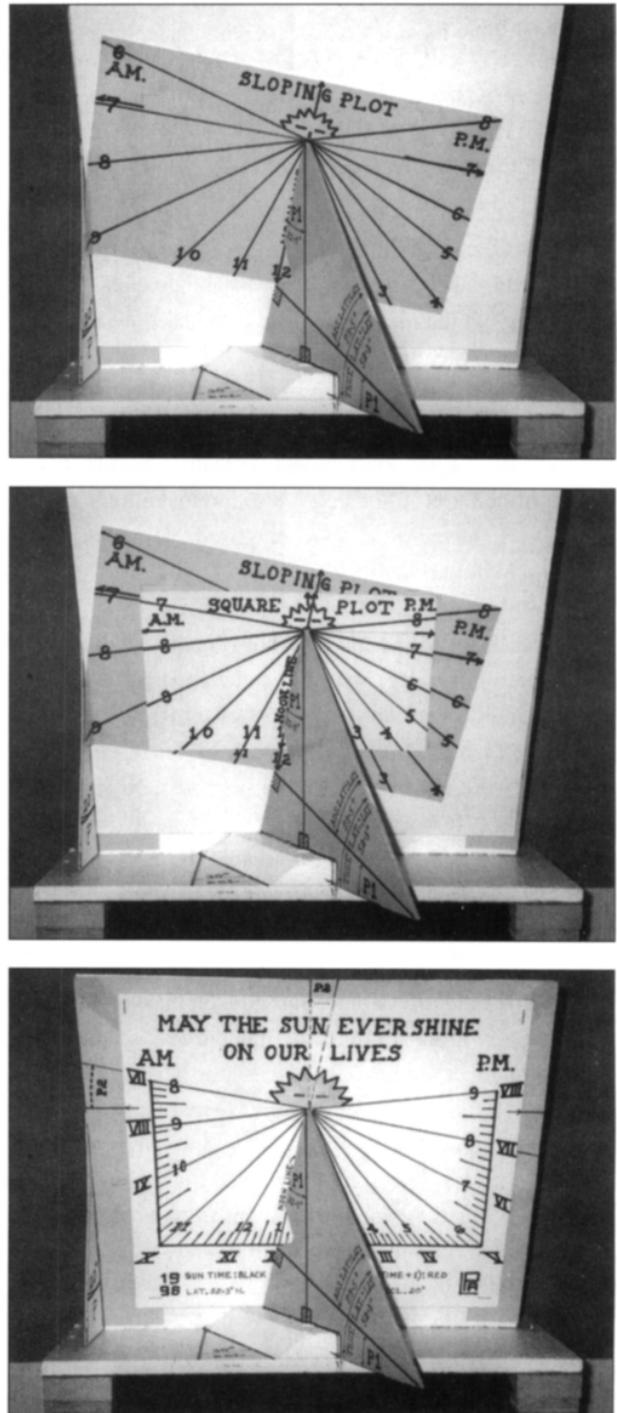


Fig. 3(a-c) Stages in the development of a declining/proclining dial

In working out a generalised program for this type of dial, no particular difficulty was experienced if calculating the angle at the rear end of the gnomon for use in adjusting the value of the latitude. (This worked out for the model as 22.8 deg. as compared with the procline of 20 deg. resulting in an adjusted latitude of 29.5 deg.). This also applied to the calculation of the true (adjusted) angle between the proclining dial face and the vertical gnomon. (This worked out for the model at 28 deg. as compared with the angle of decline of 30 deg.).

These adjustments were readily included to apply automatically within the general program, but an additional complication arose owing to the noon line on the dial face (where it intersects with the rear of the gnomon) being at an angle with its traditional centerline. (On the model this worked out at 11.8 deg.).

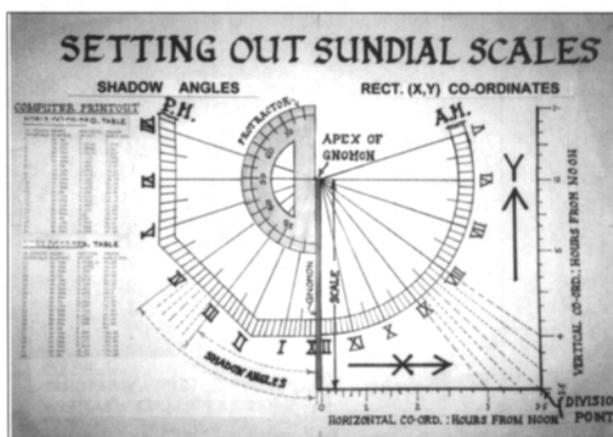


Fig. 4 Application of XY Method to circular or octagonal dial face

When the program is plotted by the XY method with the duly adjusted values for the latitude and declination, the result is a dial (see Fig. 3a) at right angles to the sloping noon line, displaying accurate times, but with a decidedly cock-eyed look.

The difficulty was overcome by an angular transformation

of the X and Y co-ordinates, thus returning the appearance to the dial to normality (see Fig. 3b). It will be noted that the shadow (hour) lines on the original and transformed dials are in complete agreement. The dial was then replotted after the substitution of a larger scale and was successfully tested over a period in the sun, much to my relief. (See Fig. 3c). The Balcony sundial was then completed and has now been in service for over six years.

Although the method is particularly suitable for dials with rectangular borders, it can also be applied to sundials of any shape by designing the XY Frame for a rectangle slightly outside the shape of the required dial and then drawing the appropriate parts of the radial lines between the rectangular border and the apex of the gnomon. See Fig. 4, which illustrates the point although originally prepared as a comparison between the use of the protractor and the XY method.

Note: I have three programs in QBasic covering the three types of dial described, all of which embody the XY Method. These have been useful to me over the years and if any member of the Society wishes to try them out I would be happy to make and send a copy on receipt of a suitable SAE and formatted disk.

An earlier version of the three programs had already been included in a recent Digital Edition (4.2) of the journal of the North American Sundial Society. The final version incorporates some additions and user-friendly improvements as well as a general astronomical program for the sun's daily and hourly position in present and future years. Thanks to the expertise and co-operation of Fred Sawyer of N.A.S.S, the programs may now be entered and run directly from Microsoft "Windows".

Address: Peter Lamont, 52 Kidderminster Road, Bromsgrove, Worcs. B61 6JU.

ULTIMA NONNA? DENIS SCHNEIDER, FRANCE

On a visit to the Tate Gallery, whilst browsing amongst the paintings, I paused in front of Dante Gabriel Rossetti's "Beata Beatrix" (Tate Gallery No. 1279), shown in Figure 1. I immediately saw the error in the hour lines of the sundial included there, see Figure 2, and in view of the importance of the painting, thought it a suitable theme for an article in the BSS Bulletin.

I left the gallery and descended to the Museum bookshop where from the literature on sale there I learnt that the shadow of the sundial style showed the hour of death of Beatrice, the life-long love of Dante (Alighieri), of which, to my shame I had never read before. However I had the chronological sense to be aware that a sundial with a polar style could not exist in Florence in 1290.



Fig. 1 'Beata Beatrice' c. 1864-70, Oil on canvas. Tate Gallery, (no. 1279) Dante Gabriel Rossetti

Many questions came to my mind. Was it not preordained that a later painter, who had Dante as one of his Christian names, was led to use the face of his wife, Elizabeth Siddal, who died of an overdose of laudanum, in the painting of Dante Alighieri's dead love?

Why this use of the reference to the ninth hour, undoubtedly treated by the painter in a different hour system to that in use in his day? I bought a postcard of the painting, went up to the gallery again to view the painting once more, and promised myself that I would read Dante's Divine Comedy at the first opportunity on my return to France.

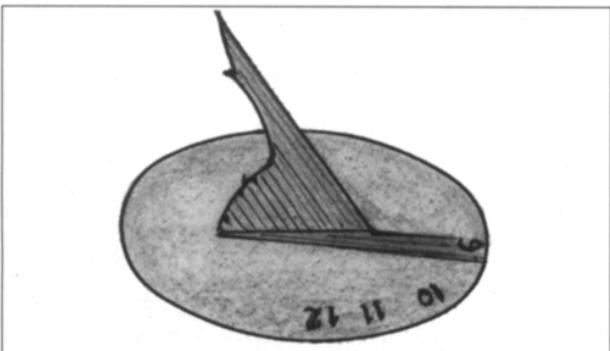


Fig. 2 'Sketch of Sundial from 'Beata Beatrice', to show numerals

Dante (see figure 3), was born in Florence in 1265, and first saw his life-long love Beatrice Portinari when they were both nine years of age, in 1274. Only one other meeting between them is known, nine years later. The story of Dante's boyish but unquenchable passion for Beatrice is told in *La Vita Nuova* [The New Life], a collection of lyric poems in the form of an autobiographical novel. Passages relative to Beatrice may be read in Chapter XXIX of this first work of this great Florentine poet. Dante states in this - "I say that if we count as usually in Arabia, her very noble soul left us on the first hour of the 9th day of the month, and if we count as in Syria, she left us on the 9th month of the year."



Fig. 3 Dante Alighieri

It is commonly accepted that Beatrice died on the 9th June 1290, just after sunset, so it was approximately the ninth hour in evening. It seems curious that Dante sought a cabalistic number from an infidel calendar, to solemnize the death of a Christian lady. It was necessary to verify that in the XIII century, hours were counted from sunrise (Babylonian hours). I made my enquiries at the "Institut du Monde Arabe" in Paris, but my two letters remain unanswered, and no solution was secured to the question of the first Arabic hour in the XIIIth century until reading Chapter XIX in Dante's "Vita Nuova" as just mentioned. We will therefore conclude the details of the sundial before raising other problems.



Fig. 4 Rossetti's 'Saint Cecile' (Pen & Ink, Birmingham City Museum) Sundial, lower left corner behind helmet

The noon of the sundial is positioned at the West of the style, (if the style is really directed at the Polar Star!). The light illuminating a Florentine bridge in the background (assuming the style is correctly oriented), is that of a sunrise.

Rossetti's two "Saint Cecile" depictions, one a pen and brown ink drawing (Figure 4) in the Birmingham City Museum and Art Gallery (1856-7); and a wood engraving (Figure 5) in the Victoria and Albert Museum, London, (1857), also show the hour numbers very incorrectly positioned, and, even worse, turning in an anticlockwise sense. Saint Cecile may also appear as a "Beata Beatrix" version.

"Beata Beatrix" was a turning point in Rossetti's painting, unfortunately for diallists, for he has left the precision of Pre-Raphaelism to plunge into the symbolic world. Elizabeth Siddal's death undoubtedly played a part in this evolution; Beata Beatrix, ecstatic, is clothed in a dun tunic, whilst in the background the Florentine poet turns himself towards the red of his love, as red as that of the mortal poppy flower.

Why then does the position of the nine on the sundial matter? It is only symbolic of the number nine which reigned from the first meeting of Dante and Beatrice until the death of Dante in 1321, thirty-one years after the death of his life-long love. We must put true love before the needs



Fig. 5 Rossetti's 'Saint Cecile' (Wood Engraving, V & A, London) Sundial, left edge

of complete scientific accuracy, even in dialling. Of course Rossetti may have been completely ignorant of the principles of dialling, but why worry when errors can be put down to artistic licence?

It is not known if ever Beatrice returned to Dante's passion, for both were married to other prearranged partners, for this was an age when children were betrothed as infants and had no say in the matter of marriage. The great love for Beatrice existed only in Dante's mind as far as can be seen, but a great poet must have an altar at which he can worship if he is to have divine inspiration in composing his masterpieces, and of the greatness of Dante as a poet, there can be doubt at all. Pity that there was no British Sundial Society in Rossetti's time, or we might have had total truth to embellish the theme of unrequited love with accuracy. But few artists, ancient or modern, delineate sundials with sufficient accuracy, or under the correct lighting conditions.

[Note: Denis Schneider writes that there is another painting by D.G. Rossetti showing Beatrice with a sundial. A painting entitled 'Meeting of Dante and Beatrice' (1859, Oil on panels, National Gallery of Canada, Ottawa) shows an angel, standing between the two halves of this diptych-style painting, holding a mass dial on which the shadow marks the 9th hour. Above the angel-figure is marked '9 June 1290', the date of the death of Beatrice. - Ed.]

THE TURNBULL DIAL AT CORPUS CHRISTI COLLEGE, OXFORD

DESMOND QUINN

In Chris Daniel's excellent 'Shire' booklet on Sundials there is an illustration of the remarkable Turnbull dial at Corpus Christi College Oxford, but it may be that many members will not yet have actually seen it. A visit to inspect this amazingly sophisticated and famous column must be put high on the priority list of any serious diallist and indeed anyone who likes to see sundials. A fairly recent article in the 'Times' described its newly completed restoration so the next time I travelled westward on the A40 I branched off into Oxford to have a look at it.

It is not really a dial but a veritable galaxy of dials, in fact a total of 27, all on a pillar standing some 26 feet in height in the middle of the quad at Corpus Christi. Every surface that can take a dial does, every projection on the heraldic ornamentation at the top of the pillar that can conceivably cast a shadow has hour lines beneath it. On a cold, sunless day I was unable to verify the accuracy of any of the dials but in any case for most of them, near to the top of the pillar, binoculars would have been necessary - certainly for me.

Started in 1579 and completed in 1583 the designer was a Charles Turnbull, a Fellow of the College and author of a short handbook on the use of the celestial sphere. Turnbull's pillar originally stood five feet lower than the present height and the uppermost dials would then have been more easily seen from ground level. In 1706, however, the old base was replaced by the present plinth (and architectural historians will notice a difference in style) an obvious reason for the addition of the plinth being to enable the sun to reach the dial from above the surrounding quadrangle buildings for a greater part of the day. Iron railings which surrounded the pillar for about 200 years were removed in 1936 when the two steps were added. Several restorations have been carried out during the history of the pillar and in 1967 an accident caused it to lean dangerously and it had to be dismantled and rebuilt. The pelican on top was added at that time. Over the centuries many of the shadow-casting features had become eroded due to weathering so rendering the dials inaccurate, also the very complex perpetual calendar for which the column is perhaps best known had become obscure due to indifferent and faulty painting over the years. The whole pillar was accurately re-painted in 1976 so that it is now exactly as it was in 1706 when the plinth was added.

On the main part of the column, the cylindrical shaft, there is the principal dial, direct south facing, with its hour and

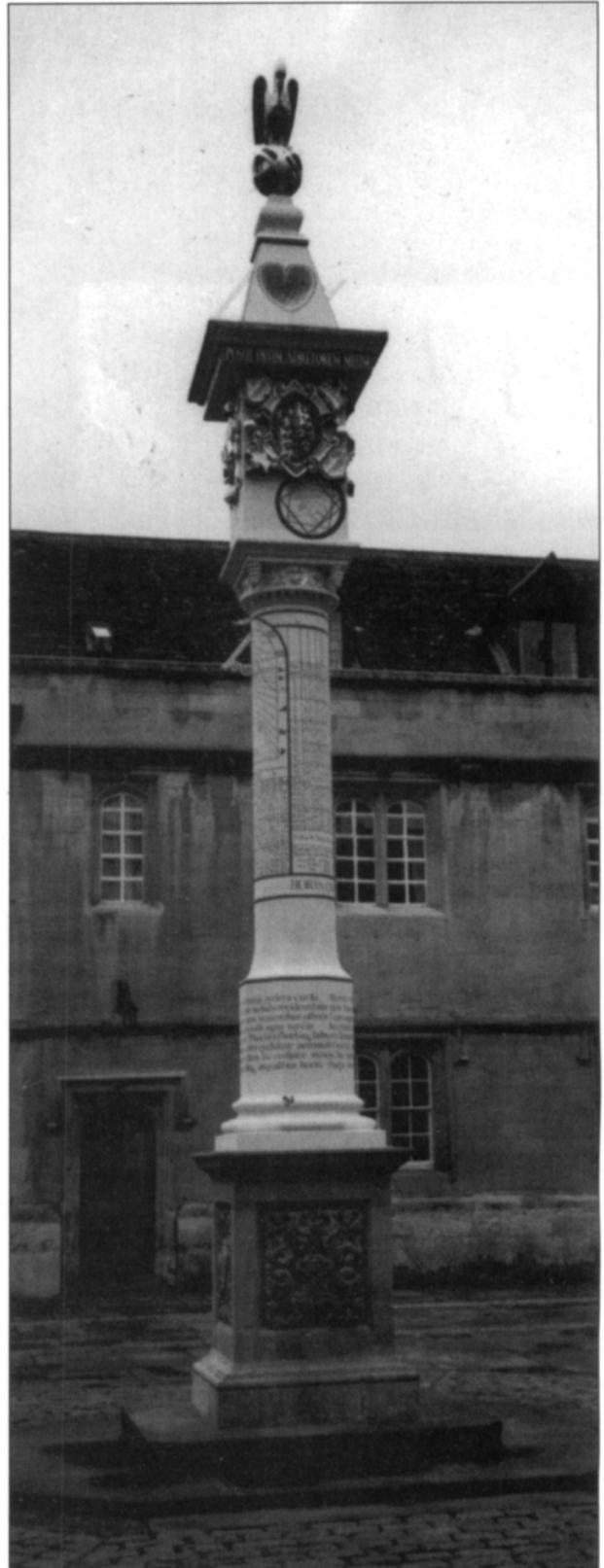


Fig. 1 The Turnbull Dial

date lines marked on the curved surface - which may well have tested Turnbull's mathematics. Further down is marked the perpetual calendar for finding the day of the week that any date in any year falls. As the day on which I was there was bitterly cold I did not stand around to verify the calendar's accuracy, I just took it as read. Further down again is a table giving the lengths of the years of each planet and of the lunar month and to the right of it a table of corrections for reading the time by the moon. At the rear of the cylindrical column there was originally a diagram showing forthcoming eclipses but this space now has dates of ecclesiastical feasts etc



Fig. 2 Upper part, north aspect. The initials on the pyramidal dial are those of Philip Pattenden, a Fellow of the College who was responsible for the 1976 restoration.

The pyramidal top to the pillar has a dial on all four faces but that on the west is a hemispherical scaphe dial while on the east face is a heart shaped concavity (Elizabethan romanticism?) using the upper point to cast the shadow.

Beneath the pyramidal apex and above the cylindrical section is a rectangular block with an heraldic carving on each of its four sides. At the base of each carving is a projection forming the gnomon for the dial marked



Fig. 3 Dial, south aspect



Fig. 4 Dial, east aspect; note heart-shaped scaphe

immediately beneath it. These are fairly easily seen from ground level but perhaps not so easily read since the addition of the plinth in 1706.

However so far so good: all the dials so far mentioned are more or less straightforward even if perhaps somewhat sophisticated. It is for the remaining dials, hidden it seems at almost every part of the heraldic carvings that could possibly cast a shadow, that one should choose a nice sunny day and plenty of time to pick them all out. I think I counted seven on the east side and I believe there is a total of eleven on the west side.

On the principal dials of the rectangular section at the top of the pillar the hour lines are those of the old unequal hour system; on the multiplicity of subsidiary dials that proliferate on the east and west faces it is difficult to see but I suspect that the readings may not be too meaningful anyway. All readings are of course for solar time at Oxford.

So for anyone who has not been to Corpus Christi College to see the Turnbull dial there is an absolute feast of dials to study - and without having to move more than a dozen yards. The rest of Oxford's not bad either.



Fig. 3 Dial, west aspect.

A MODEL DEPICTING SOME ASTRONOMICAL FEATURES OF STONEHENGE

H. R. MILLS

Visitors to Stonehenge may feel the need for reliable information concerning its astronomical significance. The monument is situated on Salisbury Plain at the particular latitude at which the azimuth of the Sun at its midsummer rising, and the azimuth of the Moon at its major standstill rising, differ by 90° . These two directions are remarkably in evidence in the rectangle formed by the four station stones, numbered 91, 92, 93 and 94. (See Fig. 1). These mark, in the 91 - 92 direction, the azimuth of the rising and setting of the midsummer sun, $50^\circ/230^\circ$. The side 92-93 represents the azimuth of the Moon rise and setting at the time of the Moon's Major standstill $140^\circ/320^\circ$. It is noteworthy that a position of Stonehenge about 30 miles to the North or to the South of its actual site would not provide this important Sun-Moon rectangle.

The model, 48cms in diameter was formed by joining 12 photographic transparencies each of which comprised 30° of azimuth from the centre, which was taken as the point of intersection of the diagonals of the rectangle formed by the four station stones. The camera for taking these photographs was mounted on a stable horizontal surface 1.5m high, at the 'centre' of the stones, and was rotated about a vertical axis in 12 steps to cover the whole horizon.

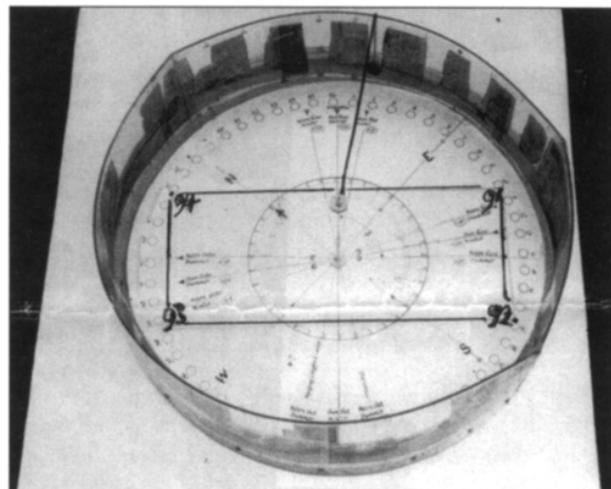


Fig. 1 The model is designed to show the horizon around Stonehenge, as seen from the presumed centre of the present arrangement of stones. The centre is taken to be the point of intersection of the diagonals of the rectangle of the Station Stones numbered 91, 92, 93 and 94, with the two sides, 91-92 and 93-94, marking the direction of the rising of the Sun at the Midsummer Solstice.

The actual width of each photograph covered a field of view of about 35° which comfortably ensured that the 12 transparencies would adequately cover the full horizon. The

photographs when mounted showed that the site of Stonehenge was well chosen for its uniformity and completeness. Examples of the use of this model are as follows: Last October 2nd, the Moon was at its Minor Standstill (Declination $-17^{\circ} 23' 13''$); it was actually seen to rise (at 20.59h U.T.) at azimuth 61° , as shown on the model. For an example concerning the Sun, its setting was observed on December 21st to be at azimuth $230^{\circ} 6'$ as predicted by the model for Winter Solstice. The model could also be used to demonstrate the relationship of significant astronomical azimuths of former times with those of today.

Selected reading on the Astronomy of Stonehenge from a report prepared by the Royal Astronomical Society Stonehenge Group for presentation to English Heritage:

Hawkins, G.S. *Stonehenge Decoded* Souvenir Press, London 1966

Hoyle, F. *On Stonehenge* Heinemann, London 1977

Newham, C.A. *The Astronomical Significance of Stonehenge*, Moon Publications, Shirrenewton 1977

Poston, M.W. *Stonehenge, Sun, Moon and Wandering Stars* Privately published, Kenilworth 1982

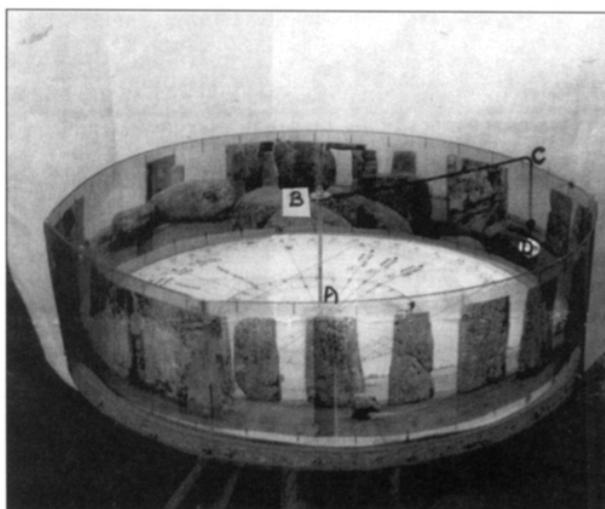


Fig. 2. The vertical rod, AB, at the centre supports a black thread BCD with a small weight hanging at D as shown. This thread is used to measure the azimuths of objects or events on the horizon, using the calibrated base circle which marks the azimuths of the rising and setting of the Sun or Moon or any required point on the horizon.

