

The British Sundial Society



BULLETIN

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FEBRUARY 2000



Front Cover: Sundial at St. Mary's Church, Donnington, Herefordshire.

*Back Cover: Saxon sundial, St. Mary's Church, Godmanchester, Cambridgeshire.
(Photos: M. S.)*

VOLUME 12 (i) - FEBRUARY 2000

CONTENTS

- 2. EDITORIAL
- 3. GRAECO-ROMAN SUNDIALS, PART 1: DIALS BASED ON THE SPHERE - *Allan. A. Mills*
- 11. RAILWAY TIME - *John Wall*
- 12. BOWL DIALS - A BRIEF COMPARISON IN DEPTH - *John Moir*
- 15. A SOLAR ECLIPSE SEEN ON A REFLECTED CEILING DIAL - *Paul Rainey*
- 16. A MERIDIAN LINE IN NORMANDY - *John Lester*
- 17. TWO SUNDIALS IN AUSTRALIA
- 19. THE MASS DIAL GROUP AT SOUTHWELL, 17TH - 19TH SEPTEMBER - *John Lester*
- 20. A REMOTE READING SUNDIAL - *David Young*
- 22. DIAL DEALINGS - *Mike Cowham*
- 26. EDITORS NOTES
- READER'S LETTERS
- 29. SUNDIALS AT NEW COLLEGE, OXFORD - *Harriet James*
- 32. TWO EARLY 18TH CENTURY SUNDIALS RESTORED AT RICHMOND, YORKSHIRE -
Alan Smith
- 35. SUNDIALS IN ANGLO-SAXON ENGLAND, PART 4, THE LATE PERIOD - ALDBOUGH AND
ORPINGTON - *David Scott*
- 39. BOOK REVIEWS
- 41. JOURNAL REVIEWS
- 42. A VISIT TO FARNBOROUGH NOON SUNDIAL - *John Ingram*
- 44. THE TOTAL ECLIPSE OF THE SUN AS SEEN FROM BULGARIA, 11TH AUGUST 1999:
A PERSONAL ACCOUNT - *Robert Sylvester*
- 45. A TRIP TO THE N.A.S.S. CONFERENCE AT HARTFORD, CT, U.S.A. 1999 - *Tony Moss*
- 47. DAVID YOUNG BOWS OUT
- 48. THE DOWNSIDE CONNECTION - *Jane Walker*
- 49. ALBERT AND THE EQUATION OF TIME - *Colin McVean*
- 51. A HORIZONTAL DIAL WITH EQUATION-OF-TIME BUILT IN - *John Singleton*
- 52. QUOTATIONS

BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

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VOLUME 12 (i) - FEBRUARY 2000

EDITORIAL

We are happy to present to readers this first issue of the final year of the 20th century. We time-and-sun-watchers are aware that centuries and millennia, (like babies) are aged Nought until they have completed one year. There were indeed festivities and celebration in the *first* year of the 20th century in *1901*. We cannot concur in the superficial view that a new Millennium has started just because the first digit of the date has changed; and we gnomonists the world over will be prepared to welcome the Third Millennium in eleven months' time, 1 January 2001.

This issue is full of travellers' tales, as our members have brought back reports from their journeyings in search of sundials and solar phenomena. One saw the Total Eclipse from Bulgaria, another found sundials a-plenty in New

England, and another came across a meridian line in Normandy; and all this apart from the organised BSS parties in Northumbria, Farnborough and Southwell. Gnomonics is not only for the craftsman in the workshop or the scholar in the library; the whole world can be our study, and thus a source of articles for the Bulletin.

Hemispherical dials feature in this issue: Allan Mills' article on Graeco-Roman sundials may tempt some readers to try their skills in making a Berossus-type dial, perhaps in some easier material than stone. John Moir seeks to convince us of the charms (and ease of construction) of a more open type of dial, a saucer rather than a porringer. We hope all readers will find something in these pages to charm the eyes and stretch the mind.