VOICE FROM THE PAST

I have just acquired a second edition 'Gatty' of 1889 and inserted in it was the enclosed newspaper clipping from The Manchester Evening News, Wednesday, January 14, 1914.

As you will see, the article is entitled 'Sun-Dials, a Plea for their Revival'. Exactly the BSS aims of today! It makes quite interesting reading, and as it mentions various dials that may still be extant and talks about their mottos, I thought that it would interest our readers. However the author does seem to have a few strange ideas in it about the accuracy of dials, but I think we can forgive this in an otherwise interesting article.

Can any member identify the author from the initials W.P.P.-H.?

Mike Cowham

SUNDIALS, A PLEA FOR THEIR REVIVAL

In these times of cheap watches and ubiquitous clocks townfolk have forgotten that there is any other way of telling the time. But in remoter country districts, even today, if you ask a labourer what o'clock it is, he will look up at the sun, mark the shadow made by a tree or a fence, and

answer you: "It's 'bout an hour off noon" or "Two hours after noon", as the case may be. Such a rough-and-ready reckoning would not serve for appointments on Change or at a solicitor's office, yet the world went quite fast enough in the old days when the sun was the only timekeeper and the sun-dial the only clock.

"I only count the sunny Hours"

I have always had a fancy for sun-dials. One of my earliest memories is of an old sundial in the midst of a garden all aglow with hollyhocks and snapdragon and marigolds. It stood by a little pond of goldfish where I used to play. I spelt out the couplet inscribed round the dial:

Let others tell of storms and showers,
I only count the sunny hours.

In those days all hours were sunny. Since then I have collected sun-dial mottoes in a haphazard way. If sometimes too obvious in sentiment and often no more than platitudes, they are all intensely human.

Most of them are Latin, and most of them refer to the fleeting of time and life. The one which occurs oftenest is

the old favourite: “Tempus fugit memento mori” (Time flies; remember death!) “Morus” in Latin also means a mulberry tree, and in one case the motto was a punning allusion to the dial-pillar, which was made from a mulberry tree. There is also a play upon words in: “Fugit, hora, ora!” (The hour flies, Pray!) Other variants are: “Time is on the wing”, “Time bears all away”. On the four sides of an old dial at Grindleford Bridge, Derbyshire, are the following:

It flies while you look.
I wait for no man.
I am nought save by a ray from heaven.
As a shadow, so is life.

Shadows

The comparison of life to a shadow is very frequent. A Yorkshire dial has the line from Macbeth; “Life’s but a walking shadow”. Others run “I will return thou never”; “The light guides me: the shadow you”; “God is light to me”; and “Light is the shadow of God”. On a dial in the garden of Fox Howe, Ambleside, is a beautiful inscription made by Harriet Martineau when she lived there: “Come, Light, visit me!” A weary man must have written: “Soon will come night”. Others are actual texts, as: “The darkness and the light to Thee are the same”, “My times are in Thy hand”, “Work while you have the light!” and “Let not the sun go down upon your wrath”. Round the dial on Lyme Cage, Disley are the words: “Remember now thy Creator in the days of thy youth!” In Haworth churchyard, the resting place of the Brontës is a dial with the inscription: “Remember thy latter end!”

Livelier Mottoes

But there are more cheerful mottoes than these. I like the thought: “The sun shines everywhere”; this is from an Italian dial: “There is no shadow in the south”; this one from Yorkshire: “Work to-day, play to-morrow”; and this also from Yorkshire: “To my friends any hour they please”. One at Kidderminster runs: “None but a villain will deface me”. Others are: “I tarry not for the slow”; “I mark the time, dost thou?” “You can waste, but you cannot stop me”. The attempts at jokes are usually feeble, such as: “We shall die all (dial)”. In the busy Brick Court of the Middle Temple is an appropriate motto; “Begone about your business!” It is said that the dial-maker, when fixing it up, asked a passing lawyer for a suitable motto; and he, being a peevish fellow in a hurry answered him thus, and the sculptor in all good faith put it on.

Most of the poetry on sun-dials is rather poor. One of the best I have seen is this couplet:

Noiseless falls the foot of time
Which only treads on flowers

The poet Andrew Marvell tells of a gardener who made a dial out of herbs and flowers. And he asks:

How could such sweet and wholesome hours
Be reckoned but with herbs and flowers?

Charles Lamb wrote thus of an old dial in the Inner Temple: “What a dead thing is a clock, with its ponderous embowelments of lead and brass, its pert or solemn dullness of communication, compared with the simple altar-like structure and silent heart-language of the old dial! Why is it almost everywhere vanished? It stood as the garden of God of Christian gardens. It spoke of moderate labours, of pleasures not protracted after sunset, of temperance and good hours. It was the primitive clock, the horologe of the first world. Adam could scarce have missed it in Paradise.”

The principle of the dial

The principle of the sun-dial is fairly simple. It consists of two parts; the style, or gnomon, a thin plate of metal, which must be set parallel to the axis of the earth (that is, pointing to the North Pole), and another plate of metal, usually horizontal, on which is marked the direction of the shadow for the several hours, their halves and quarters or sometimes further sub-divisions. One of the best local examples of a modern sun-dial is to be seen in the Marie Louise Gardens, West Didsbury. The chief practical objections to the sundial are that (in our northern climate at any rate) the shadow of the gnomon is not sufficiently clear and well-defined to tell the hour correctly, that through refraction the shadow is always thrown a little too near noon, that is, the dial is too fast in the morning and too slow in the evening, and that you can only tell *the time* when the sun is shining.

It is a thing of vast antiquity. In Babylon and Egypt it was in general use. In the Old Testament we read of the shadow of Hezekiah’s dial being set ten degrees backward as a sign from Heaven that the King would recover from his sickness and vanquish his enemies. The dial referred to was probably the one which King Ahaz had set up on an obelisk (about B.C. 740). Some of the ancient dials were most ingenious. At Byzantium was a huge brazen eagle with a serpent struggling in its claws, the gnomon being formed by its head and beak and the hour-divisions being marked on its wings.

In more recent times pocket-dials were made. In “As You Like It” Touchstone:

...drew a dial from his poke
And, looking on it with lack-lustre eye,
Said, very wisely, "It is ten o'clock"

Famous Dials

The ill-fated Charles I. had a beautifully made pocket dial, which he gave to his attendant before his execution. Before the great fire there were many public dials in London. The once notorious slum-district of Seven Dials took its name from a large sun-dial set up where seven streets converged. Another famous one was in the centre of Covent Garden Market. Sir William Temple gave instructions that his heart should be deposited in a silver case under a sun-dial at Moor Park. Howard, the prison philanthropist, made this last request: "Suffer no pomp to be used at my funeral, no monument to mark the place where I am laid, but put me quietly in the earth, place a sun-dial over my grave, and let me be forgotten!"

Most of the sun-dials in this country are to be found in churchyards, on upright pillars, or fixed over the church doors. At Knowsley, Lord Derby's house, is a fine sun-dial on three steps, with four eagles supporting the four sides of the dial, crowned by a globe. (The eagle and child is the Stanley Crest). In out-of-the-way Lancashire districts one sometimes comes across an old dial over the door of a farmhouse, the style broken or gone, and the face battered almost out of recognition. But by a turn of fortune's wheel the sun-dial is coming back to fashion and favour. In the herbaceous gardens now so popular it finds a place as a picturesque survival from a less strenuous age. If, as someone has said, "Time stands still in a garden", no fitter place could be found for it.

W.P.P.-H.

ANCIENT SUNDIALS OF IRELAND

MARIO ARNALDI (Ravenna, Italy)

Translated by C. K. Aked

INTRODUCTION

From the start of the fifth to the end of the ninth century, the green island of Ireland experienced an unexpected rise in the number of monastic communities. The new religion brought to the land by St. Patrick burnt like a fire in the night, and hardly a day passed that a monastery, or church, did not spring up in some corner of the country. In some of these places, still extant today, there are sundials, used by the monks of that far-off period to ensure that the religious services were held at the right time of day. This paper is a survey of some of the dials in Ireland from the 6th-15th centuries, together with a study of their design.

DESCRIPTION OF SUNDIALS AND SITES

The sundials of monastic Ireland differ from all others in particulars of construction and decoration, and cannot be confused with any other type. We note firstly their shape. These dials are cut and carved from a single slab of stone, a stele erected in the vicinity of the church in the interior of the sacred area of the Cashel - the stone wall surrounding the whole monastic complex. The most ancient of these dials have simply a design carved in the stone, more or less square, which hardly reaches a size of 8-9cm. The stele attains the height of a man, more or less, with an average thickness of 12cm, the average breadth being 20cm, and

almost always carrying an engraving of a Cross. Often the true and genuine dial is inscribed on the upper part; carved along the same stele are horseshoe shapes or round shields. From the gnomon hole radiate hour lines; the number of these varies from 3 to 13. The hours of the canon are always indicated with a decorative element - a half moon, a fork or a point. At a later period another kind of sundial came into use, delineated on a horizontal slab of stone, with a circle averaging 20cm in diameter, divided into 24 equal segments, the times of prayer being marked with a little cross. It seems that this type of dial was also used as a tombstone.

The strange thing, for us, is the siting of the majority of Irish sundials in the cemetery, and this has generated much perplexity. This fact, however, should not cause surprise because the Irish and Anglo-Saxon cemeteries are always found round churches. In Italy one sees the same pattern, especially in mountainous areas: the cemetery is always near the church. The nobles then often found their eternal dwelling-place under the floor of the church, or near the family chapel.

But why should a sundial be placed in a cemetery? What use could it be in such a place? Would it not have been better placed in the cloister where it would have been visible to the monks inside the abbey? These are legitimate questions, but if we had a good knowledge of the layout of

an ancient monastery site, we could possibly answer these questions more easily. First we must understand that the Irish monastery of the 6th-9th century was open to the sky, and was formed by a collection of buildings. The cloister, at least as we know it in the convents and great Continental abbeys of the 11th-13th centuries, did not exist. The monk of those days carried on his activities inside these buildings (church, cell, scriptorium, office etc.); or in the open fields, or within the various areas of the Cashel. The sundial, which was probably placed in the central area of the enclosure, displayed the times for services to the devotees of God. Monasteries at this time were never so large, except in the great schools, as not to allow every individual monk a view of the sundial, or to hear the sound of the bell at the most distant points.



Fig. 1 Sketch map of Ireland to show position of monasteries

The reason for finding most of the sundials in cemeteries today is simply that with passing time many have been found during excavations and often quite by chance. Ancient cemeteries were never abandoned by the people, and as the centuries passed the cemeteries expanded to make use of the available space. So a sundial which may very well have been sited initially outside the burial area found itself surrounded by funerary slabs. For a certain period sundials were used however as tombstones, perhaps to represent the beauty of earthly life. Often these ancient steles carried an incised cross, and perhaps the presence of such an element encouraged the use of them after the 11th century for funerary purposes. Personally I am convinced that the presence of sundials inside cemeteries was unforeseen, but later became unsuitable.

GNOMONICAL ITINERARY

For topographical reasons it is best to make a gnomonic itinerary throughout the ancient monastic sites of Ireland. Sundials are clearly difficult to date, and to follow an evolutionary line, in chronological terms, would be inexact and would require a frequent jump from one site to another on the island, with the risk of creating geographical confusion. I have chosen therefore a linear course which can also function as a guide to those wishing to visit these areas. (See Fig. 1). However it is possible to regroup the dials to the middle of two well-defined periods: the first between the 7th and 12th centuries, and the second between the 13th and 14th centuries.

The Monastery of St. Buite, Monasterboice, Co. Louth

Situated about 40km north of Dublin, this ancient monastery originated in the 6th century. The monastery as is clear from its name was founded by St. Buite Mac Bronaigh, the name latinised because he had travelled extensively in Italy, Germany and England. An account of his life is given in a manuscript on the custody of the Bodleian Library at Oxford; and as for every other Irish saint, the events of his life are interwoven with legends. The strangest legend tells how Buite, feeling tired, was walking in the cemetery, wishing for death, when he was carried up to heaven by a crowd of angels, before the astonished gaze of his followers.

The site today preserves the remains of two churches of the 10th-12th centuries, a round tower, and two High Celtic Crosses. Among these, the beauty of Muiredach's Cross stands out: the most beautiful of its type in all Ireland. The sundial (Fig. 2) was erected in the cemetery near one of these crosses, the North Cross; it stands inside an iron railing enclosure. The stele is of granite and measures 188cm in height, 37cm in breadth and 22cm in depth. The gnomon hole is conical with a diameter of 4cm at the surface, narrowing toward the inside. The quadrant is divided into four parts by lines which radiate from the gnomon hole. The times shown by the sundial are those of the classical times of the choral prayers of the monks: Prima, Tertia, Sexta, Nona, and Vespers. The horizontal line to indicate sunrise and sunset does not pass through the centre of the gnomon hole but almost tangential to the upper part of the circumference. In my opinion this line parallel to an upper one is only indicative of a simple decorative effect, almost a finishing touch. The three time-lines contained around a kind of semicircle terminate with a design of a forked trident; the extremities are completed with a deeply incised point.

Kenneth MacGowen in his illustrated guide to St. Buite's



Fig 2. *Monasterboice, Co. Louth*

Monastery shows a drawing giving a reconstruction of the sundial which does not faithfully portray the actual artefact. The reconstruction of many of the details leaves me puzzled, for the drawing shows the time lines divided with the values of 30, 90 and 150 degrees, but the examination carried out by Ann Hamlin¹ on a photograph of the dial demonstrated the care with which the delineation has

been executed: the sequence of the angles is 41, 90 and 130 degrees. I have done the same investigation on the sundial and measured the sequence to be 40, 90 and 140 degrees.

In the lower part of the stele one notes, towards the left hand side, a circular concavity of about 10cm in diameter, whose presence has given rise to the belief that anyone wishing to cure himself of warts by magic can place the affected part into this hole. The last monks abandoned the Buite monastery towards the 12th or 13th century for Mellifont, the great Cistercian Abbey, less isolated and more secure.

Nendrum, Mahee Island, Co. Down

Proceeding northwards along the shore of Strangford Lough, the monastery of Nendrum, founded in the 5th century by St. Mochaio, is soon reached. The tradition is that Mochaio was the first bishop, both pastoral and evangelical, appointed by St. Patrick. The ancient texts tell us that when the Apostle to Ireland tried to convert his old Master, Mochaio, who was a swineherd together with the saint during his period of slavery, was one of the first to respond to the call of the new faith. Returning then to an island in Strangford Lough he founded there a monastery which in time achieved a certain importance.

What remains of this ancient establishment is sufficient to enable us to imagine its relevance to the Monastic world then existing. The complex rises on one of the heights of Mahee Island and stands on the remains of an ancient Cashel. The triple ranks of walls divide the cultivated land (the outer ring) from the craftsmen's buildings (the middle ring) and from the sacred area, that part surrounded by the central enclosure. Inside this area dedicated to worship, one sees the remains of a church, of a round tower, and a rectangular construction, perhaps the dwelling of the abbot. The cemetery is situated near the church, and leaning at the

southern corner of this, the stele bearing the sundial can be seen.

The sundial, or rather fragments, were found during the archeological excavations from 1922-24 by H.C. Lowlor², and from the same source comes the composite reconstruction (Fig. 3). The present day site of the sundial is therefore conjectural. The upper part with the dial is well constructed and the drawing of the missing portion is certainly well done,



Fig 3. *Nendrum, Co. Down*

whilst the portions underneath show an interlaced design that is not completely satisfactory. The height of the stele is about 194cm, the width is 40cm whilst the depth is 14-15cm. The dial is shown in the form of a semicircle with eight temporal divisions sculptured in relief; the bronze gnomon is of course of modern manufacture. The canonical times are made clearer by a double line in relief ending in a design similar to a stirrup, whilst the intermediate lines are depicted by a simple line bearing a small circle at the extremities. Horizontally in the upper portion of the dial, as at St. Buite's monastery, there is traced a segment probably for decorative purposes. The dimensions of the angles between the lines pose an anomaly because of the unusual disposition of the temporal lines which in a mechanical clock would correspond to the times of 0, 6 and 12. The sequences of the angles is about 5, 27, 45, 65, 85, 108, 120, 132, 173 degrees. The values are susceptible to some slight variation because the gnomon has not been mounted directly on the dial. The design which can be dimly envisaged from the fragments of the base is most probably a cross executed with a typical motif of interlaced ribbons, as one can see also on numerous tombstones of the time.

Bangor, Co. Down

St. Comgall founded the monastery at Bangor in about 557AD, one of the most important scholastic foundations in Ireland. While the Saint was still living, the monastery expanded until it contained a good 3000 occupants, many of them being laity studying there. Destroyed and looted by the Vikings, the monastery was then abandoned, to be reconstructed and renovated by the spiritual vigour of St. Malachy (Mael Medoc ua Morgair) in AD 1123. Malachy was Bishop of Armagh and Abbot of Bangor.

Bangor was devastated again in 1127AD and the monks,



Fig 4. Bangor, Co. Down

with Malachy at their head, took refuge at Lismore. Unfortunately, little remains of the monastery at Bangor, and on this ancient site a church was erected in 1917, the one which can now be seen at the gate of Bangor. The sundial which came from the adjacent monastery is now exhibited in the 'rose garden' on the terrace in front of the city castle. (Fig. 4). The slab

is of fine Silurian limestone and is well preserved, along with the trunk. Unfortunately the upper part, and that of most interest to us, the sundial, were seriously damaged. Bigger and Hughes³ noted in 1900 that the height of the stele was 6ft (183cm), whilst today it rises a mere 150cm. The lower part measures 25cm wide at the bottom and increases gradually to the top when it reaches about 30.5cm. The narrower face reduces from the base towards the apex from 24 to 19cm. On the trunk of the sundial are engraved three latin crosses, two of which (the lateral ones) are very worn and not very deep, perhaps added at a later date. On the base, on the east side of the stele a round concavity is visible similar to that found on the sundial at the Buite monastery but not quite so deep. Unfortunately the damaged quadrant of the Bangor dial does not permit us to enjoy its beauty fully. The sundial was placed within a double cornice, originally a much wider piece than the trunk of its stele. It was expanded, the semicircle to the east and west as in the sundials at Kilmalkeder and Clone.

Today therefore there remain only five of the twelve lines that formed the sundial. The delineating is very precise and the angular distance between them is perfectly regular, equivalent to 15 degrees for each space. The perpendicular line for noon has been accentuated by the use of two parallel lines, the extremities of which meet the semicircle and open out towards the external space. Looking at the style and the precision with which the design has been carried out, it seems possible to date the artefact to the period when Malachy was Abbot of the monastery, in the twelfth century. Yet if one considers the attention that the Bangor school paid to the Computus, one could estimate that this stone could be more ancient than it appears to be.

The gnomon hole, which runs right through the slab without change in internal dimension, measures 4cm in diameter; it presents a strange characteristic not noticed previously, in that it is not perpendicular to the front surface but is inclined toward the base. Could this be the first

attempts to achieve a dial with a polar gnomon?

Clogher, Co. Tyrone

Proceeding in a westerly direction towards Enniskillen, we arrive at the little town of Clogher, ancient seat of the monastery of St. Macarhind (Macartan). He was one of the disciples of St. Patrick. Arriving at old age, Mac Carhind complained to his master that alone of his company, he had not yet founded his own church. So St. Patrick gave his staff and reliquary to his disciple, indicating to him where he should lay the foundation of his church.

Today at that place rises the Cathedral of St. MacCartan (1818). The cemetery surrounding it is rich in ancient slabs, amongst which there was a sundial until 1969, but it is now situated inside the church, (Fig. 5). This is a rather worn sandstone slab with an ugly long crack running through both faces for more than half the length of the stele; however the sundial is clear



Fig 5. Clogher, Co. Tyrone

and intact. The interior stone has the form of a rough cross, such that for a long time it was believed to be a fallen column. The appearance of this stone is very ancient; some of the decorative features indicate a remote date of origin. The face on which the sundial appears shows a different form from all other Irish sundials. The body of the stele, with a small rectangular extension at the top, is decorated with an interlaced design resembling basketwork, under which, in relief, is a well-shaped fish. The fish symbol was of great significance in the early dawn of Christianity, as it was the emblem of Christ the Saviour; and it is a fish which plays a leading role in the miracles attributed to the various Celtic saints.

On the rear face, now very deteriorated, one sees the indistinct face of a man, and in the part that would correspond to the torso is an engraved rudimentary cross. The stone is raised above the ground to a height of 147.5cm, the supporting trunk is 44.5cm in length and it narrows by 2.5cm towards the top; the part on which the sundial is carved extends laterally by about 6cm, whilst the small rectangle projecting upwards measures only 28cm in width and 16.5cm in height.

The time lines radiate from the gnomon hole; its diameter is 2.5cm and its depth a little more than 3cm. The sundial is inscribed in a semicircle and shows three time lines

terminating in a very deep mark. The segment angles follow the scheme 30, 90 and 130 degrees that is common in the monastic sundials of Ireland.

Kilcummin, Co. Mayo

Continuing the journey towards the sinking sun in the direction of Sligo, Ballina, one arrives at Killala, a small village rising on the grounds of an ancient monastery which to this day possesses a round tower. From here one enters a little road which winds towards the north, eventually to arrive at the coast where Kilcummin is situated: a locality with a cluster of small houses facing the sea which is in ceaseless motion. As we can clearly see from the name this place is indebted to the ancient presence of St. Cummin, the founder of this little monastery.

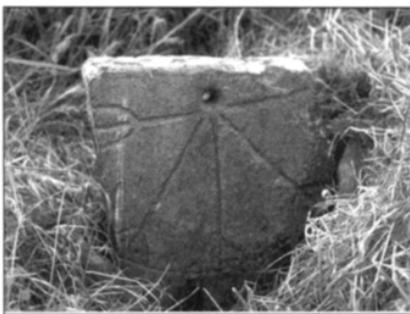


Fig 6. Kilcummin, Co. Mayo

St. Cummin was born about 590-2, the son of a king of West Munster, and he received his monastic instruction at the school of Durrow. He fought greatly to introduce into the Celtic Church

the Roman Church usage for calculating the date of Easter. He was the first Abbot of Clonfert and he founded the monastery of Kilcummin on Killala Bay. The saint returned to his Father in the year 662, and was interred in the cemetery of the monastery which he had founded. The sundial was erected in the same cemetery almost at the side of the supposed tomb of St. Cummin, (Fig. 6). The slab is not easy to find for it is driven into the top of another ancient stone tomb, penetrating so deeply that only a fraction of dial is visible, turned today towards the north. The time lines, as they are understood, are there, besides the horizontal; and the gnomon hole, which passes through the slab, is strangely situated above the intersection of these. As one sees from the photograph, all the lines terminate with the design of a trident fork; and moreover the three principal lines (third, sixth and ninth) possessed a new embellishment - two points in the space between the prongs.

The slab projects 40cm from the stones that hold it erect on the site, but it penetrates them at least another 40cm; the width is 38cm whilst the thickness does not exceed 7cm. The hole for the gnomon, as in other Irish sundials, has an external diameter of more than 3.5cm but at its deepest point is only large enough to allow the little finger to pass into it with difficulty. All these aspects suggest a date almost contemporary with the foundation of the monastery

by St. Cummin, or perhaps a little later.

Kilmalkedar, Co. Kerry

A particularly beautiful sundial is that which can be seen in the cemetery of Kilmalkedar in County Kerry, on the peninsula of Dingle. According to tradition St. Kaelchethair, together with St. Brendano, founded the local church; St. Brendano is especially venerated in this area, and this connection allows us to place the monastery in the 6th century. Kilmalkedar arose in an area particularly rich in antiquities, including the famous Ogam Stone which has representations of the first attempts to write the Celtic language.

The monastery of Kilmalkedar assumed such an importance that it became a place of pilgrimage. The architecture of the church is very interesting because the form of the old wooden church is reproduced in stone, its doorway being added later. The land surrounding the church is entirely devoted to a cemetery where amongst the ancient gravestones and crosses there emerges a beautiful sundial with the shape of a goblet which makes an incomparable silhouette with the background of the sea and sky (Fig.7).



Fig 7. Kilmalkedar, Co. Kerry, Dingle peninsula

At the end of the 1800's the trunk of the sundial was half buried in the earth of the cemetery and the total height of the projecting slab of sandstone was only 46cm, though today the stone projects to a total height of 120cm. The width of the supporting column is some 29cm narrowing to the base; the depth of the slab is 15cm gradually reducing to 12cm at the upper end. The dial is inscribed in an area the shape of horseshoe with a width of 33cm; the gnomon hole is 4cm, in the shape of a funnel, and does not pass through the stone slab. The angular divisions are 45, 37, and 135 degrees.

Particular attention must be paid to the carving of the slab. The dominant design on the supporting trunk of the sundial is a kind of frieze in Greek style which adorns the ends of double vertical lines that run the whole length of the trunk on all sides. The design of the temporal lines is particularly interesting. They are represented by a pair of lines ending with a semicircular shape. The ninth hour is marked by three parallel lines; perhaps this is an error; or perhaps this lines has special liturgical significance for the local community. A solution to the problem could be found in

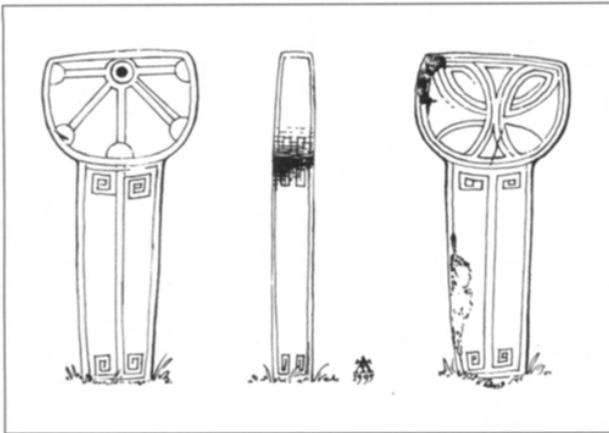


Fig 8. Drawings of Kilmalkedar Dial

the ancient monastic custom of celebrating Mass, first in the morning, then at Vespers. The evening mass, in fact, was celebrated at the ninth hour, the beginning of the night. St. Mochuaroc who lived in the 7th century was the first in Ireland to separate the celebration of the Eucharist from the canonical hour. From this point of view the sundial at Kilmalkedar is unique in Ireland in showing the time of the sacred mass.

The ever-present cross must be noticed, in this case engraved on the rear of the sundial, and its shape, derived from four semicircles, is typical of many other steles of the 7th-9th centuries, (Fig. 8).

Clone, Ferns, Co. Wexford

Ferns, a few kilometres to the north of Enniscorty, is a small delightful village in the shadow of an imposing ruin of the 12th century Anglo-Norman castle, which includes one of the most beautiful Irish towers. Ferns was for centuries the ancient capital of the kingdom of Leinster, where it is possible to admire the ruins of the 13th century cathedral and the Augustine Abbey of the 12th century. Just outside these, on the land of an old farmhouse (Clone House), arise the ruins of an 11th century church. The area takes the name of Clone 'a little fertile land among the woods'.



Fig 9. Ferns, Clone, Co. Wexford

In the little cemetery around the church of Clone, supported on a south facing wall, is a sundial with the characteristic shape of a goblet. (Fig. 9). According to the opinion of Way⁴, this artefact dates back to the 13th century. Although it is destitute of the line for the first hour, its divisions are without doubt of the

duodecimal type: the angular spacings of the lines are: 28, 47, 63, 76, 90, 106, 123, 135, 148, and 163 degrees. The total height of the sundial consisting of the trunk and the small projection at the top of the pillar is 117cm; the width of the semicircle which encloses the hour lines is 50cm, whilst the breadth averages 30cm and the depth is 12cm at its maximum.

The principal characteristic of the dial is its double holes, one being oval, at the point of convergence of the hour lines, the other round, about 6cm diameter, at the centre of a small crescent rising towards the top. Way's hypothesis was that it was used for an inclined gnomon, which was supported by being lodged in one of these holes; in effect the presence of two holes leads to the hypothesis that the oval hole was used as a support for the gnomon: it has a section inclined towards the base by about 70 degrees. Also it seem that the hole was formed in two stages. However, the angles of the temporal lines although imprecise are those of a normal sundial with temporal hours, which are quite different from those given by a polar gnomon. I cannot give an explanation fitting the facts.

SCRATCH DIALS

Towards the end of the 12th and the start of the 13th century, following Anglo-Saxon invasions, another type of sundial arose in Irish monasteries. It is quite different however from English scratch dials; one is dealing with horizontal sundials of circular form. In general they are not large; in some cases very small. They seem to be most abundant in the eastern part of Ireland. Usually they are found engraved on slabs of stone with irregular profiles such as the ancient grave stones. The diameter of the dial varies from 10 to 30cm; the interior circumference is subdivided into 24 equal parts. One is probably not dealing with a classical canonical sundial but such dials have always been discovered on ancient monastery sites. Their use by religious orders is confirmed by the evidence of some hour lines marked with crosses.

Ceanannus Mor, (Kells) Co. Meath

A fine example of this type of sundial can be admired in the cemetery of St. Columba's church, which became famous for the beautiful monastic gospel known as 'The Book of Kells'. The church was built in 1788 on the remains of the ancient church of the monastery of St. Columba, and modified 33 years later. During the various excavations at the site of the area of the cemetery numerous relics were unearthed, some early, some medieval; and these are exhibited inside and outside the present church. The slab of stone bearing the sundial stands vertically against the outside of the south wall



Fig 10. *Ceanunnus Mor*
(Kells), Co. Meath

of the church, and one has to look for it in the thick foliage of a creeper (Fig. 10). Its height is about 156cm while the diameter of the dial is 32cm. In the bottom of the gnomon aperture, 2cm diameter, there is still present a fragment of metal from the gnomon. The 24 lines are enclosed in double circle, and the lines connected with the major astronomical events of the day (dawn, noon and sunset) extend to the outer circle. A little above the dial is carved a beautiful capital letter R, probably the initial of the carver.

DISCUSSION

This long exposition on Irish sundials could not be considered complete without a final discussion of artefacts of this type. Aware that the study is only in its initial stage, I will try to arrive at some conclusions.

i. Firstly I would like to deal with the singular form of these artefacts. One of the questions, which arose in conversations and correspondence with friends, was the custom of engraving a sundial on a stele in the neighbourhood of a church. Though there is no easy answer to this, one may put forward a hypothesis. First one must remember the ritual use by the Irish Celts of the famous standing stones. This usage could have influenced the construction of later objects with a religious significance, such as monastic sundials. The almost constant use of a cross engraved on the trunk of these sundials appears to me to support this judgement. But why not incorporate the sundial in the south-facing wall of the church, as is the case with most English canonical dials? However if we remember that the first Irish churches were of wood and straw, and sometimes simply of earth, we can answer this point for ourselves: it was simply impractical.

ii. The size of the gnomon hole is another subject for discussion. One hypothesis as to the large diameter of the hole is that a wooden gnomon was used. In the bronze reconstruction at Nendrum the diameter appears excessive. The frequent funnel-like section possessed by the majority of gnomon holes induces me to believe otherwise. There is difficulty in cutting a perfectly perpendicular hole in a stone slab of up to 10cm in depth, and often right through the stone. It is much more likely that the width of the hole

served to accommodate an amount of mortar or lead to fix a gnomon perpendicular to the dial face. A gnomon with a reduced diameter permits a more precise observation of the time.

Some authors believe that the cause of these holes being wider at the front of the stone is the custom of 'oath-taking' or 'marriage vows'. In ancient Ireland, when a priest was not available for the occasion, the betrothed couple put their forefingers in the hole in the stone, and at the same time exchanged promises in the expectation of sealing the bond with a church ceremony later. The same action was performed by someone who wished to testify some oath or promise before God. Ireland is strewn with these stones, and by chance there is one with an Ogan inscription in the Kilmalkedar church cemetery not far from the sundial. If this hypothesis is correct, it would be natural that such a usage could occur only after the gnomon was lost.

iii. It is very difficult to give any explanation about the terminations of the time lines.

As we have already noted, these are quite different form those of the Anglo-Saxon canonical dials. The time lines which are most significant in the Christian liturgy are accentuated at their extremities with a fork, semicircle or point.

Some authors have suggested that the external arms of the fork design indicated a short time before and after the pre-eminent liturgical times. Others have imagined that the design of the terminating semicircle on the sundial at Nendrum, like that of Kilmalkedar, indicates the period of time equal to the duration of the prescribed prayer. Hamlin has taken into consideration these two hypotheses and has not been able to establish any logical or geometrical agreement between the various terminal embellishments. Her deduction, with which I agree, is that one is dealing only with artistry. Not all Irish sundials carry these designs; when there seem to be equivalents, these are only elements that accentuate the differences.

CONCLUSION

Ireland, the 'Land of the Saints' is rich indeed in ancient monasteries, only a few of which have been described. No other western country has such a profusion of monastic remains, going back to the fifth century AD. Perhaps this article may encourage readers to visit these places for themselves and to seek out others; and to understand the characteristics of the sundials which were used in these places for the indication of the essential times for monastic life.

ACKNOWLEDGMENTS

Thanks are expressed to Captain Owen Deignan of Dublin, Lawrence Dunne of Dingle, and Edward Martin of Stourbridge for their invaluable help. Without their advice and comments, the present study would have been incomplete and lacking in detail.

I also wish to thank all those who have helped by furnishing me with photographs of the sundials which I have not been able to photograph for myself; in particular Ms. Gail Pollack, Environment and Heritage Services, Northern Ireland; Mr. N.B. Canfield, Wales; Mrs. Kirsty Neate, Assistant Keeper of Manx National Heritage, Isle of Man, and Mr. Cormac Bourke, Curator of Medieval Antiquity, Ulster Museum, Belfast.

I also wish to express my gratitude to Mr. C.K. Aked, for his onerous work in producing the excellent English translation of my article.

Copyright

In accordance with the rights of authors, the copyright of the illustrations included in this article is reserved and they cannot be reproduced in other publications without the express permission of the author.

The copyright of the English translation is held by Mr. C.K. Aked

References

1. Ann Hamlin: 'Some Northern Sundials and Timekeeping in the Early Irish Church' in *Figures from the Past*, ed. K. Rynne (1987)
2. H.C. Lowlor: 'Divisions of the Nendrum Sundial' *Irish Nature Journal* 1, 53-55 (1926)
3. F.J. Bigger & H. Hughes: 'Some notes on the architectural and monumental remains of the old Abbey Church of Bangor' *Ulster Journal of Archaeology* 6, 195-196 (1900)
4. A. Way: 'Ancient Sun Dials' *Archeological Journal* 15, 207-223 (1858)

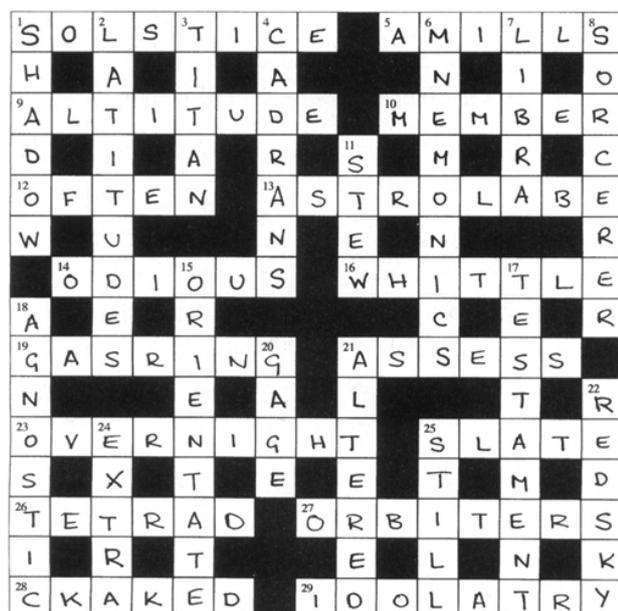
(M. Arnaldi's article has been greatly shortened in order to bring it to an appropriate length for publication in the Bulletin. The original article described and illustrated many more sundials, and also provided background information on prehistoric standing stones, the Celtic Church, lives of the Celtic saints, monastic architecture, the Benedictine Rule, and the Venerable Bede.

The B.S.S. is considering production of the complete text of the article in book form. Particulars from the Secretary, D.A. Young, - Ed.)

DIALLISTS' CROSSWORD

SOLUTION OF CROSSWORD IN BSS BULL. 97.3 (P.50)

JOHN SINGLETON



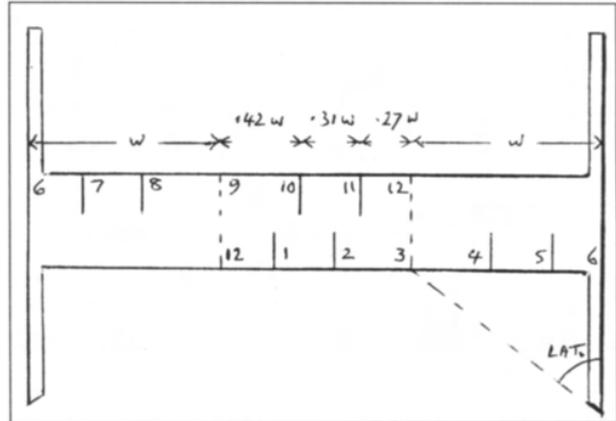
FOLDED-H POLAR DIAL

JOHN SINGLETON

This one-piece dial can be cut from a sheet of metal or card, and bent up at the dotted lines so that the central strip forms three sides of a square box. The outer limbs of the 'H' act as both gnomons and legs, with the centre section of the dial serving as third leg. The principle of operation is the same as for the Portable Polar of H. R. Mills (Bulletin 92.3), with one gnomon acting before noon and the other after.

The length of the legs ensures that the dial is inclined at the angle of latitude when mounted on a horizontal surface.

The GMT hour marks shown are for zero longitude, and their positions follow a tangent law ($\tan 15$, $\tan 30$ and $\tan 45$ on each face). For other longitudes the neatest approach is to retain the symmetrical set-up, but shift the hour marks. For 5° west, say, the marks fall at $\tan 10$, $\tan 25$ and $\tan 40$ or $\tan 5$, $\tan 20$ and $\tan 35$ (or alternate segments). Thus in the second segment, for example, the 10, 11 and 12 hour



marks divide the scale into portions of .30, .335, .275 and .09.

Away from the equinoxes, the shadow transforms to a narrow bar of varying width, the exact timing being that side of the bar due to the outer edge of the gnomon.

ST. JOHANN'S SUNDIAL

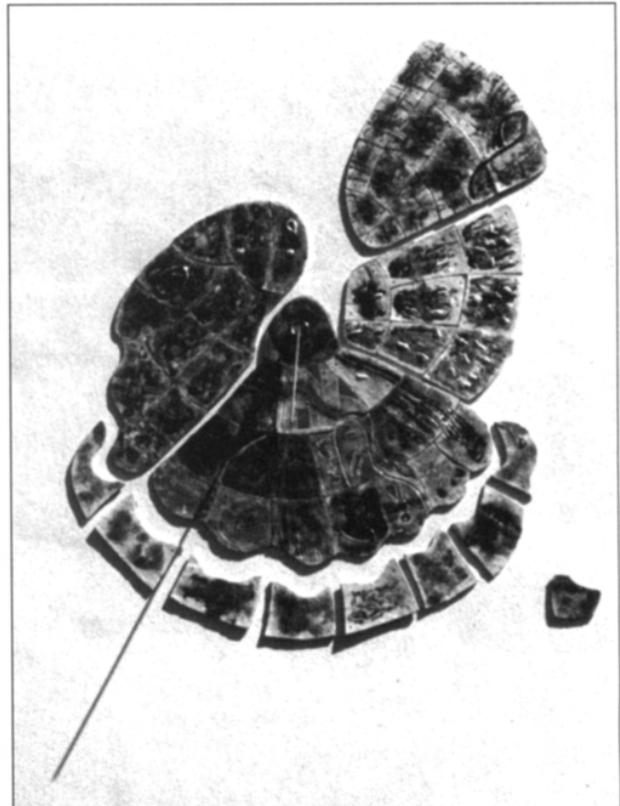
MIKE COWHAM

I have recently visited Austria where we stayed at a hotel in St. Johann im Pongau. Next to the hotel was a school building and on its wall was a rather strange pattern consisting of what appeared to be glazed ceramic tiles. It was not until near the end of the week that it suddenly dawned on me that this 'pattern' was possibly a sundial. Closer inspection revealed a simple gnomon. But where are the hour numerals? As a person with some knowledge of sundials, I could reasonably assume that the lower tile should be noon, thereby working out the times represented by the other tiles. What chance has any lay person of actually using the dial?

The enclosed photograph shows the best view that is possible to get. It does not look too exciting in black and white, but each tile is quite prettily coloured with abstract patterns.

May I nominate this dial as 'The World's Most Useless Sundial'?

Perhaps other members know of more obscure dials, but let St. Johann start the ball rolling.



BOOK REVIEWS

CHARLES K. AKED

APPUNTI PER UNO STUDIO DELLE MERIDIANE ISLAMICHE, Gianni Ferrari and Nicola Severino.

123 + 24 pages, 56 illustrations & 124 line diagrams. Thin card covers with front plastic guard. A4 format. Privately published by the two authors, Modena-Roccasecca, Italy, June 1997. Price not known.

This is an in-depth study of Islamic sundials, a subject scarcely known to English gnomonists. Unfortunately it is in Italian and therefore it is going to be no more accessible than the original Islamic texts. This is a great pity for Islamic dials with polar gnomons preceded those in Europe.

The main work is divided into seven parts. According to part 1, the work seems to have been inspired first by the three volume work of C. A. Nallino published 1899-1907, also the well known book by J-J Sédillot, *Traité des Instruments Astronomiques des Arabes, Composé au Treizième Siècle par Aboul Hhassan Ali de Maroc.....* published in 1834; (Treatise of Arabic Astronomical Instruments composed in the thirteenth century by Aboul Hhassan Ali, of Morocco). A later work by the same author appeared in 1841, dealing with the armillary sphere, the astrolabe, altitude quadrants and the great astronomical observatory instruments. A third work is that of H. Suter - *Die Mathematiker und Astronomen der Araber und Ihre Werke*, published in 1900. (Mathematics and Astronomy of the Arabs and their work). Other similar works are mentioned by the two authors.

The main work opens with an historical outline, leading to the discovery of Arabic gnomonics by the Napoleonic Expedition to Egypt in 1798 when a dial engraved in stone was found in the wall of a mosque near Cairo. Both are illustrated. Page 10 gives a list of mosques and palaces where such dials have been found.

The second part opens with the premise on which the study of the sundials of the Islamic world is founded. Essentially, in spite of Mahomet wishing to avoid use of the sun lest he was associated with the old sun-worshippers, those charged with ascertaining the times for the compulsory prayers of the day had little option but to make use of the only time measurer available. The astrolabe was used for this purpose, but was of little use to the vast multitudes; hence the appearance of sundials on the walls of mosques, the first being marked out in temporary hours. This section goes into great detail on the system of hours, although the

emphasis is on the times of prayer throughout, so this leads into the Prayer-times of the Islamic religion and sundials, then the Prayer-times of Islam and the canonical hours of the Christian faith and on to the Quibla.

The Quibla is a device for determining the direction of Mecca, to which an Islamic adherent must face when observing his prayers. This is fully detailed by the authors. The rest of the second part deals with trigonometry, the gnomon, and tables for constructing sundials.

Part 3 deals with the various types of sundials and details types which have specific names in Arabic. Part 4 goes on to the calculation of these various sundials in detail. The universal sundial, its principles of functioning and construction, its errors; and a modern hour type, fill the pages of part 5. Part 6 deals with specific examples of Islamic sundials on mosques, a Tunisian sundial of the 14th century and a modern example.

In Part 7 the use of computer programs for delineating these dials is outlined; one must of course, have a disc with the program, and it can be used with DOS, WINDOWS, and WINDOWS 95, and a suitable computer.

Appendix 1 starts at page 1. The start is illustrated with the well known painting of an Islamic Observatory, going on to cover Latitude, Temporary and Modern Hours, calculations for the start of Musulman Prayers, Start of the Day and the Islamic Calendar, calculation of the Quibla, the Musulman Year, signs of the Zodiac, etc. Appendix II commencing on page XVIII, deals with earlier authors, their works being in the Arabic script.

Penultimately is a list of works consulted in the preparation of the treatise, and finally a list of acknowledgments to those who have written the various Islamic sundial programs. These are great achievements.

All in all this is a profound study of Islamic sundials, well researched and written. These two authors, and other Italian researchers are doing far more to unearth and explain the early dialling endeavours than any other European gnomonists. If the work were in English the reviewer would not hesitate to recommend that it should be in every diallist's library. The reviewer congratulates the two authors on their excellent work. It will be an inspiration to later researchers in the field of gnomonics.

A ROMAN CYLINDER DIAL; WITNESS TO A FORGOTTEN TRADITION *Mario Arnaldi and Karlheinz Schaldach.*

Offprint from the *Journal of the History of Astronomy*, xxvii, 1997 Cambridge. Paginated 107-117

Once in a while it falls to the lot of some fortunate person to make an epoch-making discovery. This article by Arnaldi and Schaldach describes one such event. Yet the object of the article had been on public view since 1901 in the museum of Este, near Padua, in Italy, without anyone recognising it for what it was. The archaeologist who found it in 1901 did not recognise it as a sundial, and termed it an *astuccio* (case), for want of a better description so it remained unknown until 1984 when it was perceived to be a cylinder dial.

The authors first deal with sundials in antiquity and give a list of portable sundials dating from the 1st century onwards. This leads on to the account of the excavations in Palazzina Capodaglio near Este, which led to the discovery of twenty Venetian and Roman tombs, and more than sixty ceramic jars. In the "tomb of the physician" were found twenty-six artefacts, including what is now known to be a small sundial, which was particularly well preserved. This is well described by the two authors; and the description is followed by an analysis and

mathematical reconstruction of the scales of the sundial, which has a pair of gnomons, one for use in the summer, the other in winter. Such a cylinder dial with two gnomons is shown *Gnomonices* by Christopher Clavius, 1581.

The authors conclude that the instrument was intended for use at the latitude of Este, although it is known that the Romans had dials which would function within the range of latitudes encompassed by the Roman Empire.

This outstandingly interesting article concludes with a short account of the cylinder dial in history. This cylinder dial is one of the oldest Roman examples now extant. It shows that the cylinder dial has been in use longest amongst all the many varieties of portable sundials.

There is a long list of references following the main article, indicating the thoroughness of the authors' research into the subject.

This article, to the reviewer's mind, is of monumental importance. The two authors are to be complimented on their researches which have contributed greatly to the advancement of knowledge of the early years of dialling. They have powerfully influenced the thoughts of the reviewer with the results of their research.

JOURNAL REVIEWS

CHARLES K. AKED

ZONNETIJDINGEN

This journal is that of the Belgian Sundial Society, this issue being No 5 for March 1997.

It commences with an article on the analemmatic sundial by the well known writer R. J. Vinck. Surprisingly it mentions only one reference, that of Samuel Foster - *Elliptical Horologigraphy*, 1654.