GRAECO-ROMAN SUNDIALS

PART 1: DIALS BASED ON THE SPHERE

ALLAN. A. MILLS

We are conscious of two natural measures of the passage of time:

Short-term: the alternation of day and night

Long-term: the rhythm of the seasons making up the year.

Both are obviously dependent on the apparent motion of the Sun in the sky, so a means of quantitatively keeping track of its position would automatically delineate both timescales. The facts that shadows furnish a simple and reliable method of coping with the Sun's blinding brilliance, and can be arranged to fall upon a calibrated scale, appear to have been discovered by Mesopotamian and Egyptian times, but we know little of the techniques involved. However, all subsequent Western cultures adopted their convention of dividing the sunlit portion of the day into twelve equal parts. These intervals vary absolutely with the season (short in winter, long in summer) so are known to us as 'seasonal hours'. The six divisions either side of midday are emphasised by their Greek name 'hectemoria'. The year is divided into four slightly unequal astronomical seasons by the equinoxes and solstices, and the incommensurable relationships between the year and the day have resulted in many problems with the calendar. Not until the spread of the mechanical clock in the 14th century did the 'equal' hour and the sloping-gnomon sundial begin to come into widespread use.

THE HEMISPHERIUM

The first really satisfactory sundial appears to have been invented by the ancient Greeks,^{1,4} and was dependent for its accuracy upon the replacement of a plane receiving surface for the shadow (e.g. the ground surrounding a tree or pillar - or oneself) by a three-dimensional surface of revolution. In due course Greek sundials were captured, copied and incorporated into Roman technology.⁵

One source of our knowledge of early sundials is Vitruvius⁶, but as no illustrations have survived it is difficult to identify or reconstruct the instruments from their brief descriptions in the Latin text. Interpretations therefore vary. It seems to me logical to suggest, along with Mayall and Mayall⁷, that the first accurate sundial was the hemispherium⁸, and that it consisted of a hemispherical stone bowl with a pointed bronze rod rising vertically from the bottom. This pin was of such a height that its point coincided with the centre of the hemisphere. It could well

be that this was originally intended as a symbolic or teaching model⁹, with the point (or a ball) representing the stationary Earth at the centre of the geocentric celestial sphere. Demonstrated outdoors, the vertical pin-gnomon would throw a shadow into the bowl that would be observed to move inversely with the Sun, and division of its arc of movement into 12 equal parts would automatically produce a sundial delineating the seasonal hours. This is diagrammed in Fig.1, where it is further shown how the limiting arcs are generated at the summer and winter solstices. An intermediate arc (a semicircle) is produced at the superimposed vernal and autumnal equinoxes. This particular arc is therefore both a representation of the celestial equator and a 'great' circle of the model hemisphere. On it, lengths of 'day' and 'night' are equal, and its twelve 15° divisions within the bowl represent the equal 'equinoctial' hours. Both solstitial arcs (the 'tropics') are parallel to it, and are 'small' circles of the celestial sphere and the model hemisphere.

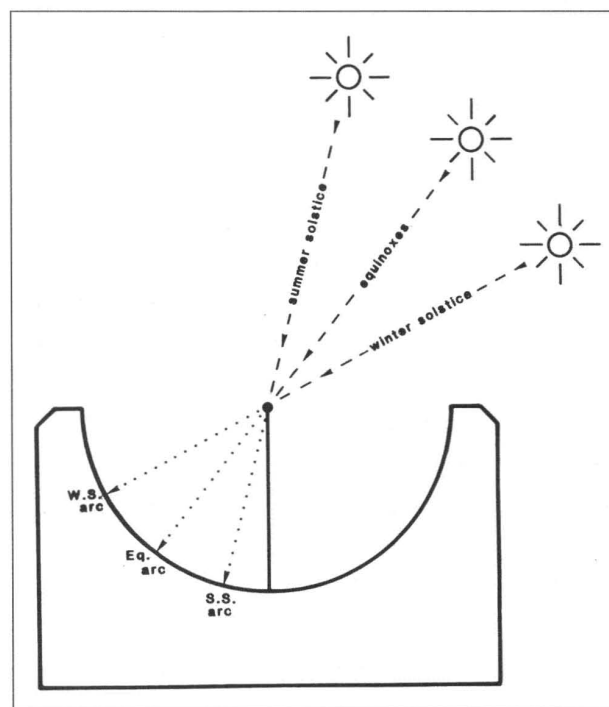


Fig.1. Diagrammatic representation of the working of the hemispherium.