An announcement for an excursion on 25th November 1997 is given on page 6, followed by an article on a remarkable sundial in Brussels Hoofdstedelijk. It is a mosaic sundial on the frontage of the Pharmacie Delacre, the illustration first making the reviewer think it was a glass sundial. The author of the article is E. Daled. On page 9 there is an article on the Sundial Park project in Genk, giving the results of the competition held last year to find suitable designs. It is pleasing to record that our member John Moir was successful with one of his submissions, out of eight British entrants; none of the entrants from Italy, Portugal and Israel were successful in

spite of submitting novel designs. Naturally most of the awards went to Belgian gnomonists, seven in all. The article outlines the criteria on which the selection was made by a jury.

There follows a listing of the sundials in Molenvijerpark, a total of thirteen, with brief details of type and maker, the author being J. De Graeve.

A half-page article outlines the sundial at the Swan Hunter Shipyard and its return to a Newcastle museum. Evidently the article was supplied by C.K. Aked and it was translated into Belgian by Mrs H. Vinck Quisenarts, a photograph of the dial following restoration being shown.

P. Oyen concludes the articles with an account of a polar sundial with date lines. It has a mathematical analysis and proof, with two tables for a cycloidal and circular style.

Three inclusions were inserted in the journal, one on errata to the article on the Analemmatic Sundial In

Zonnetijdengen in December 1996, showing the corrections to the equations used, numbers 12-17. The second was mostly on the Genk Park sundial competition (Molenvikverpark), the official opening of which is scheduled for Summer 1998. The third was an English translation of the article part 3/4 on the linear analemmatic dial, which naturally the reviewer read after penning the previous lines.

Altogether an interesting compilation. Membership costs 1050 BEF, send to account number 068-2214580-97 of the Zonnenwijzerkring Vlaanderen vzw B-9150 Rupemonde (Belgium) Correspondence to: Oeverstraat 12-B-9150, Rupelmonde, Belgium.

DE ZONNEWIJZERKRING

Bulletin of the Netherlands Sundial Society (May 1997) commences with a general oversight of dialling activities discussed by the Secretary Fer de Vries. There is a short article about the Museum Havezate Mensinge.

E. Roebrech deals with cross dials in a two-page article accompanied by six illustrations. F. J. der Vries writes under the title of "World Sundial" about the sundial described by Fred Sawyer in *Compendium* Volume 3, No 3, 1996, under the title of "Drawing a Geographic Sundial by Jaques Ozanam (1673)". It is followed by a short note on the Astroid Latitude-Independent sundial developed by Fred Sawyer, described at the 1997/BSS Conference at Newton Rigg, Cumbria.

A. Van den Beld describes a cycloidal Cylinder Sundial, the basis of which is given in Sir Robert Ball's 'A Treatise of Spherical Astronomy', 1923, thus:

A sun-dial is constructed of a reflecting cylinder whose cross-section is a cycloid, mounted upon a card so that the generating lines of the cylinder are parallel in the earth's axis and perpendicular to the card, whilst the axis of the cycloidal cross-section lies in the plane of the meridian. Prove that, if the distance between the cusps of the cycloid on the card be provided with a proper uniform graduation, the cusp of caustic due to the reflection of the solar rays will always indicate apparent local solar time.

The article goes on to demonstrate this proof over three pages. The same author, in an immediately following article, goes on to deal with the lines on a sundial engraved by Van Willem Blau.

J. T. H. C. Schepman deals with a sundial in a portrait of Johan Radermacher, dated 1607. The sundial is first

described, then its functioning. There is a half page of bibliographical references. Two full page line drawings illustrate the dial and its various faces.

Under the title of "Arabische Gnomonik" is a commentary on the doyen of dialling, René R-J Rohr, published in *Bulletin* 96.3.9. The reviewer searched for some time to find the author - Jan Kragten. This has four pages followed by another ominously headed "BLUNDERS".

Dees Verschuren describes a competition for a sundial for the recreation ground of the Asten-Someren College. This is followed by *Zonnewijzers in Nederland*, compiled on this occasion by Wil Coenen, and this gives further details of the Asten-Someren College sundial. About eleven dials in all are described, with some crude illustrations.

What is now the most comprehensive coverage of contemporary dialling literature continues on pages 45-50, items 1223 to 1243. The compiler on this occasion is D. Verschuuren. The BSS Chairman's contributions to the *Clocks* magazine are given full coverage. BSS Bulletin 97.1 is thoroughly reviewed in detail, as is *Compendium* Volume 3, No 4, of the NASS and a number of Continental dialling journals. This is a most useful feature.

On the last page is a full page diagram of a Gnomon's eye view of its own Analemma. The inside rear cover carries an outline of the excursion to Asten, Lierop en Weert, Saturday 21st June 1997.

It is a great pity that the very first of the regular sundial bulletins still appears in a photocopied version when all others are produced in a printed version. It is impossible to have decent illustrations in this out-of-date presentation, and one can only get half the information on the pages compared to a printed bulletin. The importance of the material presented by the Netherlands Sundial Society warrants a better production. And in view of the difficulties of the Dutch language to outsiders, it would be most helpful to present summaries in the universal language of the world - English.

COMPENDIUM

NASS journal Number 2, Volume 4 for June 1997, opens with an article of fundamental importance with a discussion of the Tiberius manuscript preserved in the British Library. Within this manuscript is a folio containing the Tiberius Horologium which gives the precise details of how a man can find the time by means of the length of his shadow. This is a splendid article, well researched and presented, plus a mathematical analysis, illustrations of the original

text and an English translation. This article could be used as a model for anyone seeking information on how to present his material.

There is an interesting quiz presented by Fred Sawyer which was originally set out by Charles Leadbetter - "... let him repair to some old dial that was made many years ago, and according to the Distance of the Substile from the Meridian, let him find out the Declination when first made, as any Man that is an Artist can easily do...." Fred Sawyer sets out one solution in a neat and succinct form. On similar lines is another problem set by Edward Hauxley in 1736/7, sent to Charles Leadbetter. Leadbetter sets out a less than convincing answer at the end of his *Mechanick Dialling* London, 1737.

Richard Threeth deals with "Dialling with the Stereonet", which is a planar projection. The explanations are clearly and simply set out. Rene J. Vinck gives the explanation to a little known phenomenon where sunset occurs ten minutes earlier in mid-November than on the shortest day of the year, and the sun rises ten minutes later at the end of January than on December 23.

Nicola Severino contributes an article on Portici Ham, the first correct modern explanation of how it functions. John Edelmann describes a sundial made as a gift for his daughter Erika, using the ZONWVLAK computer program (sold as the BSS computer program), including a noon analemma.

"The Etched Glass Sundial" by Casimir Piotrowski, gives full instructional details for making and mounting. Beautiful but delicate for the average garden. Lastly is an article by Allan D. Pratt on simplifying The Equation of Time correction to obtain mean time from Solar Time. What is really required is a correction from Mean Time to local Solar Time, for Solar Time is truly correct, not a bodge to suit mechanical timekeepers.

LA BUSCA DE PAPER

This is the Bulletin of The Catalan Gnomonic Society, issues no's 23 and 24 for Summer and Winter 1996 having only just been received - August 1997.

No 23 commences with an article based on that of J.G. Freeman (see BSS Bulletin 93.3), where the latitude can be found by the use of only three shadow observations. It is mainly a mathematical approach, first to calculate the azimuth of the Sun, then the Latitude, then considerations of the use of this method, and finally a colophon outlining

the practical details. As with most of the articles, it is given first in the Catalan language, then repeated in the Spanish language.

A bibliography follows, giving the more commonly met dialling works in the form - Author's name, Title, number of pages, Publisher, and finally date of publication. There is no attempt to translate the titles or give a brief description of the contents. At a quick glance, most of the works quoted are only available via a suitable library.

A second article deals with a sundial at La Platja on the coast of Malaga. It is in the form of a severe tapering four-sided column, with a small dial near the top. The gnomon is formed by a block of stone standing out from the top of the column, the accompanying short text being provided by Don Rafael i Gaya of Palma de Mallorca. On the last page is a photograph of a young man supporting his whole body weight by his hands on the rim of an equatorial type dial. The first conclusion is that no matter how well the calculations have been made for the dial, the structure must also be strong enough to act as a gymnastic apparatus as well. The second conclusion is that no matter the fame of the artist, it is no excuse for doing such things for publicity. Frankly the reviewer would feel most apprehensive in performing such a foolhardy thing, with the risk of severe personal injury should the structure fall under such a loading.

There is the usual enclosure which contains the long-running listing of dialling terms in seven languages, for the terms beginning with M - May to Multiface.

* * * * *

Issue no 24 starts with an article entitled "Construction of a Sundial with Equidistant Diurnal Lines" by Josep Maria Albaiges i Olivart. It outlines the problem and then analyses this mathematically, using polar coordinates and differential equations, with an Appendix giving the solution to the differential equation $p^2 + p'^2 = 1/(1 - \tan^2 \Delta / \tan^2 \Delta_m)$. There are full page line diagrams for figures 3 and 4 of this article.

The second article visits Denmark, the title calling it the country of 500 islands. There is a brief two-page Catalan - Spanish - Danish gnomonic vocabulary listing the most commonly used dialling terms. At the end of this article is a cartoon showing an artist painting sundials, with a range for sale from 5,000 to 30,000 pesetas. Alas the reviewer's acumen is insufficient to get the joke.

There is a gnomonic problem with the title "Time to Think of Time" (..... if you have the time). It concerns the

mysterious hour of Dom Gunegard. Given a list of clues, the reader is invited to state what hour it is.

The enclosure carries the dialling vocabulary on from M to N. To consult this listing strikes the reviewer as not a very easy procedure, the vocabulary needs to be on a 3¹/₂ disk with a little program to select any item required. But for all

that, it is a most laudable project and the most comprehensive dialling-term vocabulary ever to appear.

The reviewer regrets that the inclusion of these journals is so late, but unless these are sent at the time of publication, there can be no timely comment. The above is merely an historical record.

SUNDIALS GO GREEN IN NEWCASTLE

TONY MOSS

Saturday, 14th June 1997 dawned grey, wet and windy. Whatever had happened to the promise made that it would be fine and clear? The display was, after all, organised by Helen Lunn of St. Thomas the Martyr Church in Newcastle on Tyne and she'd assured me that the 'man upstairs' had "given his word...."

For once the car-sharing scheme I operate with my son had let me down so I had risen early to pack my display material into a *luggable-on-public-transport* size suitcase. As the "bus into Newcastle passed by St. Thomas" church where our 'Green Day' was to be held *outdoors* I hardly dared look at the few dismal early arrivals huddled in the rain outside. This was going to be a *big* mistake!! It had all begun in the tea queue at the Penrith Conference when Piers Nicholson was 'looking for someone from the Tyneside area to talk about sundials to a church group'. And now here we were on a bleak Tyneside morning about to attempt to project the wonders of sundialling!

Imagine my delight when I discovered that commonsense had dictated a move into the church where there were lots of tables, display screens, lights and music. Within a few minutes BSS members Frank and Rosie Evans and David Edwick had arrived and as we busied ourselves setting up a small display the prospects for the day became suddenly brighter. Even more so after Rosie had made some signs to indicate that there was "More Inside" to tempt the public beyond the green diehards outside in the rain.

Considering the day and the weather we spent a fair proportion of our time chatting to interested visitors. In particular it was good to have Frank's wealth of local dialling knowledge available and he kept the *lady* Lord Mayor of Newcastle deeply interested in his researches into the

Wigham Richardson dial for some time as she made her tour of the various activities on display.

The gratitude of a young teacher who bought my copy of "Make a Sundial" as something she'd "...been seeking for years" made my own contribution to the day seem worthwhile.

In Frank's words, I don't think the day "did too much for either Green Issues or the cause of Sundialling" but we all enjoyed getting together to celebrate the various facets of our subject. At the very least there are now a fair number of people on Tyneside who know that BSS exists and local members had a pleasant opportunity to talk about dials and dialling.

Oh - and I almost forgot - as we were packing up the display at the end - the sun came out!

With many thanks to the little band of dialling stalwarts who attended, to Bob Throssell who kindly loaned examples of his work and to our Secretary David Young for sending a parcel of colourful material to brighten up the BSS aspects of the display.



READERS' LETTERS

CORDIERITE IN NAVIGATION

In his article 'Polarised Skylight Sundial' (BSS Bulletin, 96.3 p13) David Colchester makes reference to the use of cordierite by the Vikings as a navigational tool. May I offer some suggestions as to why this is probably a myth in more than the Nordic sense?

In one of the Viking sagas handed down by word of mouth over aeons, the King is said to have asked Sigurd where the sun might lie, (on a cloudy day); to which Sigurd bade the King take up the sunstone and hold it up, whereupon he would see the light from the sun. There have been many attempts to show that the 'sunstone' was cordierite, but there are sufficient objections to show that this was highly improbable.

Cordierite is a silicate mineral of a quite dense blue-violet colour, occurring in metamorphic terrains. It is not particularly common and large crystals are rare. Like many minerals it is pleochroic, which simply means that it shows different colours in different directions of transmitted plane-polarised light. In the case of cordierite the colours are violet to pale blue-grey to pale yellow. This is quite striking but best seen in thin (30 micron) sections. In theory it would be possible to observe the sky through a piece and detect the polarisation band at 90° to the sun, and hence infer the sun's position. But there are problems.

While Nordic countries (Denmark excepted) are places where cordierite can be found, sizeable crystals are rare, and sizeable crystals of consistent colour without fractures or flaws are very rare. Also, its deep body colour means it rapidly becomes opaque in pieces much larger than a pea or a bean. Holding such a tiny piece to the eye to detect a colour change is impracticable at best. More importantly, it will work only with plane-polarised light, and the presence of any cloud or fog renders daylight almost completely unpolarised. It follows from this that if at least a patch (and preferably more) of blue sky (where the light is strongly plane-polarised) is required then it is likely the sun will be visible anyway, or that one can infer its position by bright feather edges around clouds, or sunbeams protruding from them. Indeed, in Britain one has only to look around on a grey cloudy day (no shortage alas!) not just to be able to infer where the sun is, but actually to see it as a dingy yellow orb in the sky! Finally, if the method is rendered nearly useless by fog, it seems it would hardly have been

used by the Vikings in travelling across the northern Atlantic, where some of the worst fogs are likely to be encountered. As a mind exercise, one can just about imagine its use in a jungle environment where only a zenithal patch of blue sky is visible due to the dense vegetation, but in the north Atlantic where there is a totally unobstructed view from horizon to zenith for 360 degrees, any position of the sun is surely going to be at least inferable.

In an attempt to try and solve this problem, in 1996 the sailor Robin Knox-Johnson took two large flat polished pieces (approx. 2-3" diameter each) of cordierite out into the English Channel, away from the sight of land, and attempted to use them to navigate some 50 miles. This act was part of a BBC Horizon programme on the Vikings. Alas, the method (even using two of the largest pieces of cordierite he is ever likely to encounter) was so poor the programme makers cut it out entirely! Knox-Johnson did much better with a copy of the crude compass described by Thirlund (1).

The best one can say about this is that the Vikings might have known of the properties of cordierite. It is perhaps within the bounds of possibility to imagine a young Viking strolling across a shingle beach and seeing a polished pebble of bluish-violet cordierite glinting in the sun. He would then very likely have put it to his eye to see the glinting better, and thus stumbled upon the colour change (how many of us have not at some time put a piece of coloured glass or coloured sweet wrappers to the eye the better to view the world?; it seems a natural human trait). As no other pebble would show the same effect and as there would be few of such cordierite pebbles, perhaps this stone was held to have some magic powers, and guarded, even handed down through generations. Fanciful? Well perhaps, but I believe it is safe to say, in the absence of any hard evidence, that the 'sunstone' theory is a Nordic myth.

REFERENCE:

1. Thirlund, S. 'The Discovery of an Early Bearing Dial --further investigations' *Journal of Navigation*, **46**, 33-48 (1993)

Peter Tandy

ADVANCED MACHINES IN ANTIQUITY

In Mr Charles K Aked's article "The Angel of Chartres", BSS Bulletin No. 97.3, the 14th century clocks at Salisbury and Chartres are described as "the most advanced machines ever made up to then". I know of two counter examples.

The Antikythera Mechanism was fetched up out of the Aegean Sea as a mass of concretion about two thousand years old. It was X-rayed and described by the late Professor D.J. de Solla Price (1). A substantial amount of his description is reproduced by King and Millburn (2). The machine is a form of what we would now call an orrery, and includes an epicyclic movement which Price called a 'differential turn-table'. Professor Allan Bromley suggested an alternative mode of operation (3) and I heard of this in his lecture to the Antiquarian Horological Society in January 1980. Further radiology was undertaken by Prof. Bromley under my guidance (4). The previous account of the construction of the machine was confirmed in greater detail.

The so-called 'Chinese South-Pointing Chariot', better 'Chinese Constant-Pointing Chariot', was described by Joseph Needham (5), quoting a Chinese author of 1345 A.D. who was probably using sources 200-300 years old. Even to a reader of Chinese the account is said to be mechanically obscure, but it was eventually solved by Professor A.W. Sleeswyk of Groningen (6). The constant pointing function certainly needs one differential mechanism, and Prof. Sleeswyk's analysis showed that in fact two were used. I made a model which he agreed perfectly demonstrated the practicality of his solution.

Mr Aked's aside is shown to be less accurate than the rest of his article. As the 'rude mechanicals' of antiquity were mostly illiterate, it may well be that many complex mechanisms are lost for ever, and that some more will yet be discovered.

REFERENCES

1. Derek de Solla Price, *Gears from the Greeks*, New York 1974
2. Henry C King and John Millburn, *Geared to the Stars*, Toronto 1978 pp. 8-10.
3. Allan G. Bromley, 'Notes on the Antikythera Mechanism', *Centaurus* 1986 29, 5-27
4. Allan G Bromley, *A Method for Linear Tomography of the Antikythers Mechanism*, University of Sydney Australia, 5 April 1990
5. Joseph Needham, 'The South Pointing Chariot',

Science and Civilisation in China, Cambridge 1965, Vol IV part 2 pp. 256-303

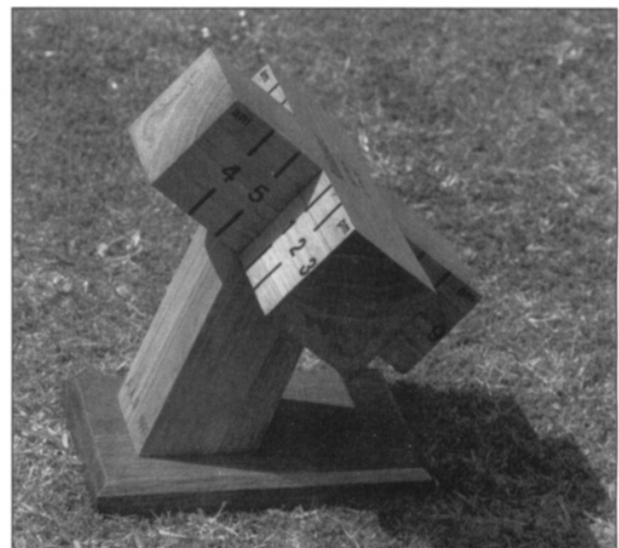
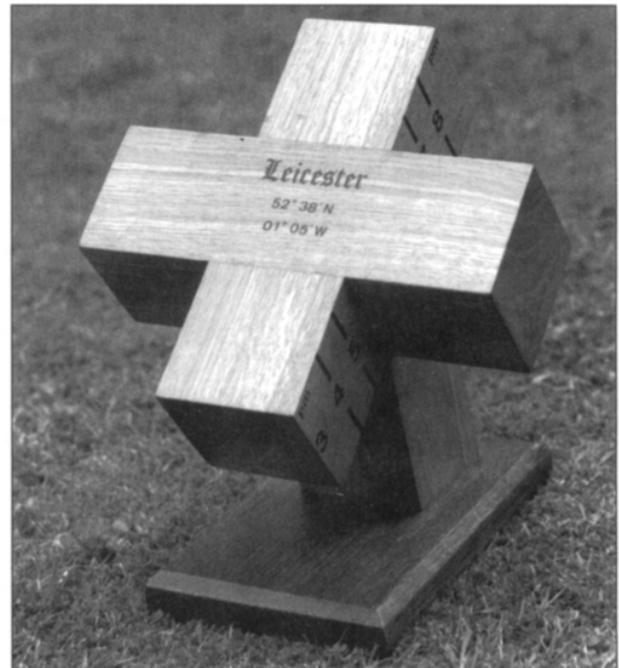
6. A W Sleeswyk, 'Reconstruction of the South-Pointing Chariots of the Northern Sung Dynasty. Escapement and Differential Gearing in 11th Century China', *Chinese Science*, Philadelphia 1977 pp 4 - 36.

Alan Partridge

CROSS DIAL

in English Oak, by Allan Mills. Based on the Kew design by Sir Charles Vernon Boys (BSS Bull, 97.2, 29-33 (1997)

The dial was photographed at 1pm on a date towards the end of May, 1997.



SUNDIALS IN BINARY NOTATION

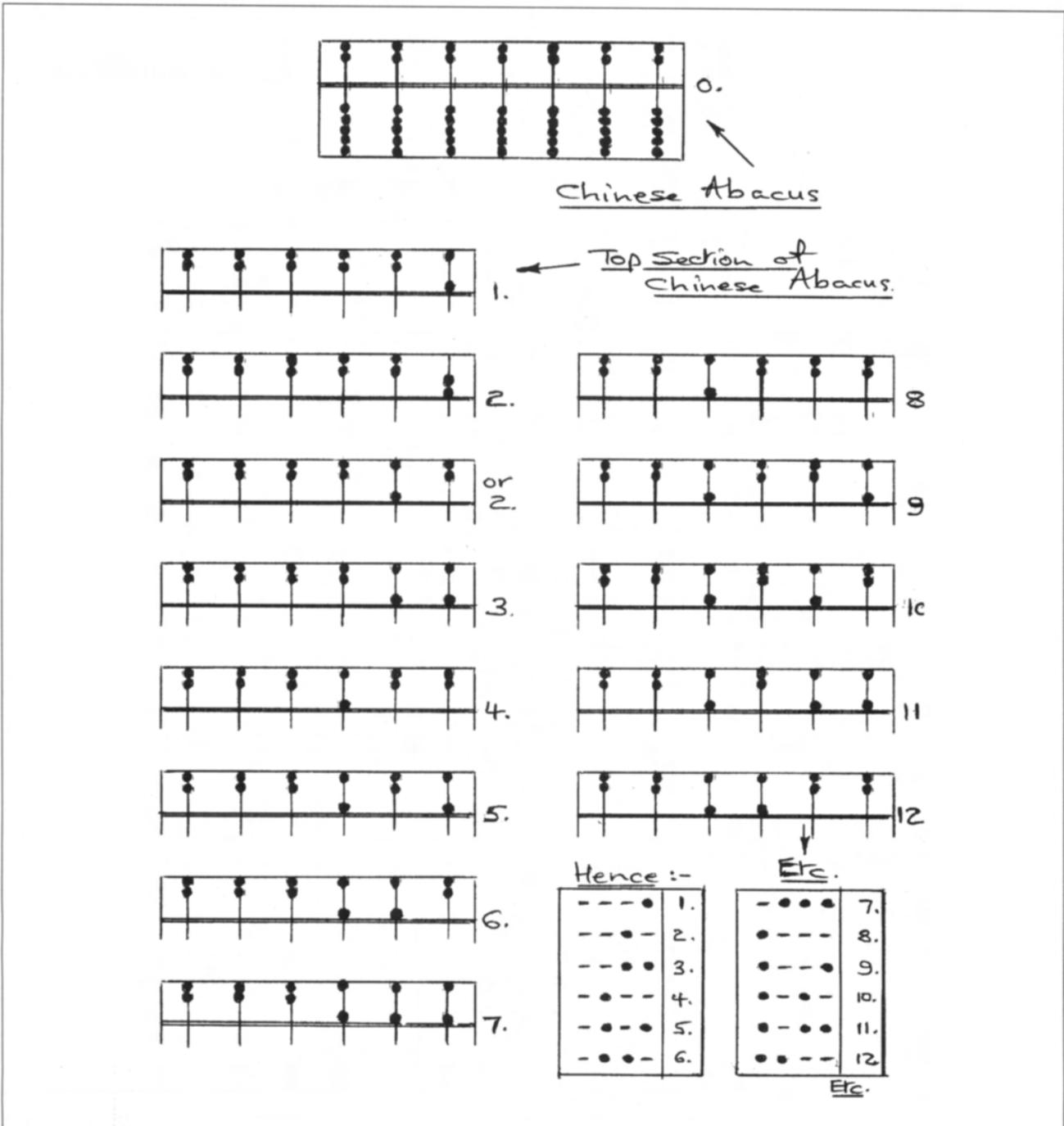
In order to decipher (and check) the binary notation inscribed on the "Sundial dedicated to James Taylor" (BSS Bulletin, No 97.3, July, 1997, pp 38-39) I, for simplicity, resorted to the use of my Chinese abacus.

The beads on this instrument only "count" when they are close to the main, horizontal, dividing bar. In normal use, those beads below the bar are each assigned a value of one unit whilst those above the bar ("In Heaven") are each deemed to be worth five units.

However, for the present purpose only those beads above the main bar were brought into play and each bead was assigned a value of one unit. The results of counting in this "Binary" system are shown in Figure 1 and may just be of interest to your readers.

Incidentally, my Japanese abacus could have been similarly adapted for the present purpose. However, the Japanese abacus has, "In Heaven", only one bead on each wire and in consequence, although simpler, it is perhaps not quite so instructive.

Maurice J. Kenn



Chinese Abacus adapted to use the Binary System

SUNDIAL SUPPORTERS

Referring to Roger Bowling's articles on Sundial Supporters, (BSS Bull. 97.1 34 and 97.2 43), I believe that one of the missing figures maybe at Flaxley Abbey (a manor house) in the Forest of Dean, Glos. The Figure is Kronos as drawn in the first article and the dial has recently been recorded and placed on the register. Two or three colour prints accompanied the record which was made in 1996. The dial gnomon pointed east, and there are two more dials (one vertical, one pedestal) at the house.

A.O. Wood

SUNDIALS PORTRAYED IN GLASS

Over the course of various meetings and Bulletin articles, we have become familiar with sundials delineated in glass. But has any member encountered dials *portrayed* in glass? I have photographs too poor to reproduce in print, of a stained glass window in Durham University that portrays a vertical south dial held by a king (Zachias?).

Since the usual timekeeper of those who people the vitreous world is the hour glass, does anyone have any comments on this?

Graham Stapleton.

APERTURE GNOMONS, MERIDIAN LINES, AND ACCURATE DETERMINATION OF EARTH'S ORBIT

In a recent article¹ I examined a well-known problem inherent in large sundials, viz. the $\frac{1}{2}^\circ$ angular diameter of the Sun producing an increasingly blurred edge to the shadow cast by an opaque gnomon as the 'throw' increases. However, by the 13th century, the Chinese had learnt how to use a card perforated with a tiny hole as a 'pinhole' lens, holding it near the scale to produce a small real image of the solar disc with the gnomon silhouetted upon it.²

An alternative is to remove the shadow-forming gnomon entirely, replacing it with a small aperture in an opaque screen. This acts as a more distant pinhole lens, throwing a larger inverted image of the Sun upon the scale or dial. With a receiving surface perpendicular to the incoming rays at a distance ℓ , the diameter of the solar image d is given by $d = \ell/108$. In general, though, the surface will be inclined, producing an elliptical image where both size and ellipticity

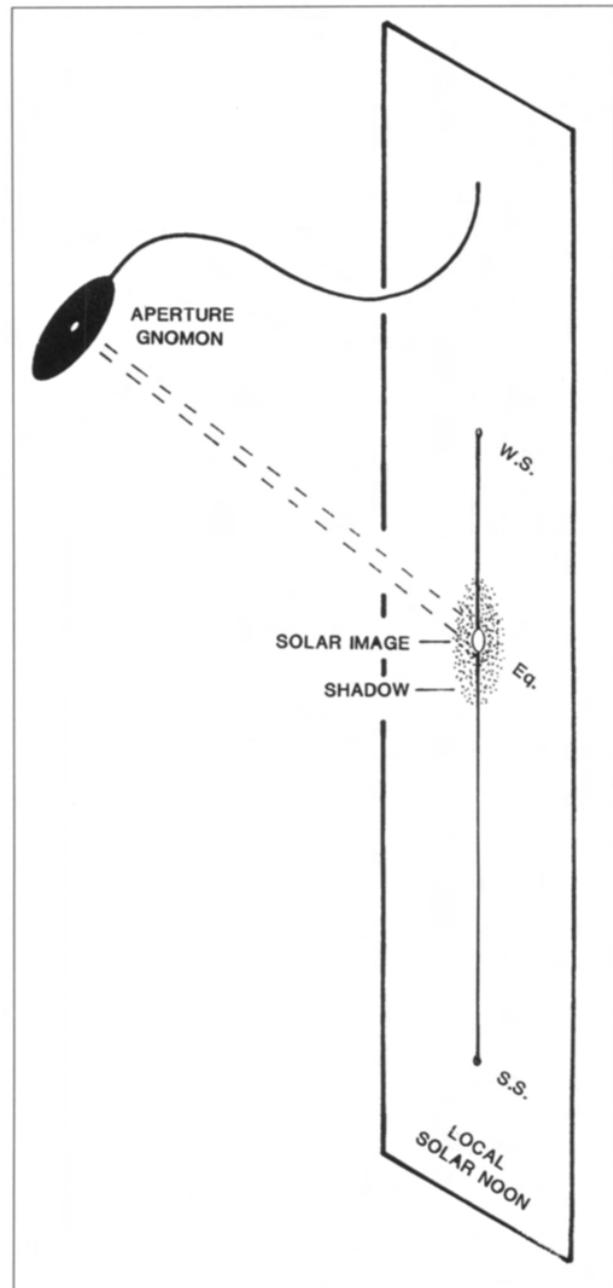


Fig 1 Use of an image of the Sun generated by pinhole projection.

increase as ℓ increases.

An ordinary convex lens would give a sharper and brighter image, but only at a certain fixed distance corresponding to its focal length. A simple 'pinhole' has no specific focal length, is easy to make, and need not itself be circular. (A circular hole fixed perpendicularly at the equinoxes will appear elliptical to the Sun through most of the year!)

Some vertical sundials and noon marks,³ and most meridian lines for finding the solstices,⁴ incorporate a 'perforated gnomon' of this type (Fig 1), although it is by no means clear that the principles involved were always fully

appreciated. A plain or decorated disc (e.g. a symbolic Sun) with a central aperture is supported at a point corresponding to the tip of a conventional triangular sloping gnomon, and produces a fuzzy shadow zone upon a wall or floor. Near the centre of the latter will be the brightly contrasting elliptical solar image. Effective visual estimation of its geometric centre is not difficult, even if the circumference is somewhat ill-defined due to the inherent nature of projection from a hole of finite size.

The optimum diameter of aperture (a) to give the best definition was stated by Rayleigh⁵ to be given by the expression $a = 1.9\sqrt{\lambda\ell}$, where λ is the wavelength of light and ℓ has the same meaning as before. (All must be in the same units of length). For white light, this reduces to $a \approx 1.4\sqrt{\ell}$, where a is measured in millimetres and ℓ in metres, giving an optimum size of about 1.4mm diameter for an aperture 1 metre from the receiving surface. The formula given above shows that the solar image would be about 9mm in diameter - and so rather too faint for comfortable viewing and accurate estimation. It appears usual to increase the size of the hole (ideally in stages controlled by experiment) until it is three or four times the Rayleigh optimum, image intensity being proportional to the square of the effective aperture diameter.

Whilst on the subject of meridians and solstices, it is worth emphasising that the latter (and the equinoxes) are by definition instants in time; there is no reason why any such instant should coincide with noon at any given locality. With monumental meridian lines it is only possible to find directly the day nearest a solstice: an error of up to 12 hours

is possible. Plotting the centre of the solar image on the meridian line every day would help, but involves estimating the apex of a very shallow curve. The 'maximum' and 'minimum' positions along the meridian will vary every year, and unfortunately an orderly cyclic advance and retreat from the true instant will be disrupted by the leap year cycle. The 'obliquity of the elliptic' is represented by the maximum theoretical excursion in angle between the winter and summer solstice images, and the equinoxes occur at one half this angle - not halfway between the solstice marks on the floor or wall.

REFERENCES

1. A.A. Mills, 'Sunlight and Shadows', *Bull. BSS* 1996 No. 1 22-27.
2. J. Needham, L. Gwei-Djen, J. H. Combridge and J.S. Major, *The Hall of Heavenly Records: Korean Astronomical Instruments and Clocks, 1380-1780*, C.U.P. 1996.
3. D.A. Bateman, *The Noon Sundial* (at Farnborough). Leaflet published by DERA, Ively Road, Farnborough, Hampshire GU14 0LX.
4. C. K. Aked, 'Meridian Lines', *Bull. BSS* 1997 No.3 24-28.
5. J. Thewlis (ed.), *Encyclopaedic Dictionary of Physics*, Pergamon, Oxford, 1961.

A.A. Mills

DIPTYCH SUNDIAL CARDS FOR ANY LATITUDE BETWEEN 40° AND 60° N

ALLAN A. MILLS

Many members have probably considered making sundials for friends, but have been deterred by the labour involved and the need to match the latitude of every intended recipient. The diptych dials described here (Fig. 1) are simple but effective, and light enough to be mailed as unusual greetings cards. A special feature is the ease by which they may be adjusted for latitudes from 40 - 50° and 50 - 60° N respectively.¹

DIPTYCH DIALS

Portable diptych dials were popular in Europe from the 16th to the 18th centuries. 'Diptych' means two leaves, and indicates that this design was based on two hinged plates

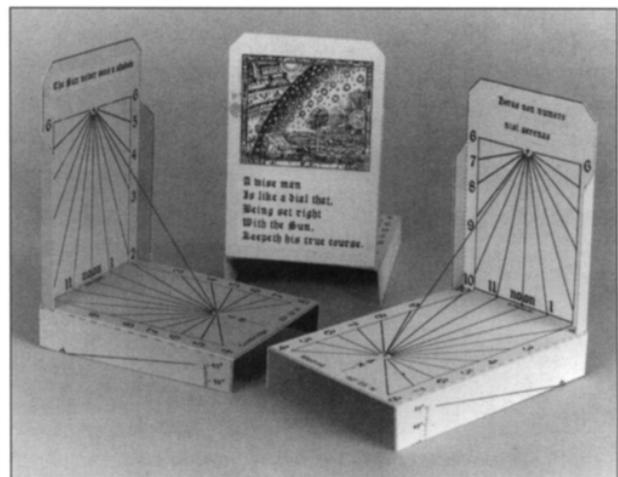


Fig 1 Three versions of the adjustable diptych card

that could be opened in the manner of a book until restrained at 90° to one another by a taut string or cord. The latter then constituted a gnomon and, provided the instrument was correctly oriented by means of a built-in compass, the time of day would be indicated by the positions of the shadow of the string upon a dial (or dials) inscribed upon the inner surface(s) of the leaves. The basic design was comparatively simple to lay-out for a given location (latitude), and when closed protected the dial graduations whilst cleverly obviating the problem of storing a projecting rigid gnomon.

No doubt the majority of commonplace diptych dials were made in wood, but for rich patrons a superior range was available in ivory, beautifully carved and decorated by a few specialist craft families working in Nuremberg.^{2,3,4} The innate elegance and value of these dials caused them to be preserved when the cheap wooden models were being discarded, so it is diptych dials in ivory and other valuable materials that are now generally to be found in museums or commanding high prices at auction.

SUNDIALS AND THE LATITUDE

The gnomon of an equal-hour sundial must point upwards at the pole star.⁵ By geometry, the altitude of this star is equal to the latitude of the observer. It follows that a sundial should be designed to suit the latitude of the place where it is to be used. In practice (and certainly when time was a less highly-valued commodity) a single dial would serve for an entire city and twenty miles around it. However, a



Fig. 2 A universal dial in brass, with face and gnomon laid out for 45°. (Harvard Collection of Historical Scientific Instruments).

wider-ranging traveller or merchant could purchase diptych dials with alternative string holes and calibrations for a number of named towns and latitudes.

THE 'THEOREM OF THE SUNDIAL'

Yet these alternative positions and dials are in a sense unnecessary: if the entire instrument is tilted so that, wherever it is used, the gnomon always points at the pole star, then the dials will read correctly even though (in general) they will no longer be horizontal and vertical. This 'theorem of the sundial' was first enunciated by Atkinson⁶ in 1962, and given wider publicity in Cousins' book⁷ of 1969. The principle is obviously inherent in universal equatorial dials, but it is remarkable that it was not clearly stated as applicable to all sundials until such a comparatively recent date. Thus, a common horizontal dial constructed for a given latitude may be adapted for another site by simply inserting an appropriately-angled wedge beneath the dial plate.⁸ That someone was aware of this many years ago is shown by an adjustable dial now in the Harvard Collection of Historical Scientific Instruments (Fig. 2). Unfortunately, date and maker are unknown, although it is thought to be English, late 19th century.⁹

ADJUSTABLE DIPTYCH CARDS

The above principle is utilised in the adjustable diptych cards. However, as tilts exceeding 10° are so unfamiliar as to appear 'wrong', two patterns are presented here:

Fig.3:50 - 60° N, serving Britain, northern Europe, and part of Canada.

Fig.4:40 - 50° N, serving northern USA, the border region and Maritime Provinces of Canada, and southern Europe.

Members will have no difficulty in designing masters for other latitudes, or the southern hemisphere, if they refer to one of the listed practical tests.^{5,7,8,9} The following procedure is then recommended:

1. Find latitude of location of intended recipient from an atlas.
2. Photocopy the appropriate grid same size, or as desired. (Change of scale will not affect angular relationships.) An antique effect may be obtained by tinting the paper (preferably before using it to make a photocopy) with a cold solution of instant coffee. (A well-known faker's trick!)
3. Spray the photocopy with a non-aqueous adhesive, and fix to thin card.

continued page 36

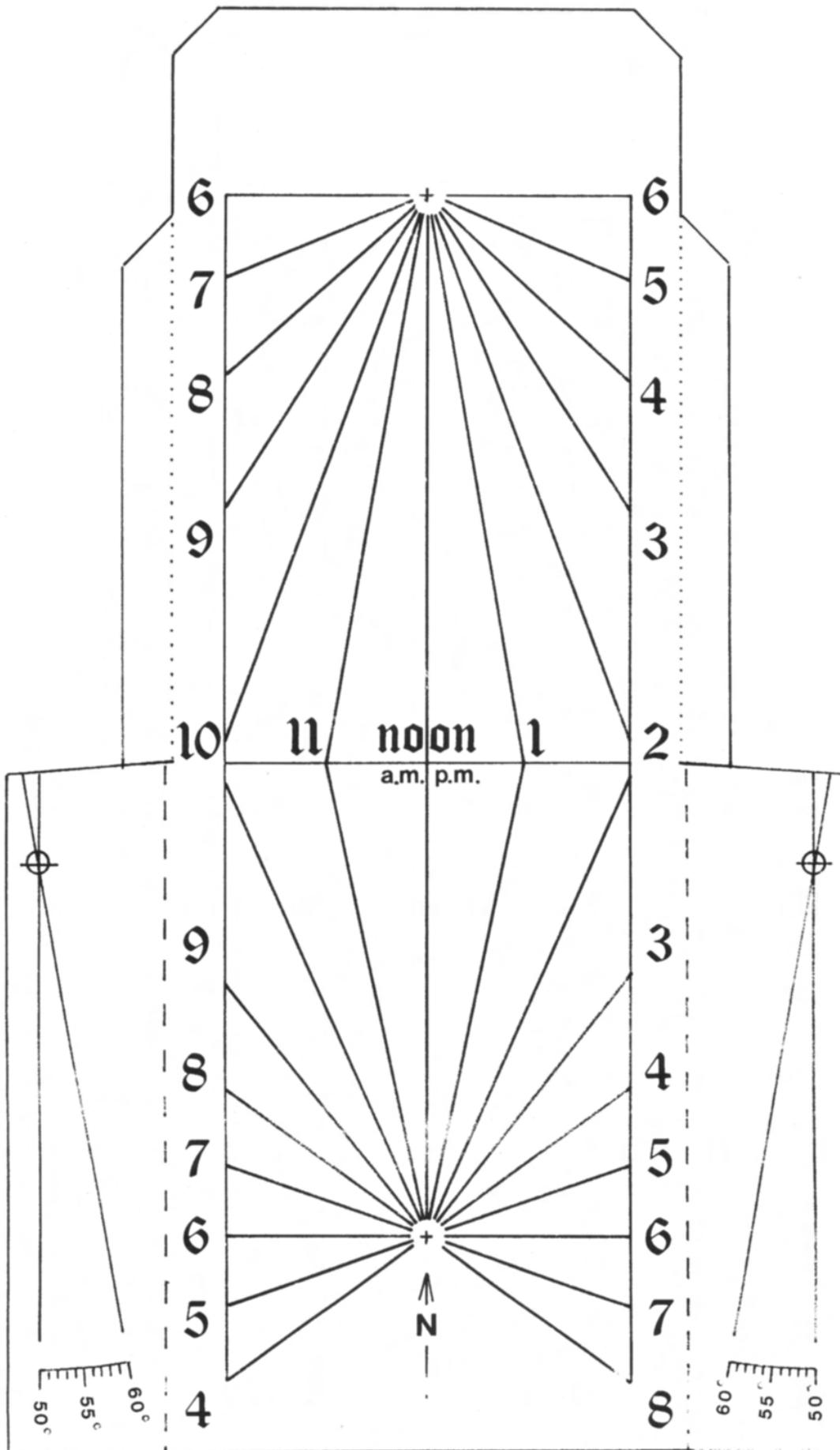


Fig. 3 Pattern for 50 - 60° N

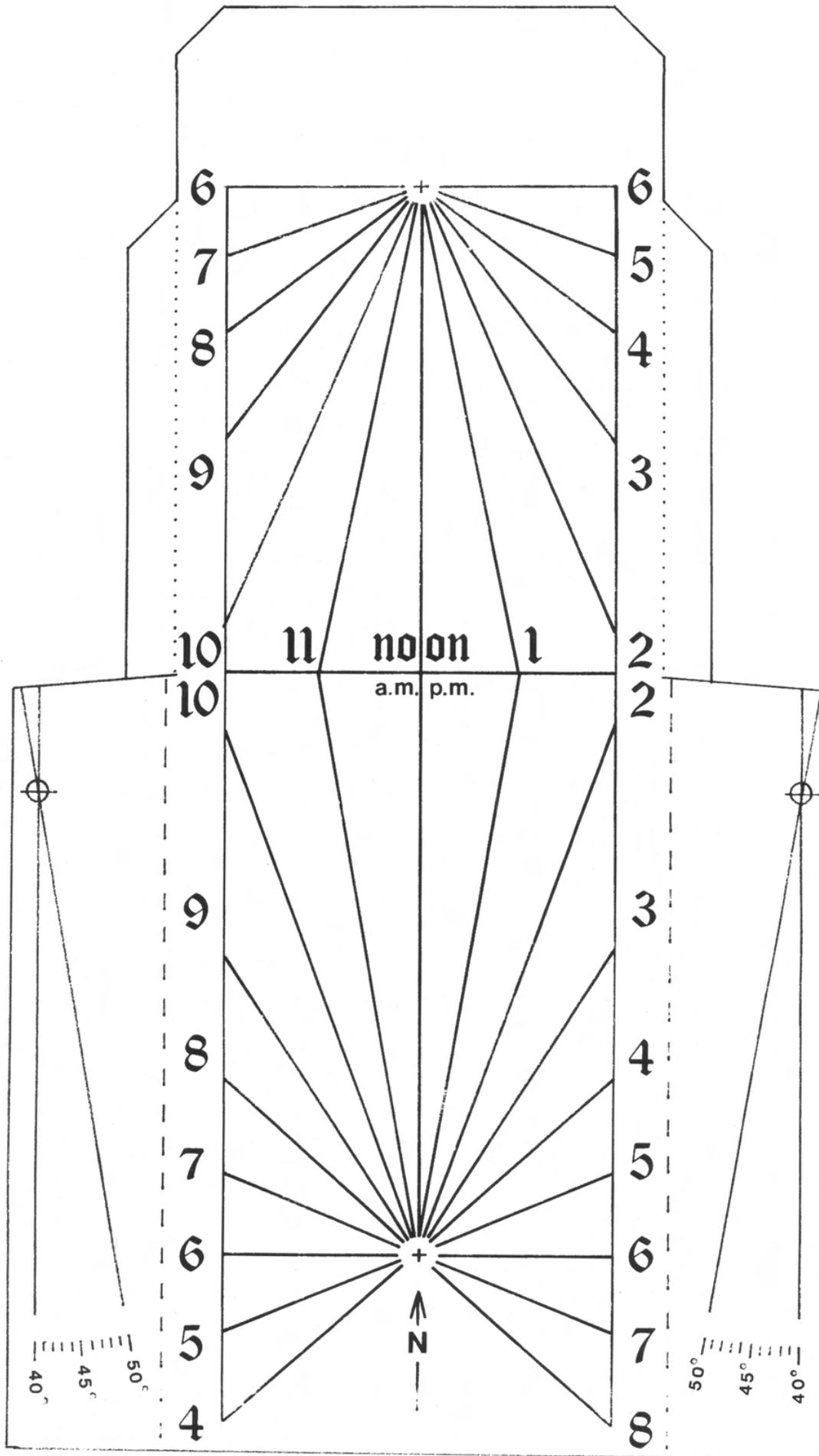


Fig. 4 Pattern for 40 - 50° N

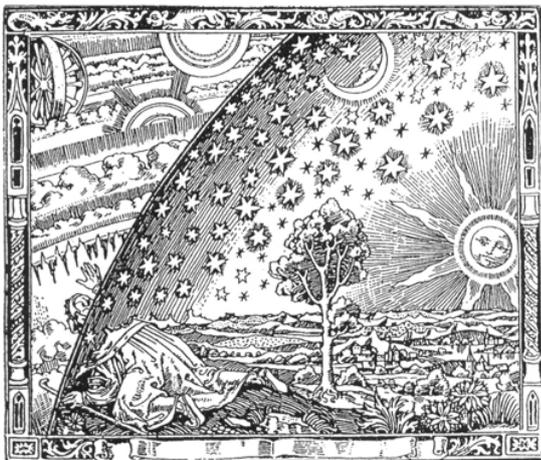
**THIS IS A MODERN, ADJUSTABLE, VERSION
OF THE ANTIQUE DIPTYCH SUNDIAL**

1. Open the card and bend forward the small tabs so that the upper dial remains at right angles to the lower dial.
2. Bend the base tabs downwards at right angles to the lower dial. These sides must be cut to suit your location.
3. Place the assembled sundial on a horizontal surface. In general, both base and upright sections will now be sloping: this sets the angle of the string gnomon, and the dials, to your latitude.
4. Turn the entire instrument until the arrow on the base points true north. The string gnomon will now be pointing at the pole star, and the shadow thrown by the Sun will indicate local apparent solar time on both dials.

For more information, and details of membership, write to
The Secretary, British Sundial Society, 112 Whitehall
Road, Chingford, London E4 6DW.