No classical hemispherium appears to have survived: a modern reconstruction for a latitude of 38°N (Athens) is shown in Fig.2. A ball-gnomon has been employed to emphasise the relationship with Ptolemaic theory. The three arcs were each divided into 12 equal parts by trial-

and-error with draughtman's dividers - an instrument with a very long history. These points were then joined by lines scribed with the aid of a narrow flexible straight-edge placed in the bowl, providing seasonal hour divisions for every day of the year. Although I feel confident that this is how the hour lines would originally have been constructed in antiquity by Greek philosopher-astronomers, and Oronce Finé¹¹ recites this method in 1532, it does involve the implicit assumption that the hour lines are parts of circles on the sphere. This question will be taken up again later.

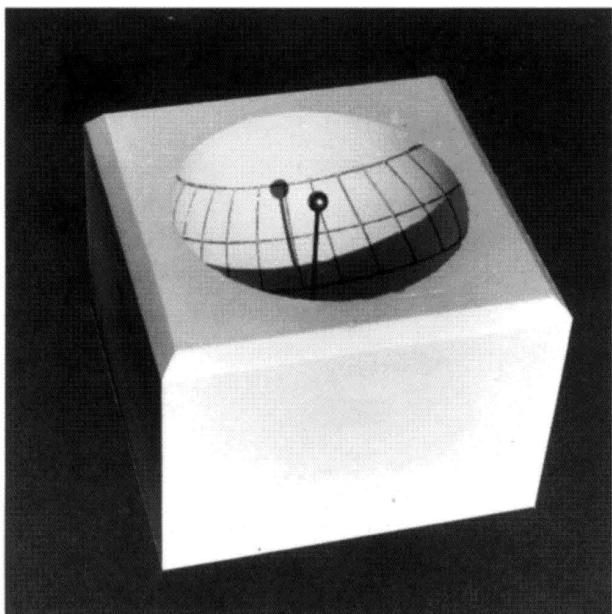


Fig.2. Plaster model of a hemisphere graduated for a latitude of 38°N (Athens).

THE HEMICYCLIUM

As the shadow of the ball or point never falls outside the limiting solstitial arcs, it would be no loss for timekeeping purposes to simply cut away the unused portion of the hemisphere as shown in Fig.3. This shape not only saves stone and weight, but also obviates the need for a close approach to read the time. This sundial is generally termed a hemicyclium. It is convenient to reposition the pointed gnomon horizontally across the top, but it will be appreciated that the only vital requirement is that its apex coincides with the geometric centre of the incomplete hemisphere.

A technological success, the hemicyclium appears to have been an important and prestigious time-measuring instrument in the Greek and Roman empires^{12,13}. Gibbs¹ lists 75 museum specimens, with dates ranging from 3rd century B.C. (Greek) to 4th century A.D. (Roman). Eight examples have been recovered from Pompeii alone. A dial excavated at Città Lavinia in 1891, and now in the British Museum, is illustrated in Fig.4. The gnomon is missing, as is almost always the case - metal was far too valuable to be thrown