Adapted from a woodcut in a 16th century bible



Adapted from a drawing by Camille Flammarion (19th century)

**A wise man is like a dial that,
Being set right with the sun,
Keepeth his true course.**

**A wise man
Is like a dial that,
Being set right
With the Sun,
Keepeth his true course.**

I mark only the sunny hours

**Set me right and use me well,
And I to thee the time will tell**

**Of shade and sunshine for each hour
See here a measure made**

The Sun never sees a shadow

Horas non numero nisi serenas

Sol omnibus lucet

Carpe diem

Lux mea lex

Happy Christmas

Birthday Greetings

With Best Wishes

Fig.. 5 Directions for recipient, and some possible motifs

4. Mark the recipient's latitude on the short arcs, and draw straight pencil lines going through the marked point.
5. Cut out entire dial with a craft knife, including cutting along pencil lines made above.
6. Score along the dashed lines on the front, and on the back along lines corresponding to the dotted lines of the pattern. Also score the back along the line joining the two dials.
7. Bend sides of base downwards along dashed lines.
8. Bend tabs upwards along dotted lines, and raise face until it is at right angles to the base dial. Note how the tabs are slightly angled at the bottom to provide a certain resistance.
9. Prick intersections of hour lines with a needle, and thread through a length of the thin elastic cord used by dressmakers for shirring. Black or scarlet are suitable colours: these are commercially available, or the standard white material is easily coloured with a felt tip pen.
10. Secure one end of the 'string gnomon' to rear of the upright face with adhesive tape.
11. Draw the elastic cord through the hole in the base until tension is sufficient to hold the upright dial at 90° to the base. Fix with another small piece of adhesive tape on the underside.
12. Cover underside of lower dial with the directions for recipient (Fig. 5).
13. Cover string fixing on reverse of upper dial with a suitable motif. Some examples are given in figure 5 and could be coloured by hand. Alternatives could be cut from commercial greetings cards, magazines, etc., and still more have already been featured in the Bulletin.¹⁰⁻¹³
14. Finally, mottoes^{14,15} and greetings may be added as desired. Some possibilities are printed here at a suitable scale (Fig. 5).
15. For mailing, open out small tabs and fold in the sides

of the base.

REFERENCES

1. Previously described by the author in *Bulletin of the Scientific Instrument Society*, 1990 No.27 pp.20-24.
2. Gouk, P., *The Ivory Sundials of Nuremberg, 1500-1700* (Whipple Museum, Cambridge, 1988).
3. Lloyd, S.A., *Ivory Diptych Sundials, 1570-1750* (Collection of Historical Scientific Instruments, Harvard University, 1992).
4. Moore, J., 'The Ivory Diptych Dial', *Bull. BSS* 1993 No.3 16-19 and 1994 No.1 3-7.
5. Mayall, R.N. and Mayall, M.L., *Sundials: How to Know, Use and Make Them* (Branford, Boston, 1938; and later editions).
6. Atkinson, R.d'E., 'Forum', *Journal of the Institute of Navigation* **15** (1962) 454-455.
7. Cousins, F.W., *Sundials* (Baker, London, 1969) pp.78-82.
8. Waugh, A.E., *Sundials: Their Theory and Construction* (Dover, New York, 1973).
9. Dolan, W.W., *A Choice of Sundials* (Green, Vermont, 1975). Fig.21, p.55.
10. Briggs, J., 'Kircher's Sunflower Clock', *Bull. BSS* 1993 No.2 42-43.
11. Aked, C.K., 'Sundials in Illustrations', *Bull. BSS* 1994 No.1 9-16.
12. Briggs, J., 'Some Early Dialling Title Pages and Illustrations', *Bull. BSS* 1995 No.1 28-33.
13. Cowham, M., 'Henslow's Sketches', *Bull. BSS* 1995 No.2 49-52.
14. Gatty, Mrs. Alfred, revised H.K.F. Eden and E. Lloyd, *The Book of Sun-Dials* (Bell, London, 1900).
15. Sawyer, F.W., 'Contemporary Mottoes for Sundials', *Bull. BSS* 1994 No.3 23.

AN ORIGAMI SUN CALENDAR

JOHN MOIR

INTRODUCTION

About two years ago, at the Newbury meeting, I was most intrigued by a ceramic dial designed and made by Chris Lusby Taylor. The purpose of the dial was to indicate the date, not the time.

Many "Hour Dials" possess a form of calendar (e.g. all those with declination lines). Likewise, some of the much

rarer "Sun Calendars" also possess hour markings. One such example is to be found in the Oxford Museum of the History of Science. It uses the shadow of the rim of an Equatorial dial plate to indicate the date on a central "gnomon". The rate of change of the sun's declination is so slow that the shadow appears stationary throughout the day.

The ceramic dial shown at Newbury also reverses the roles of dial plate and gnomon, but in a delightfully perverse

way, it has no truck with the hour whatsoever.

One of my interests is cardboard engineering, and what follows is the result of my efforts to reproduce Chris Taylor's dial in cardboard. It is meant to be not only a complement, but more especially a compliment to his very original design. But first of all let us consider a hypothetical scenario.

THE PROBLEM

You have landed up on your Desert Island, complete with your eight favourite records and book, but you've left the all important calendar at home. It would provide some solace to know when you are missing such jollities as Pancake Day and Halloween, so you decide to make a sun calendar, as shown in Fig. 1. However, although your salvaged baggage contains scissors, cardboard calculator etc., you have carelessly forgotten to pack the GLUE. This means that you must produce your device from one single sheet of card, folded as necessary. (It can be secured to a piece of card, to act as a base, using thorns from a nearby bush).

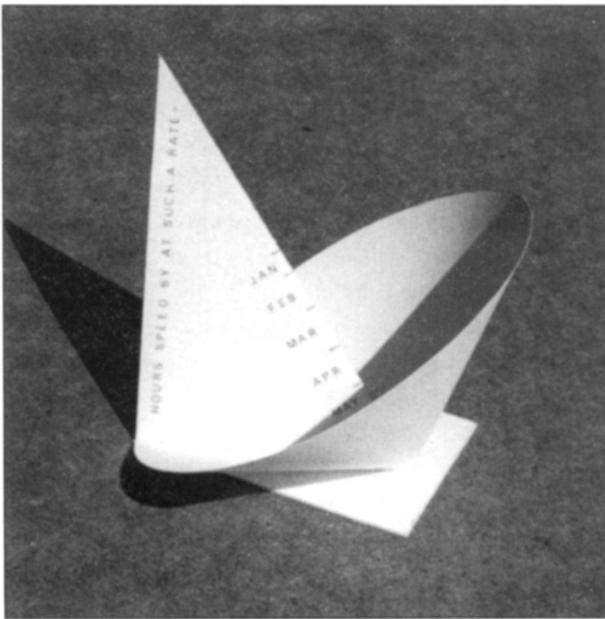


Fig 1

THE SOLUTION

Keys to symbols:-

- \emptyset = Latitude
- α = Semi-apical angle of cone
- l = Length of side of cone
- x = Angle cut out of circle

I decided first to examine the dial's design as if made from two separate components, shown in their pre-folded state in Figs 2 and 3. Fig 2 shows the lozenge from which to fold

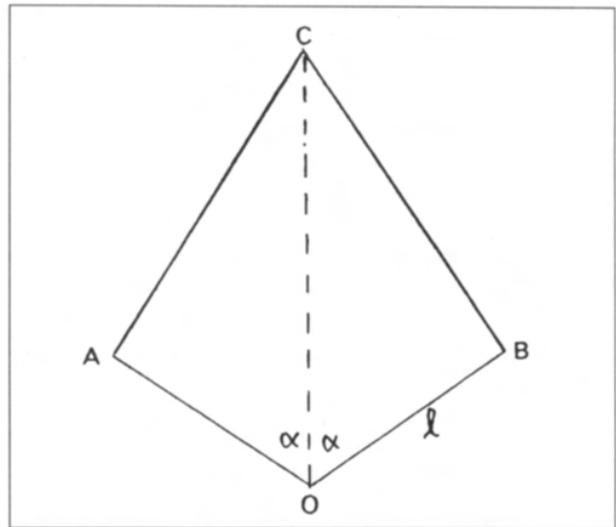


Fig 2

the central scale or "gnomon". Fig 3 shows a part-circle from which to fold the cone (or rather part cone). It will be noted that when assembled (see Fig 5), line OA of the "gnomon" will be congruent with OA, the side of the cone, and that line CO of the "gnomon" will be congruent with the cone's axis. It follows that angle COA = α , the semi-apical angle.

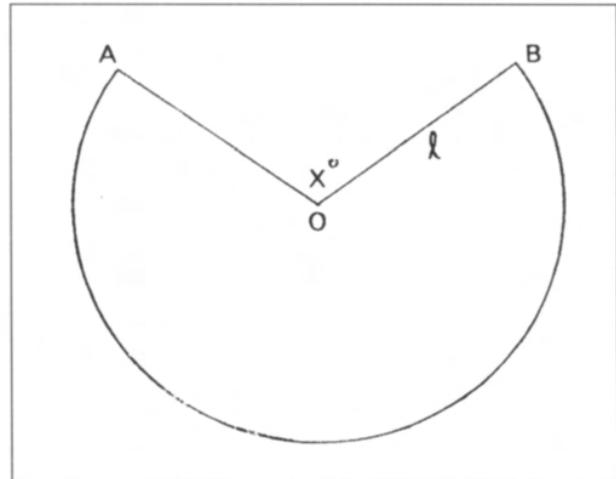


Fig 3

Fig 4 shows the meridional section, with CO in the polar axis. It can be seen that α must exceed \emptyset (to provide a plane of intersection OP, to act as a base). Also, x must be less than $66\frac{1}{2}^\circ$ in order for the cone's rim, Q, to cast a shadow up to the Summer Solstice.

Now comes the first question. Fig 5 shows the lozenge in its folded position. The corners A and B are now closer together than in Fig 2. But, to what length has AB been reduced in order to produce the required configuration, where angle COP = \emptyset ? The dotted lines through R are drawn in the equatorial plane at 90° to CO. Solving triangles RPO,

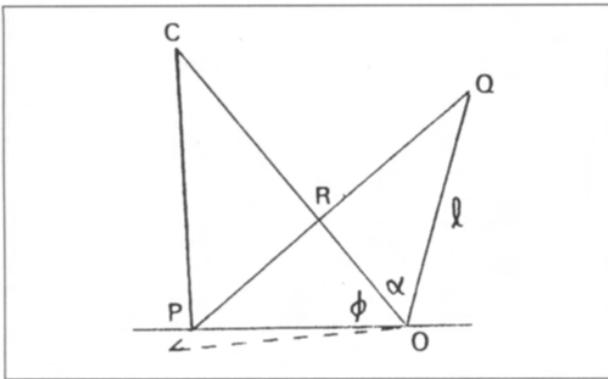


Fig 4

RAO, and RPA by simple trigonometry gives:-

$$AB = 2 \sin \alpha \sin \text{Arc cos} (\cot \alpha \tan \phi) \dots\dots\dots(1)$$

The problem now is to find cut-out angle X (as in Fig 3), such that when the circle is wrapped round the folded lozenge (as in Fig 5), matching up lines AO and OB, the rim of the "sliced" cone so produced lies in the equatorial plane, ARB. For this to occur, it can be shown that

$$X = 360 - \sin \alpha [360 - 2 \text{Arc cos} (\cot \alpha \tan \phi)] \dots\dots\dots(2)$$

Now, after selecting values for ϕ and ℓ , it is possible to design a whole range of dials by varying α (between the stated limits), in formulae (1) and (2) above. However, with one exception, all these dials would require assembling and glueing from two components.

Another glance at Figs 2 and 3 reveals that the only case where a single sheet can be used is when the flat lozenge fits exactly into the circle's cut-out, i.e. when $X = 2\alpha$. By replacing X with 2α , and giving a value to ϕ , formula (2) is now an equation to find α . I must confess I found my value for α by a graphical process, having neither the patience and/or ability to solve the equation by algebraic means (any offers?).

CONCLUSION

The specifications for this single sheet sun calendar are:-

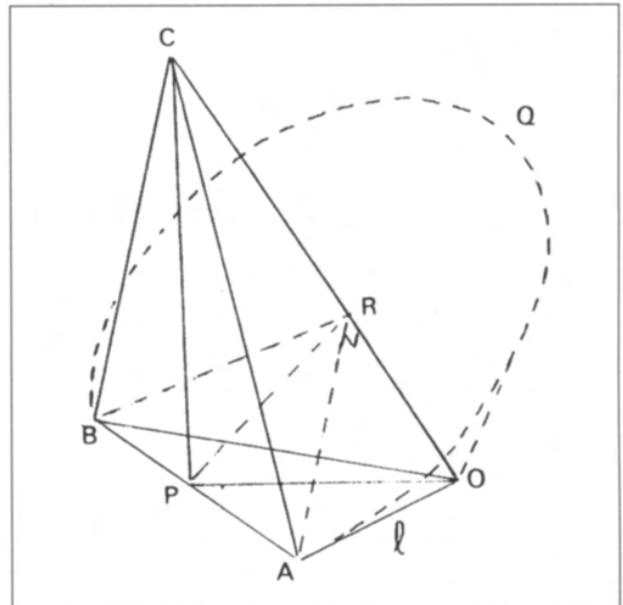


Fig 5

- $\alpha = 54.15$
- $x = 108.3$
- $\phi = 51.5$
- $\ell = 85 \text{ mm}$
- $AB = 58 \text{ mm}$

With regard to the delineation, Fig 5 shows that R lies in the Equatorial plane, and thus represents the point of zero declination on the date scale. Its distance from O is found by:-

$$OR = \ell \cos \alpha$$

The distance d of any scale point from R is given by:-

$$d = \ell \sin \alpha \tan \delta \text{ (where } \delta = \text{sun's declination).}$$

In order to make the Sun Calendar, it will first be necessary to photocopy the page onto a suitable piece of card. Folding is best achieved by gentle persuasion, and wood glue is best for fixing to a base.

Finally, if you should take some glue to your desert island, why not also take, as your one book, a copy of "Spooners Moving Animals" by Paul Spooner? It is cardboard engineering at its very best.

NOTES FROM THE EDITOR

RESEARCH FELLOWSHIP OFFERED

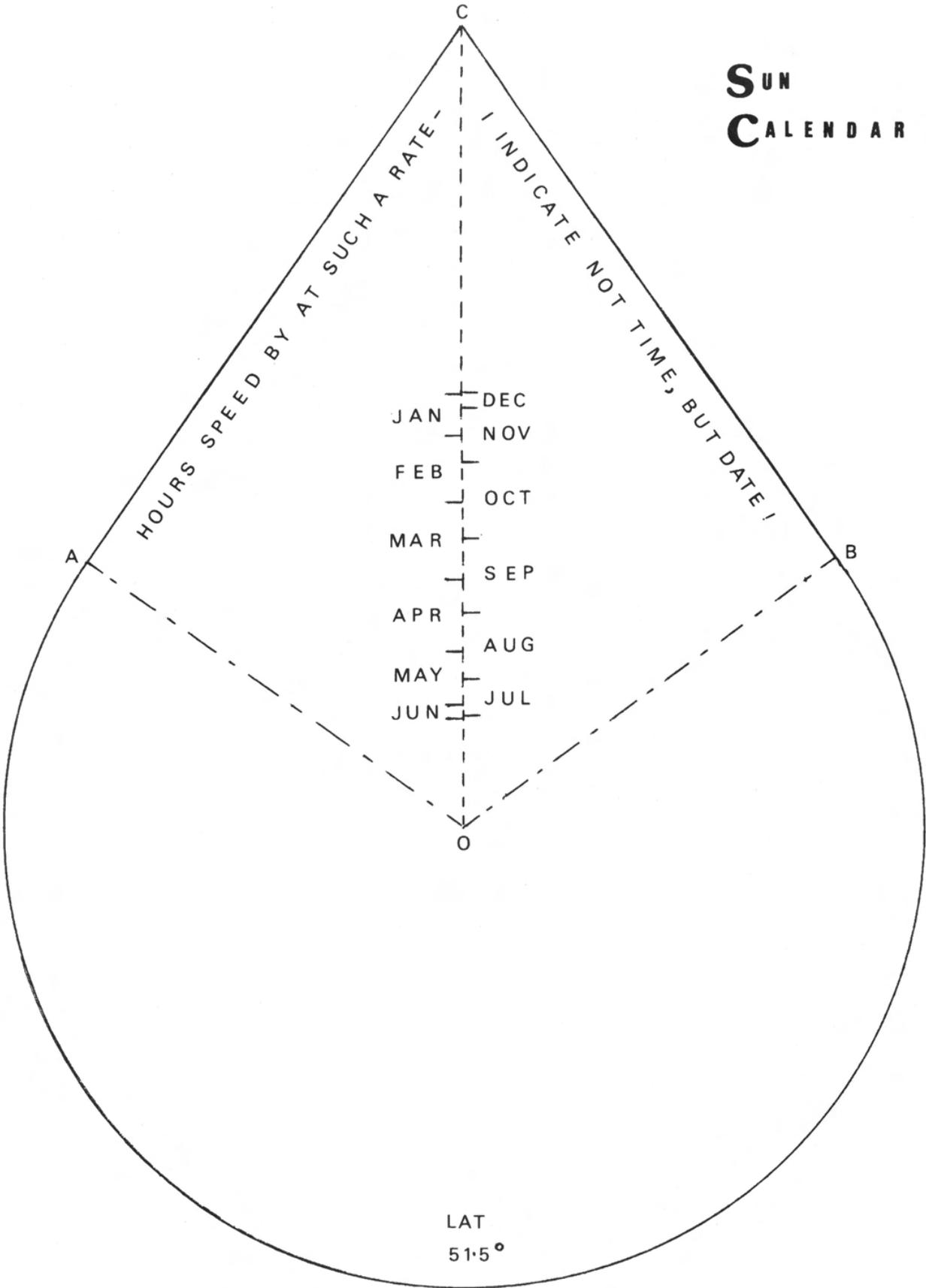
The National Maritime Museum invites applications for the Sackler Research Fellowship for research in one or other of the fields of Astronomy, Horology, Hydrography and Navigational Instruments. The Fellowship is of value £12,500 p.a. and is intended for younger post-graduate scholars. Applications must be submitted by 24th October. Further particulars and application form can be obtained from the Editor.

SUNLESS SUNDIAL

We thank Dr. J. R. Davis for drawing our attention to a short note in the Sunday Times of 11 May '97, describing London's first indoor sundial. It is to be placed in Times Place, a new development at 45 Pall Mall. A moving artificial light will provide the shadows on a 3-foot wide dial face.

We think that the Horniman Museum Sundial Trail will be more interesting.

SUN
CALENDAR



- 1 LIGHTLY SCORE OA OB OC
- 2 CUT ROUND ABCA (SOLID LINE)
- 3 FOLD RIDGE - - - - - AND VALLEYS - - - - -

IN LIMBO

The Editor has received two items for consideration for publishing in the Bulletin:

(a) 'Four 19th century meridian lines in Rome', by Nicoletta Lanciano, not a member of the B.S.S., who may be connected with the Mathematics Dept. of the University of Rome. No covering letter or author's address accompanied the script.

(b) A review of a booklet in German: 'Catalogue of fixed dials in Austria'. No name or address of author accompanied this item.

If any reader of the Bulletin can provide an address for the author of (a), and a name and address for the author of (b), the editor would be glad to receive the information. If such information is not received by the end of this calendar year, these items, currently in limbo, will be destroyed.

'NEW OPUSCULUM'

Mr. C. K. Aked has compiled a bibliography of dialling works. It is called 'A New Opusculum of Dialling References', and it is a revised version of his 'Opusculum'. The 'New Opusculum' lists some 3200 items. Its cost is £16, and it is obtainable from Mr. Aked: (Mr. C. K. Aked, 54 Swan Road, West Drayton, Middlesex, UB7 7JZ).

'DE BOERENRING': CORRIGENDA

The article by Fre J. de Vries, B.S.S. Bull. 97.3 40-42, (printed from a typescript received by the present editor) contained many errors and omissions, which have been pointed out by the author and by the assistant translator/annotator Mr. C. J. Thorne. Mr. Thorne has kindly supplied a copy of the original longhand manuscript, and with his help a list of corrections has been compiled. Readers who wish to correct their copies of this article are invited to do so by using the list below.

'De Boerenring' 97-3

Page 40

Column 1

1st para, line 3: after 'Bulletin' add superscript 1,2

3rd para, line 8: add '-11.5' at end of line

4th para, line 4: after 'altitudes' add 'for the second half of the year'

Column 2

3rd para line 2, and

4th para line 3: for 'a' substitute α

Page 41

Column 1

1st para: should read:

'First assume that the movement will be 2σ , so for each dateline we now have a new nodus angle: $\alpha' = \alpha + 2\sigma$. The result of these new calculations is to give us a straight hourline for noon. See Fig 3. Bear in mind that α' must be less than 90° (For an easily read dial it should really be not much more than 60° or the gnomon hole will be at a very oblique angle to the sun at low altitudes. C. J. T.)

Next we choose a movement equal to σ so $\alpha' = \alpha + \sigma$

This gives rise to a new scale, as shown in Fig, 4...'

(The text continues as printed, from 1st para line 3 onwards.)

3rd para, line 5: for 'a' substitute ' β '

4th para: Drecker's equation should read as follows:

$$\gamma = \frac{d}{\sin h} \cos (h - \alpha + P) \sqrt{\sin (2h + P) \sin P}$$

where

P = angle of correction

γ = offset of date lines

d = internal diameter of ring

h = height (altitude) of sun

α = angle of the gnomon hole (or α')

Column 2

After NOTES add '(C.J.T.)'

In line 2 of note 1, for 'northern' substitute 'higher'

In line 8-9: delete 'See reference 3'

In last line of Note 3: for 'altitude' substitute 'latitude'.

References:

No. 3: for '1935' substitute '1925'

THE ACCURACY OF SUNDIALS

ERWIN H. OVERKAMP (GERMANY)

1. SYNOPSIS

Misreadings on sundials arise from three sources of errors. They are not avoidable but they are modifiable up to a certain degree by the outlay in the performance of dialling. The aim of this article is to show the effects of errors; thereupon a decision can be made about the scope of the work needed to attain values of misreadings reasonable in accordance with the diallist's view.

Annual recurring misreadings come by errors in the adjustment of dials; furthermore, the accuracy is affected by errors in the fabrication, which includes an imperfect design. These errors may be compared with the incorrect setting of the hands of mechanical/electric clocks. The misreadings depend on the quantity of the errors and the geographic latitude of the dial as well as on the declination and the hour angle. The calculation of the misreadings is based on the proportionality between the shadow's course on the dialface and the associated celestial path of the sun. The four termini of these motions are fixed by the sun's hour angles/declinations as well as by the position of the dialface in its horizon system and the dial's nature. Such errors cause a distortion of the shadow's position which is nevertheless proportional to an accompanying fictitious motion of the sun. The unknown termini of these motions are calculable for any daytime if the effects of the errors are considered. Thus the misreadings are represented by the divergencies in the threshold values of the hour angles/declinations of the sun's path. The computations are based on the formulae of the plane/spherical trigonometry. The relationships between the errors and the misreadings are linear. On permanent dials, the latter can be limited to less than 60 seconds of time; this value can be reduced by careful work.

Annual accumulating misreadings are caused by the unequal lengths of the calendar year and the tropical year as well as by the effects of the motion of celestial bodies. These misreadings may be compared with defects of the drives in mechanical/electric clocks. Their values are deduced from the divergencies in hour angles and declinations of the sun at equal dates in consecutive calendar years; they reach amounts of up to 18 seconds after 60 years.

The transit of a shadow through an hour line on permanent dials can be defined within an accuracy of about ± 15 seconds. It increases on portable dials equipped with a plumb-line.

The misreadings caused by these three sources of errors can be added up. Their relations are very complex due to the magnitude and signs of the errors.

Among others, Loeschner¹, Noble² and Lauroesch/Edinger³ have reported about the accuracy of dials.

2. DENOTATIONS

The shadow of a "Point Dial" is cast by a globule assembled in the normal through the zero of the rectangular coordinate system of the dialface. The "Polar Style Dial" is a point dial too. A string of globules may be regarded as the rod parallel to the axis of the earth. Only one of these globules would suffice to read the dial.

As far as the following denotations are marked by an apostrophe, they indicate false or corrected values respectively:

- P_a : any location of a dial, coordinates: λ_a, φ_a .
- P_o : Point of Origin: the dialface lies horizontally, it is equivalent to the dialface in P_a , coordinates: λ_o, φ_o .
- A_a : geographic direction of the great circle rectangular to the dialface
- Z_a : distance between P_a and P_o in degree
- ΔV : twist of the dialface around its normal, counted negatively in clockwise direction
- B_s : location on the earth in which the sun is in the zenith, its coordinates: $GHA =$ Greenwich hour angle; $\delta =$ declination
- $HA/AZ/ZD$: hour angle/azimuth/zenith distance
- R : atmospheric refraction
- EQN/CY : equinox/calendar year
- SS/WS : summer/winter solstice
- AP : annual period of 365 days counted from 01. March of each calendar year
- noon line: coincides in P_o with the meridian and the y_o axis of the dial's rectangular coordinate system
- example of differences: $\Delta GHA = GHA - GHA'$
- counting of angles in the 360° circle:
GHA and λ from $\lambda = 0^\circ$ to the west
AZ and A_a : from north in clockwise direction
- transformations: ΔGHA to time by the relation $360^\circ/24$ hours;
 $\Delta \delta$ to days according to the declination of the observation day.

3. ANNUAL RECURRING MISREADINGS

The errors causing the annual recurring misreadings are described here below.

Adjustment Errors

The geographic coordinates of the dial to be assembled can be determined exactly by rectangular coordinates available with surveying institutions. Nevertheless, geographic errors are mentioned here for reasons of completeness. They are treated in the same manner as the effects of the adjustment errors ΔA_a and ΔZ_a .

These errors ΔA_a and ΔZ_a displace the dial's Point of Origin P_0 to the incorrect location P_0' , there the dial's plane lies horizontally anew. The geographic coordinates of P_0' yield from the application of the angles $A_a - \Delta A_a$ and $Z_a - \Delta Z_a$ instead of A_a and Z_a in the spherical triangles $P_a P_0' N$ and $P_a P_0 N$ respectively, see Fig. 1. Thus, the geographic errors $\Delta \lambda_0$ and $\Delta \phi_0$ are calculable. The noon line y_0 remains in P_0' parallel to the meridian P_0 , it diverges from the meridian P_0' by the angle $\Delta \omega = \omega - \omega'$. The relationship between the pair of errors ΔA_a , ΔZ_a and $\Delta \lambda_0$, $\Delta \phi_0$ is linear. If the dial is installed in the incorrect location P_a' , the real values of A_a and Z_a are to be applied in P_a' to find P_0' .

An error ΔV is not influenced by the displacement of the dial from P_a to P_0/P_0' , it can appear in addition to the error $\Delta \omega$. The effects of both errors are equivalent but they should not be confused.

A control whether the line of sight of a portable altitude dial hits the centre of the sun is not possible. Therefore misreadings may occur due to an error ΔZD .

Errors in the Fabrication of Dials

Errors in the design of the graphs of the dialface are taken for this category of errors.

The refraction R reduces ZD , the neglect of R occasions misreadings in time and date. They can be comprehended with sufficient accuracy if adequate mean values of the air pressure and the air temperature are considered in the design. The parallax entails a maximum alteration of about 0.5 seconds of time in a latitude of $\phi_a = + 50^\circ$, it is not followed up.

The centre line or the centre point of a shadow can only be determined if the whole umbra is visible. Therefore, misreadings occur on dials if edges are used as shadow casters. Misreadings on point dials appear by a misplaced

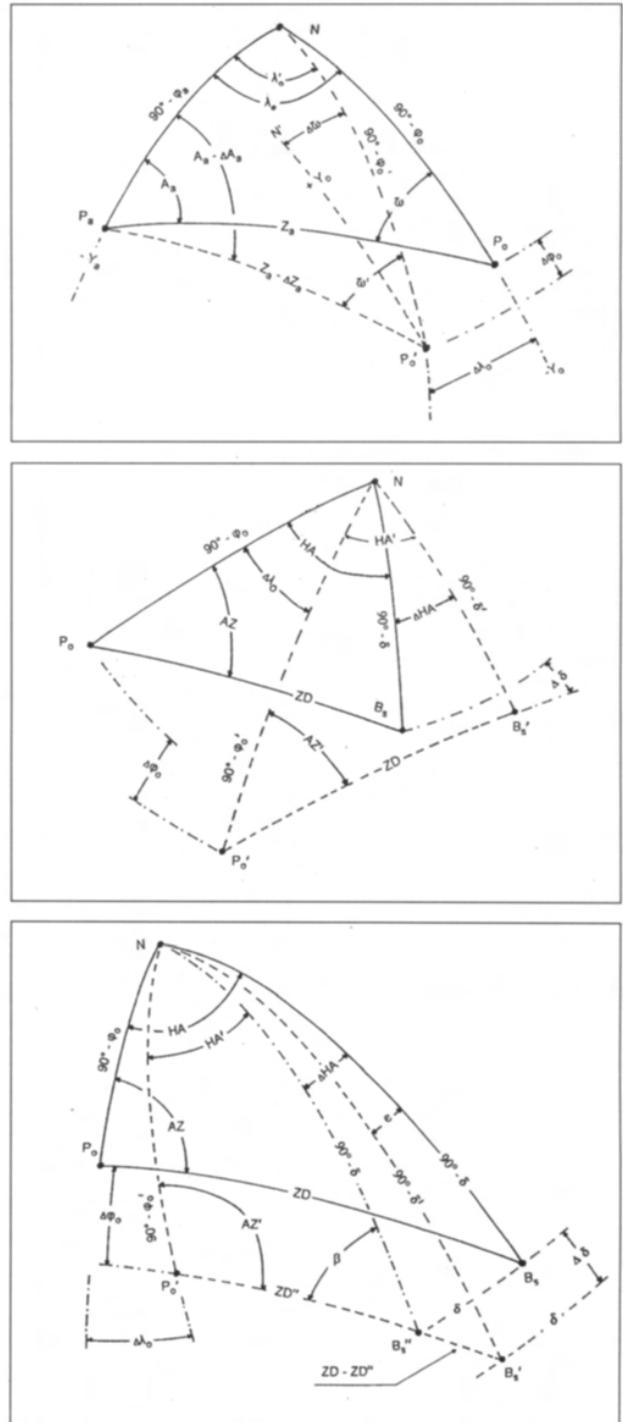


Fig 1-3. Examples of annual recurring misreadings

globule or if the rod of a polar style dial deviates from the axis of the earth.

4. MATHEMATICAL TREATMENT OF ANNUAL RECURRING MISREADINGS

Equal errors cause on all dials equal misreadings. The graphs on dialfaces of point dials are projections of the sun's path on the celestial sphere, but they are fictitious on azimuth/altitude dials. Therefore, debasements of the

misreadings appear on the two last mentioned dials. All calculations presuppose that the geographic coordinates of P_0/P_0' , as well as the sun's coordinates GHA and δ are known for any regarded daytime.

Adjustment Errors

The adjustment errors affect the dial's position in its horizon system. The violent motion of the shadow due to these errors is abolished if the sun is moved to a fictitious position B'_s which would generate the initial proper values of the azimuth/zenith distance on the dial affected by the errors. Thus, a correct reading would occur, the proportionality of the shadow's course and the sun's path would be warranted.

The errors ΔA_a , ΔZ_a and ΔV may affect a **point dial**. The three sides of the spherical triangle $P_0 B_s N$ in Fig. 2 are supposed to be known, furthermore the errors $\Delta \lambda_0$, $\Delta \varphi_0$. The azimuth AZ refers in P_0 to the local meridian = noon line, therefore it must be adapted to the form $AZ' = AZ - \Delta \omega - \Delta V$ before it can be applied to the meridian in P'_0 , the zenith distance remains unchanged. Thus, the coordinates of the position B_s'' of the fictitious sun can be calculated. If the hour angles are referred to the meridian of Greenwich, the required differences amount to $\Delta GHA = GHA - GHA'$ and $\Delta \delta = \delta - \delta'$.

An **azimuth dial** may be affected by the errors ΔA_a , ΔZ_a and ΔV , see Fig. 3. The same treatment is applied as for the point dial. To begin with, the sun moves from B_s to B_s' , the latter lies on the declination δ' . These two positions of the sun differ by the angles ε and $\Delta \delta$. At reading the dial, the declination δ' is unknown, furthermore the declination δ' alters continuously during the day of observation. Therefore, the reading off ensues from the fictitious position B_s'' of the sun which is defined by the real declination δ shown on the dial as well as by the azimuth AZ' . The calculation of the decisive hour angle HA' consists of the following steps:

- angle β : from $90^\circ - \varphi_0'$, AZ' and $90^\circ - \delta$
- ZD'' : from the pairs of angles β , $90^\circ - \delta$ and AZ' , $90^\circ - \varphi_0'$,
- HA' : from the sides of the triangle $P_0' B_s'' N$.

The knowledge of the angle ε is not needed. The value ΔGHA can be found as mentioned before, the value $\Delta \delta$ does not appear on this dial.

Using portable **altitude dials**, an incorrect value of the zenith distance may amount to $ZD - \Delta ZD$. Additionally, an incorrect value of the azimuth may occur but it does not influence the debased misreading. The mathematical treatment can be deduced from that of the azimuth dial, see

Fig. 3. The debased misreading on such a dial in the correct location P_0 can be computed from three sides of a spherical triangle: $90^\circ - \varphi_0$, $90^\circ - \delta$ and $ZD - \Delta ZD$. If the dial is employed in the incorrect location P_0' , the decisive sides of the spherical triangle are: $90^\circ - \varphi_0'$, $90^\circ - \delta$ and the measured zenith distance. Thus the difference ΔGHA is found as described above, the value $\Delta \delta$ does not appear. The value ΔZD is not found on permanent altitude dials such as pillar dials having a globule as a shadow caster.

Errors in the Fabrication of Dials.

The calculation of the effects of an imperfect fabrication of a dial is based on the position of the resulting incorrect shadow point. The relationship is explained by the example of a misplaced globule of a point dial. The correct position of a globule is defined by its height H above the dialface and the rectangular coordinates $x = 0$, $y = 0$ of the nadir of the globule's normal. Supposed, the coordinates of the misplaced globule are H' , x' , y' then the proper position B_s of the sun yields the incorrect shadow point S' . A shadow cast in S' by the correct globule would require a fictitious position of the sun in B_s' . It can be calculated by the values AZ' and ZD' resulting from the coordinates of S' and the height H of the correct globule. This method warrants the proportionality of the shadow's way and the sun's path. Thus the required values ΔGHA and $\Delta \delta$ are calculable.

This system enables the calculation of the misreadings on a polar style dial with a rod deviating in one or two angles from the axis of the earth. Instead of the rod, a globule will be considered having equal distances in its correct/incorrect position referred to the rod's nadir in the dialface.

This treatment is applicable in the case that the shadow is cast by an edge in such a way that only one limit of the umbra is visible. Again, a globule serves as an expedient for the computation. The divergencies in the azimuth and zenith distance respectively never can exceed the sun's semidiameter. The replacement of a point dial's globule by the tip of a rod brings about the same effects; additionally inaccuracies of the shadow's image impede the reading. Errors in the design of dials can be dealt with in the above mentioned sense.

The treatment described for the point dial is applicable for the determination of the effects of the **refraction** if the value ZD is replaced by $ZD - R$. The calculation yields ΔGHA and $\Delta \delta$ but it is always referred to the location in which the dial is to be installed.

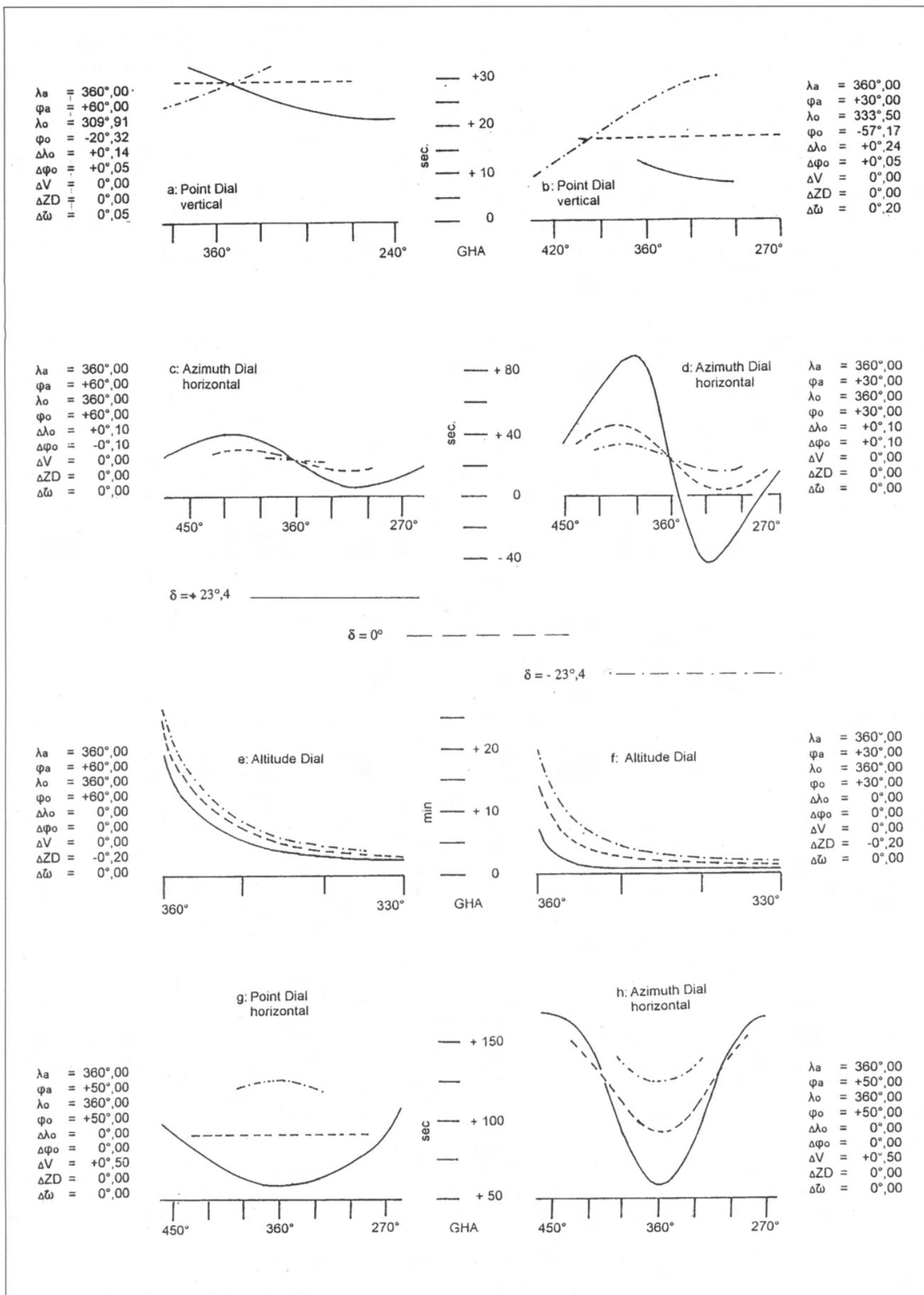


Fig 4. Annual recurring misreadings on dials of various types.

5. NUMERICAL EXAMPLES OF ANNUAL RECURRING MISREADINGS

The random examples presented here cover the daily solar irradiation time of the installed dial. The daytime expressed in graphs in the form of GHA may be converted to mean time or to solar time. The signs of the misreadings originate from those of ΔGHA and $\Delta\delta$, thereupon follows whether the dial is slow/fast.

Effects of Adjustment Errors

By a research program, the A_a directions causing the maximum value of $\Delta\lambda_o$ have been found for vertical dials installed between $\varphi_a = +60^\circ$ and $\varphi_a = +30^\circ$. Given that, **vertical point dials** are assembled in the said A_a direction under the errors $\Delta A_a = +0^\circ,10$ and $\Delta Z_a = -0^\circ,10$, then the limiting values of misreadings vary during the year between + 8 seconds and + 35 seconds. An additional twist of the dial by $\Delta V = -0^\circ,10$ increases the limits to + 32 seconds and + 45 seconds respectively. The declination is changed by about $\Delta\delta = 0^\circ,10$. The applied order of magnitude of $0^\circ,10$ for the errors seems to be reasonable in the practice of dialling, a reduction is possible. The increase of errors to 1° would yield misreadings between + 320 seconds and + 450 seconds.

Two examples of this series are shown in the graphs (a) and (b) of the Fig. 4. The other graphs are largely self explaining. The enormous misreadings on portable altitude dials near to the meridian transit are attributed to the ratio $\Delta ZD/ZD$, see graphs (e) and (f). Presupposing a constant value ΔZD , this ratio increases between the sunrise and the meridian transit due to the decreasing zenith distance. The consequence is that ΔZD influences the misreadings near to the meridian transit much more than near to the sunrise. The inverse proportion is true for the afternoon.

The combination of a *polar style dial* = point dial and of an *analemmatic dial* = azimuth dial on a common base plate is known to determine the time as well as the meridian direction. The function of this device is attributed to the debasement of misreadings on azimuth dials. The small differences of the misreadings near to the meridian transit - see graphs (g) and (h) - impede the utilization of the instrument, but more exact results are attainable towards to the sunrise/sunset due to the sensitivity of the device in these ranges.

Refraction

The misreadings $\Delta\text{sec.}$, $\Delta\delta$ listed in Table 1 would occur if the effects of the refraction are ignored in the design of a dial for the latitude of $\varphi_a = +50^\circ$. The relevant values of the refraction R have been calculated in accordance with the formulae published in the Astronomical Almanac⁵.

TABLE 1

ZD	- 10°C 1040 mb $\delta = -23^\circ,4$		+ 10°C 1040 mb $\delta = 0^\circ$		+ 20°C 1040 mb $\delta = +23^\circ,4$	
	Δsec	$\Delta\delta$	Δsec	$\Delta\delta$	Δsec	$\Delta\delta$
30°,0	-	-	-	-	1	0°,01
60°,0	-	-	3	0°,03	5	0°,02
75°,0	4	0°,07	9	0°,05	10	0°,05
87°,5	62	0°,40	66	0°,33	63	0°,34

The misreadings due to the influence of the refraction are reduced if adequate mean values of the air pressure and the air temperature are applied. The remaining misreadings under other atmospheric conditions must be accepted. They amount according to Table 1 to 5 seconds and 1 second if the atmospheric conditions of +10°C and 1040mb are used as adequate mean values, see ZD=75°,0.

6. ANNUAL ACCUMULATING MISREADINGS

The differences of the lengths of the tropical year and the calendar year as well as the motion of the celestial bodies alter GHA and δ at equal dates in consecutive calendar years. The resulting misreadings are calculated using the relevant differences ΔGHA and $\Delta\delta$; they are not modifiable unless an adapted dial is installed. The data of the Astronomical Almanac⁵ have been used for the calculations. The graphs of Fig. 5 refer to dials for hour angles of meantime; dials designed for solar time are not affected by the said differences. The denotation AP... = 0 indicates that the sun's position of that AP has been applied in the design.

The development of the misreadings between the consecutive intercalary days in the short term period from AP 1988 = 0 to AP 1991 are shown in the four graphs (A) - (D). Their characteristics are that the misreadings accumulate linearly at equal calendar dates in consecutive calendar years reaching the extremes in the AP 1991. They depreciate enormously after the intercalary day 1992 but they do not reach the zero values of the AP 1988 = 0. In the AP 1992 the inclination of the misreadings between the equinoxes and the solstices is inversed compared with that in the four periods ahead. This can be recognized clearly in graph (B) showing additionally the misreadings since the AP 1976 = 0.

The long term development of the misreadings is marked out by the addition of the short term values to those reached in the AP following an intercalary day. An example is shown in the graphs (E) - (H) referring to the AP 1932 = 0.

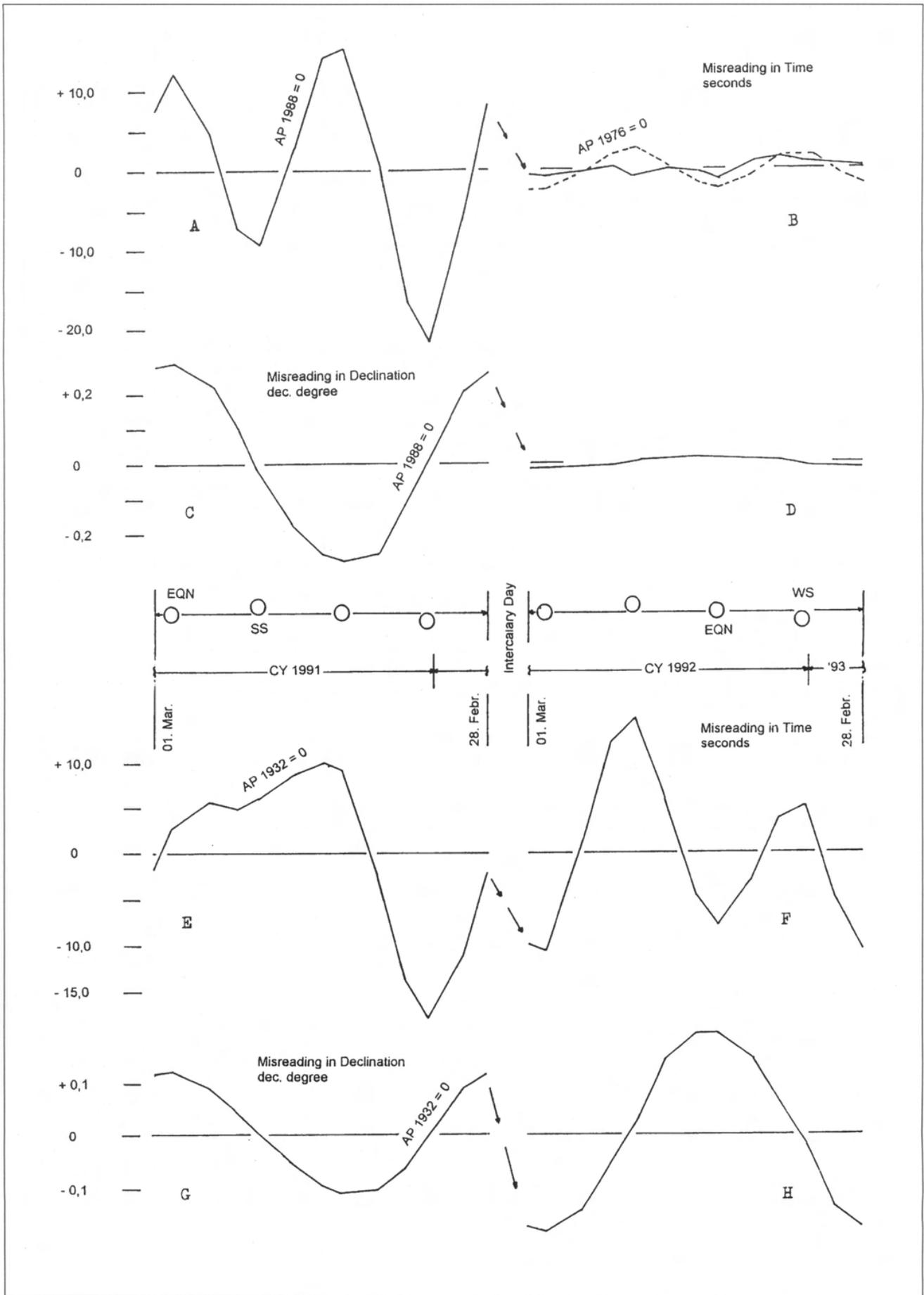


Fig 5 Amount of annual accumulating misreadings (meantime dials)

The conversion of the inclination of the misreadings causes consecutive shifts of the extremes on the time axis during the long term development. The values of the misreadings are influenced by the declination, they reach in every calendar year zero values.