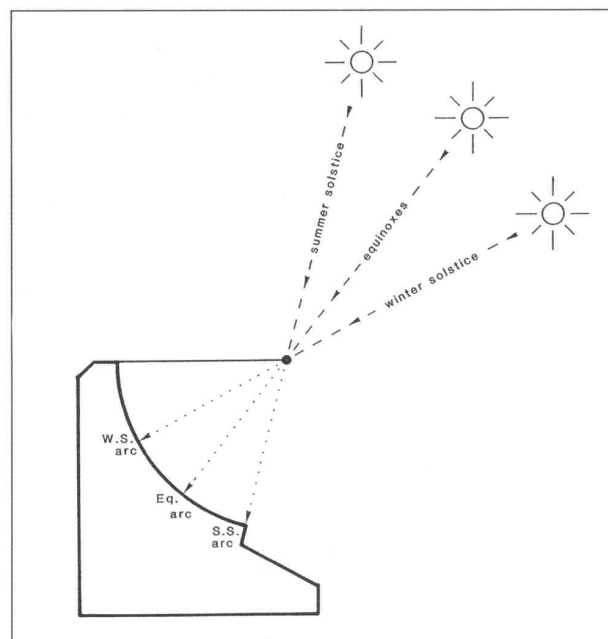


Fig.3. Diagram showing the derivation of the hemicyclium from the hemisphere..

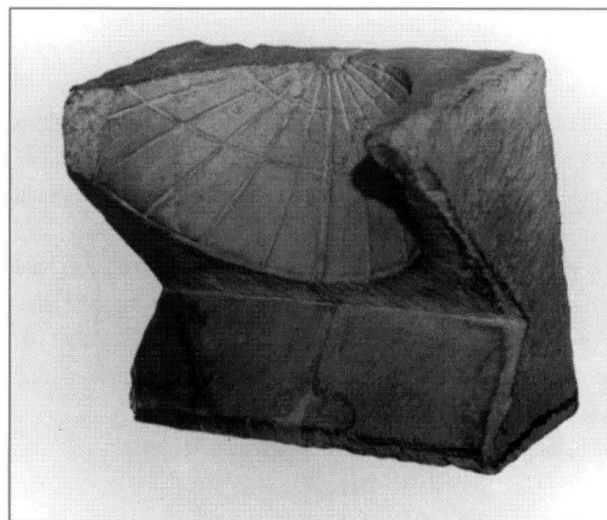


Fig.4. Roman hemicyclium from Civit  Lavinia. (British Museum 2547; 28 cm wide, 23 cm high, 18 cm deep).

away. It will be observed that in this example the hour lines extend to the base of the gnomon, although the shadow of its tip can never fall above the winter solstice arc.

The sphericity of some archaeological hemicyclia is poor, so an accurate working model for the latitude of Rome (42°N) was cast in dental plaster, using a modern 6" terrestrial globe as a pattern. It was calibrated in the same way as the hemisphere (Fig.5).

THE NUMERATION

By definition, the seasonal hours began at sunrise and ended at sunset. The zero was not introduced until the Renaissance (as part of the Arabic 'positional' system of counting) so the first entire division was known as the 'First

Modern 'arabic' symbol	English name		Greek symbol		Transliterated Greek	
	As a cardinal number	As a ordinal number	Capital form	Cursive form	Name when used as a letter	Name when applied to the seasonal hours
1	one	first	Α'	α'	alpha	prote
2	two	second	Β'	β'	beta	deutera
3	three	third	Γ'	γ'	gamma	trite
4	four	fourth	Δ'	δ'	delta	tetarte
5	five	fifth	Ε'	ε'	epsilon	pempte
6	six	sixth	Ζ'	ς'	digamma	hekte
7	seven	seventh	Ζ'	ζ'	zeta	hebdome
8	eight	eighth	Η'	η'	eta	ogdoe
9	nine	ninth	Θ'	θ'	theta	enate
10	ten	tenth	Ι'	ι'	iota	dekate
11	eleven	eleventh	ΙΑ'	ια'	iota, alpha	hendekate
12	twelve	twelfth	ΙΒ'	ιβ'	iota, beta	dodekate

Table I: Greek Numeration

It is apparently uncertain whether *hora* or *gramme* (line) is to be understood as following the ordinal adjectives in column 7. Usage probably depended on the historical era.