The misreadings are not reduced if the sun's position of any 12 months period between two consecutive intercalary days is used in the design of the dial. This would shift the misreadings on the time axis only.

REFERENCES

1 H. Loeschner: 'Ueber Sonnenuhren',
Graz (Austria) 1906

- 2 A.E. Noble: 'The Sundial and Its Errors',
Horological Journal, Jan. and Feb. 1995
- 3 T.J. Lauroesch + I.R. Edinger jr.: 'Error Analysis of the
Horizontal Sundial', *Compendium, Journal of N.A.S.S.* 2
(3) 18-22 (1995)
- 4 E.H. Overkamp: 'The Theory of Equivalent Sundials',
B.S.S. Bull 95.1, 36-38 (1995)
- 5 Yearbook: *Astronomical Almanac*,
London and Washington

THE SUNDIALS OF HESSE

MARGARET STANIER

B.S.S. SUNDIAL TOUR IN GERMANY, 27 JULY - 3 AUGUST 1997

On Sunday 27 July a group of some 20 sundial enthusiasts gathered at Bad Soden, a small spa town about 40 km east of Frankfurt, at the start of a week-long viewing tour of the sundials -- some ancient, some very modern-- in this area of Germany. The programme had been planned with great care by BSS member Karlheinz Schaldach and his wife Elke, who acted as our guides throughout the week. On the first and several subsequent evenings Karlheinz gave a short illustrated talk in the hotel's conference room, to provide a helpful preview and description of the dials we were to see.



Our guides: Elke & Karlheinz Schaldach

A hired bus took us in a different direction each day. On the bus we travelled through the romantic countryside of Hesse: woodlands and pasture, rolling hills, ancient abbeys and small medieval towns, the fairytale country of Red

Ridinghood and the Grimm Brothers. On the first day we visited several small towns and villages north-east from our base: Alsberg and Homberg were the main objectives. At Homberg we saw, besides several historic sundials, samples of the work in stone and glass of a present-day working dial maker. On other days we travelled to Frankfurt, Kassel, Fulda, Gelnhausen, stopping for dials in villages at intermediate points. One day was spent on a Rhine river cruise, with dials at the start and finish. We also visited museums of clocks, dials and astronomical instruments in Frankfurt, Kassel, Gelnhausen. In some towns there was time for shopping and sightseeing, and Karlheinz provided guide-leaflets and maps.

We were interested to notice that the mass dials were mainly rather high up on church walls, and in quite good condition (or perhaps Karlheinz did not show us the poor ones). Many were of the handsomely carved 'Saxon' type, with lines standing proud of the dial surface. There were two examples of the work of M. Bernhardt, a modern

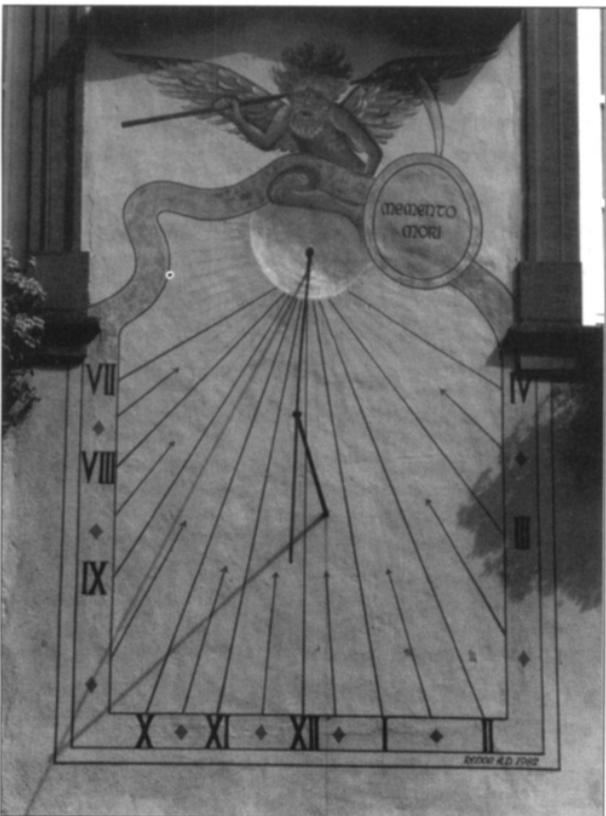


The group at Bad Soden

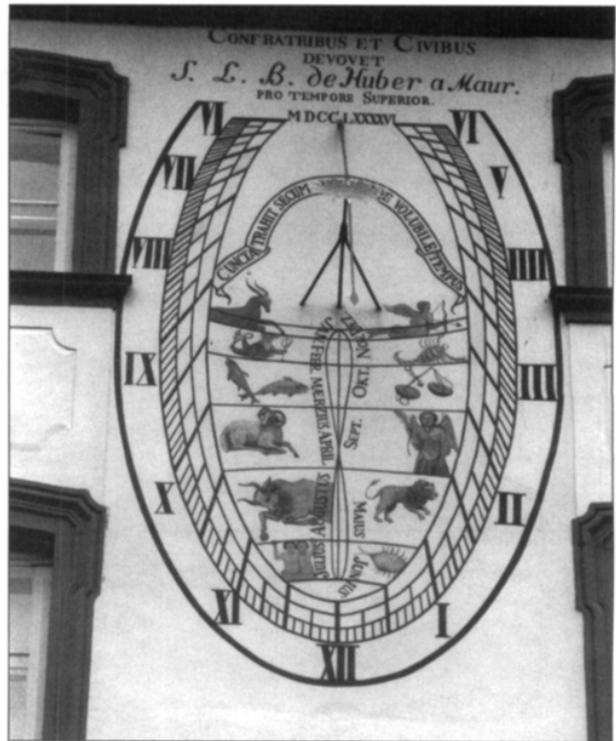
designer, whose dials have an unusual type of gnomon with built-in equation-of-time adjustment. The 'largest sundial in Hesse' is painted on the entire south wall of a six-storey block of flats in Gravenbruch, hour and declination lines just visible among a blend of soft rainbow-coloured stripes. Particularly beautiful vertical dials were seen on the wall of the Theological College in Fulda, and on the Schloss at Bad Soden, currently under restoration. There were some comic items too, such as the spherical stone 'dial' carefully provided with a useless gnomon, and a dial on the west front of Fulda Cathedral unreadable even in bright sunlight as the shadow would fall on a black surface.



Homberg: Stadtkirche St. Marien. 14th Cent.



Arensburg: Cistercian Monastery 18th Cent.



Fulda: Cathedral Library, 1796



David Young, presents gifts to our guides

There was time for some relaxation at the end of each strenuous day. The public gardens at Bad Soden are charming, and there is a fine view from the tower on the wooded hill above the little town. Some of us took advantage of the warm heated indoor pool of the Spa, and even of the outdoor pool with its wave-making machine. On the last evening at the hotel, Karlheinz and Elke joined us for a formal farewell and a hearty Thank-You! Karlheinz was presented with a brass equatorial dial made by Mr S. Higgon, one of the participants of the tour; and Elke received a small wooden addition to her tortoise collection. David Young, the indefatigable BSS Secretary, deserves an equally hearty Thank-You for the care and attention-to-detail with which he organised this happy trip, full of interest, information and delight for all.

THE 1997 ESSEX SUNDIAL MEETING

MICHAEL LOWNE

The second Essex meeting was held on September 20 at Moulsham Mill on the outskirts of Chelmsford. The Mill is a large eighteenth century flour mill, adapted as a craft centre, shops and offices, with a pleasant conference room. About twenty members attended, under the chairmanship of David Young. As is traditional at such events, members had brought sundials and other equipment and sundial literature for display.

The meeting commenced with a history of the development of the calendar, by Ivor Fishman. Any calendar is intended to reconcile the incommensurable values of the day, the lunar month and the year, possibly with religious constraints. Our present calendar is based on that of the Romans and keeps the dates in step with the year by means of an extra day in leap years. The Muslim calendar is based on the moon and reckons a year as twelve lunations and therefore has only 354 days, while the Hebrew calendar uses a combination of all three parameters.

The next speaker was Ami Carvalho, who spoke about the birth, life and death of the sun and explained the nuclear reactions which occur in the sun's core and account for the outpouring of radiant energy on which life on earth depends.

Tony Sizer showed us slides of the complex of masonry sundials and other astronomical instruments at Jaipur in India. Built in the early eighteenth century, they are massive in scale; the gnomon of the large equatorial dial is 26 metres high. Their use was to determine the positions of the sun, moon and stars in the equatorial (declination and hour-angle) and ecliptic (celestial latitude and longitude) co-ordinates. Interestingly, each of the large instruments has a smaller copy: were these used to train the observers before they were allowed to use the larger ones? The purpose of Tony's visit to India in 1995 was to observe a total eclipse of the sun and we were shown slides of that occasion.

The meeting was concluded by David Young presenting slides of the recent 'sundial safari' to Germany. We saw something of the area visited, and pictures of medieval church sundials as well as some attractive modern examples.

It is a pity that the attendance at this interesting meeting was rather sparse: my three-hour journey from the South Coast was certainly worth-while.

MASS DIAL GROUP: GLOUCESTERSHIRE MEETING

JOHN INGRAM

13 SEPTEMBER 1997

The meeting of the Mass Dial Group was held at 'Nature in Art' Walsworth Hall Twigworth, Gloucester. The programme followed the popular format of talks in the morning; then, after lunch, visits to nearby mass dials and sundials. The meeting was arranged by local member Tony Wood, and chaired by John Ingram.

After Tony Wood's welcome to members and friends, Professor Simon Trapwell spoke about the work of the 'Nature in Art' centre, winner of a special commendation in National Heritage Museum of the Year awards. Professor Trapwell also described the development of a sundial for an educational exchange with Kenya, very nearly on the Equator, for which Tony Wood had assisted the centre.

John Ingram then gave a talk on the use of the video recorder camera for the analysis of mass dials. By way of

example John had made a film of two dials at St. John the Baptist Church, Stockton, Wiltshire, covering operations for a complete morning; (on the day of chosen, cloud and shadow from trees had prevented afternoon filming). Gnomons had been placed in the dial holes, and very crisp clear shadows could be seen. There were several advantages of a VCR: in particular the camera time clock could be set to local apparent time, and a permanent record of the actual times when the shadows passed the scratches or pock marks could be made and replayed later.. Also instant pictures could be taken as the sun emerged from clouds, then almost immediately became obscured again. Disadvantages are that VCR's need batteries or power supply; confidence and practice in the use are essential, and so also is the use of a tripod.. For static situations there is no advantage over a camera.

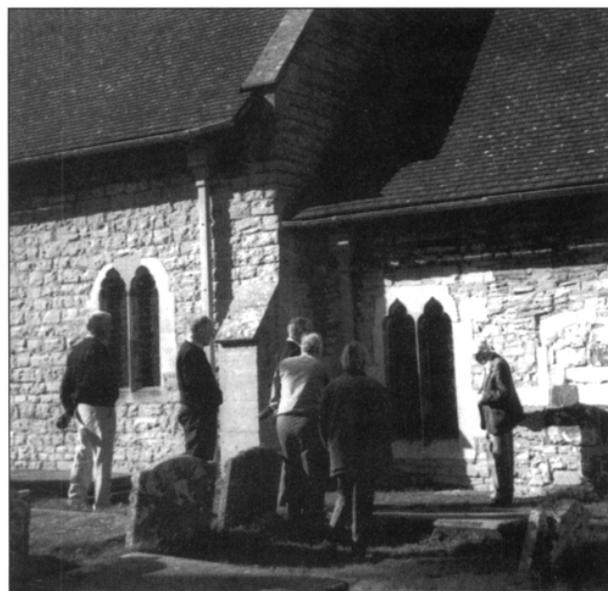
Tony Wood considered the subject of mass dials with numerals, and transitional dials, illustrating his talk with

some excellent slides. Dials with numbers seem to have been introduced with the advent of clocks, and were sometimes overlaid on previous scratch dials, or accurately made mass dials. An interesting aspect was that the square sundial was almost universal and that the circular mass dial does not seem to have become a circular sundial.

Edward Martin read a paper by member David Scott on Saxon Dials. As well as describing the different types and their locations, David showed that of the twenty surviving examples 7 or 8 predated the Danish invasions, and the rest were later, though all before the Norman Conquest. The use of these dials may have stemmed from the Rule of St. Benedict for the conduct of Monasteries. David had analysed the angles of the radial lines and illustrated the significance of the solstice. One of the difficulties of such work is the lack of understanding how the Anglo-Saxons thought.

After a pleasant lunch at the Centre's Buffet, and a visit to the Centre's gardens where some amazing and imaginative metal sculptures could be seen, the meeting adjourned to three local churches. The first was St. Mary the Virgin at Great Witcombe where a 1752 dial can be seen: the clearest in Gloucestershire. There were also 6 mass dials. Then came St. Mary Magdalene at Boddington. This church featured a 'standard' church dial which though worn was telling correct time. There were 2 known mass dials and we found a third.

By now the sun was shining brightly and was set fair for the rest of the afternoon. The last church was St. Lawrence at Sandhurst, which proved to be the climax of the day. Here was a transitional dial, re-positioned under the nave eave, complete with Hindu-Arabic numerals and sundial style spacing. Also, on an adjacent buttress step capping-stone, at eye level facing south, probably its original position, was what appeared to be another mass dial in a rectangular surround. However, closer examination with the benefit of oblique sunlight revealed markings clearly identifiable as



Discovery of Window Cill Dial at St. Lawrence Church Sandhurst, Glos. Douglas Scarrett, Gerald Stancey, Richard Chambers, Tony Wood, Diane Morgan, Haydn Morgan.

those of an early equiangular reclining dial. The gnomon hole indicated a vertical gnomon situated at the origin of the radials towards the front of the dial. The numerals '3', '4' and '5' could be made out on the p.m. side, and the slope of the capping was approximately the latitude of the church. We had not finished: inside the church behind a choir stall in the chancel Haydn Morgan discovered a window cill dial with mid-morning mass and noon lines generated from the adjacent window opening. Tony Wood has contacted the church historical and recording society and is providing an input for the dials.

So ended an excellent day's dialling. Many thanks to our hosts at Nature in Art, Professor Trapwell for the use of the facilities; and to Tony Wood for arranging the meeting, the publicity and the very interesting programme, and the clement weather, traditional on these occasions.

A 'TIME TRAIL' IN THE CITY OF LEICESTER

Dr. A. A. Mills (University of Leicester) has been awarded a grant from the Millenium Awards Scheme, to be used in conjunction with the City of Leicester Museums Service, to establish a Time Trail within the City. It will demonstrate and explain the various methods of timekeeping that have been used by mankind over the centuries, evolving from the simple noon mark, through sundials, water clocks and mechanical clocks, to the quartz crystals that now quietly control so many aspects of modern life.

The construction of full-size working replicas of an ancient

Egyptian water clock, a Roman sundial keeping seasonal hours, and the Jacobean automaton clock that was once on All Saints' Church are planned and will complement other sundials, mechanical and electric clocks already in the city or in the museum collections. Principles will be explained in a brochure, and the trail is planned to end at the astronomical clock on the university campus.

It is hoped that the scheme will encourage businesses and communities to commission unusual dials and clocks for their own premises or cultural centres.

MORE SUNDIALS OF HESSE, GERMANY

PHOTOS BY D. A. BATEMAN



Stone equatorial dial by Kieling



Viewing a Mass Dial on church buttress, Steinau



Dial, vertical, declining E, by K-H Schaldach



St. Goarshausen, in park beside the Rhine

B.S.S BULLETIN 1997

97.1

1. Editorial
2. Samuel Foster of Gresham College (F. Sawyer)
16. Portable Dials: Care & Resoration (J. Moore)
21. Umkhonto we Langa Sundials (R. Holliday)
24. Somerset Mass Dial Survey (J. Ingram)
25. Finding Meridian Line by Meridian Transit (R. Vinck)
26. Destruction by Vines (C. Aked)
34. Sundial Supporters, I (R. Bowling)
37. How to determine time by moonlight (J. Schepman)
39. Derbyshire Scratch Dials (F.Fisher)
43. Sundials based on lateral thinking (M. Kenn)
45. Sundial House (C. Aked)
47. North declining vertical dials revisited (P. Meadows)
48. Book Reviews
49. Readers' Letters
52. Dialogue

97.2

1. Editorial
2. Portable Dials, starting a collection (J. Moore)
6. Book Review
7. George Higgs Memorial Window (D. Young)
8. BSS Northern Ireland Tour (D. Young)
10. Mass Dials in Vale of White Horse (M. Stanier)
11. Mass Dials in Sussex and Kent (C. Lowne)
17. Story of Naturalised Dutch Twins (T. van den Heiligenberg)
24. Altitude Dials at Extreme Latitudes (C. Thorne)
29. Sundials at Royal Botanic Gardens Kew (A. Mills)
33. Sundials on the Internet (P. Nicholson)
34. Restoration of an 18th cent. vertical sundial (A. Smith)
37. Walker, Fecit, Dublin (C. Thorne)
38. Profile, Joanna Migdal
40. In Arthur Mee's Footsteps (J. Davis)
45. Sundial Supporters, II (R. Bowling)
47. Opusculum of Dialling References
48. The Pelignum (N. Severino)
51. Queens' College Sundial (C. Aked)
55. Immanuel Halton (C. Aked)
56. Book Review
57. Readers' Letters
59. Dialogue

97.3

1. Editorial
2. The Zodiac (C. McVean)
3. Sundials in Israel (S. Adam)
7. Two poems (F. Poller & H. Wynter)
8. The Stephenson Sundial at Killingworth (F. Evans)
9. QBasic Sundial Programs SUNDL1, 2 & 3 (P.A. Lamont)
10. When the Sun Shines (J. Davis)
12. A new analemmic sundial in Istanbul (S.R.C. Malin)
13. The Floating Gnomon (E.G.A. Marianeshi & N. C. Severino)
15. Window dial at Apuldram, West Sussex (R.A.

- Nicholls & C.M. Lowne)
18. D.I.Y Dialling scales - (G.N. Thorne)
20. The Angel of Chartres (C.K. Aked)
22. Telling the time by cardboard (D. J. Boullin)
24. Meridian Lines, the Andrew Somerville Memorial Lecture (C. K. Aked)
29. Readers' Letters (A.O. Wood, J. Migdal, Rev. J. Wall, J. Lynes, J. Lester, J. Singleton, J. Moir)
32. 'I am a sundial' (C. St.J.H. Daniel)
- Search for Author
33. Charles K. Aked:
Founding father, first editor and vice president, from the Chairman's pen
34. Sundial in Pajala, Sweden (Dr. G.B. Townsend)
35. Book Reviews (C.K. Aked)
36. Journal Reviews (C.K. Aked)
37. Dials of Bonar (G.E. Taylor)
38. A Sundial dedicated to James Taylor (E. Vilaplana & P. Gagnaire)
40. De Boerenring (Fer J. De Vries)
43. The Guernsey Liberation Monument (D.O. Le Conte)
50. Diallists' Crossword (J.Singleton)
51. Invitation from France
Advertising in B.S.S. Publications
52. Sundials and Sun at Newbury (M.Stanier)
53. A New Sundial for Christ Church, Oxford (M.Stanier)
54. B.S.S Conference at Newton Rigg, Penrith, April 1997 (R.B. Sylvester)

97.4

2. Editorial
3. Marking Time (P. Lamont)
5. Ultima Nonna? (D.Schneider)
8. The Turnbull Dial (D. Quinn)
10. A model depicting some astronomical features of Stonehenge (H. R. Mills)
11. Voice from the past (M. Cowham)
13. Ancient Sundials of Ireland (M. Arnaldi)
20. Crossword Solution
21. Folded-H Polar Dial (J. Singleton)
St. Johann's Sundial (M. Cowham)
22. Book Reviews (C. K. Aked)
23. Journal Reviews (C. K. Aked)
26. Sundials Go Green in Newcastle (T. Moss)
27. Readers' Letters (P. Tandy, A. Partridge, M. J. Kenn, A. A. Mills)
31. Diptych Sundial Cards (A. A. Mills)
36. An Origami Sun Calendar (J. Moir)
38. Notes from the Editor
41. The Accuracy of Sundials (E. H. Overkamp)
47. The Sundials of Hesse (M. Stanier)
49. The 1997 Essex Sundial Meeting (Michael Lowne)
Mass Dial Group: Gloucestershire Meeting - (John Ingram)
50. A 'Time Trail in the City of Leicester
51. More Sundials of Hesse, Germany - (Photographs by D. A. Bateman)
52. BSS Bulletin 1997 - Contents

HONORARY OFFICIALS OF THE BRITISH SUNDIAL SOCIETY

Patron: The Rt. Hon. The Earl of Perth P.C.
President: Sir Francis Graham-Smith F.R.S.
Vice-President: M. René R.-J. Rohr (France)
Vice-President: Mr. C.K. Aked

Chairman: Mr. Christopher St.J.H. Daniel
General Secretary: Mr. David Young
Finance: Mr. R.A. Nicholls
Membership: Mr. Robert B. Sylvester
Bulletin Editor: Dr. M.W. Stanier

COUNCIL MEMBERS

Mr. Charles Aked 54 Swan Road WEST DRAYTON Middlesex UB7 7JZ	Tel: 01895 445332	Mr. Alan Smith 21 Parr Fold Avenue WORSLEY Manchester M28 7HD	(Northern Liaison) Tel: 0161 7903391
Mr. Graham Aldred 4 Sheardhall Avenue Disley, STOCKPORT Cheshire SK12 2DE	(Restoration) Tel: 01663 762415	Mrs. Anne Somerville Mendota Middlewood Road HIGHER POYNTON Cheshire SK12 1TX	(Library, Archival Records & Sales) Tel: 01625 872943
Mr. John Churchill 55 Rushington Avenue MAIDENHEAD Berkshire SL6 1BY	(Advertising) Tel: 01628 27382	Dr. M.W. Stanier 70 High Street Swaffham Prior CAMBRIDGE CB5 0LD	(Editor) Tel: 01638 741328
Mr. C.St.J.H. Daniel 57 Gossage Road PLUMSTEAD COMMON London SE18 1NQ	(Chairman) Tel: 0181 3178779	Mr. Robert B. Sylvester Barncroft, Grizebeck KIRKBY-IN-FURNESS Cumbria LA17 7XJ	(Membership) Tel: 01229 889716
Wing Cdr. John Ingram Polnish, 40 Imber Road WARMINSTER Wiltshire BA12 0BN	(Mass Dials) Tel: 01985 214397	Mrs. Jane Walker 1 Old School Lane West Lydford SOMERTON Somerset TA11 7JP	(Education) Tel: 01963 240421
Mr. E.R. Martin West Lodge, Thicknall Lane CLENT, Stourbridge Worcester DY9 0HJ	(Mass Dials) Tel: 01562 882709	Miss R.J. Wilson Hart Croft 14 Pear Tree Close CHIPPING CAMPDEN Gloucestershire GL55 6DB	(Sundial Makers) Tel: 01386 841007
Mr. R.A. Nicholls 45 Hound Street SHERBORNE Dorset DT9 3AB	(Treasurer) Tel: 01935 812544	Dr. I.D.P Wootton Cariad Cottage Cleeve Road GORING-ON-THAMES Oxon RG8 9BD	(Vice Chairman) Tel: 01491 873050
Mr. P. Nicholson 9 Lynwood Avenue EPSOM Surrey KT17 4LQ	(Internet) Tel: 01372 725742	Mr. D.A. Young Brook Cottage 112 Whitehall Road CHINGFORD London E4 6DW	(Secretary) Tel: 0181 5294880
Mr. P. Powers 16 Moreton Avenue HARPENDEN Herts AL5 2ET	(Registrar) Tel: 01582 713721		