Modern 'arabic' symbol	English name		Roman		
	As a cardinal number	As a ordinal number	Symbol	Name of the cardinal number	Form when applied to the seasonal hour
1	one	first	I	unus	prima hora
2	two	second	II	duo	secunda "
3	three	third	III	tres	tertia "
4	four	fourth	IIII	quattuor	quarta "
5	five	fifth	V	quinque	quinta "
6	six	sixth	VI	sex	sexta "
7	seven	seventh	VII	septem	septima "
8	eight	eighth	VIII	octo	octava "
9	nine	ninth	IX	novem	nona "
10	ten	tenth	X	decem	horam decimam
11	eleven	eleventh	XI	undecim	" undecimam
12	twelve	twelfth	XII	duodecim	" duodecimam

Table II: Latin Numeration

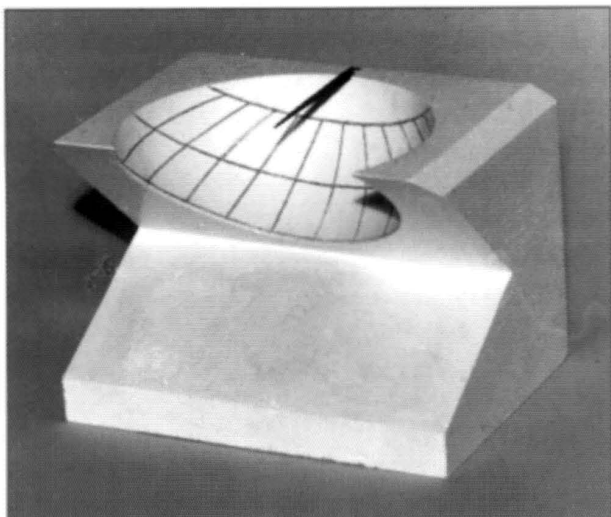


Fig. 5. Plaster hemicyclium for a latitude of 42°N.
(Rome).

Hour', the second division as the 'Second Hour' and so on, with midday marking the end of the sixth hour and the beginning of the seventh. The termination of the third hour marked the mid-morning point, and the end of the ninth hour occurred at mid-afternoon.

Neither Greeks nor Romans commonly entered the numeration on their dials: the observer was expected to know it, needing only to note the angle of the shadow. Much the same applies to many modern designs of clocks and watches, of course. However, literature and a few surviving incised examples¹ show that the ancient Greeks applied alphabetical symbols¹⁴ to the twelve seasonal hours (Table I). The symbol for six - digamma - remained in use for this purpose long after it had become redundant in ordinary text. The capital forms of the letters were normally used when incised in sundials (Fig.6).

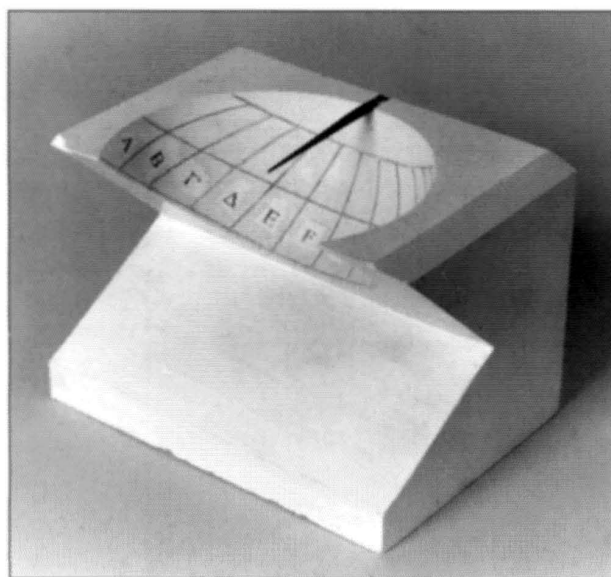


Fig. 6. Model hemicyclium with Greek numeration

The Romans - a practical people - used numerical symbols derived from counting on the fingers. Thus, 'one' was a vertical stroke denoting a single raised finger, 'five' was the vee between fingers and thumb of a 'full hand' and 'ten' a stylized picture of the crossed thumbs of two hands (Table II). The IV symbol was a later development. The decimalisation inherent in our ten digits is obvious in both languages, but took a long time to become codified into arithmetical symbology.

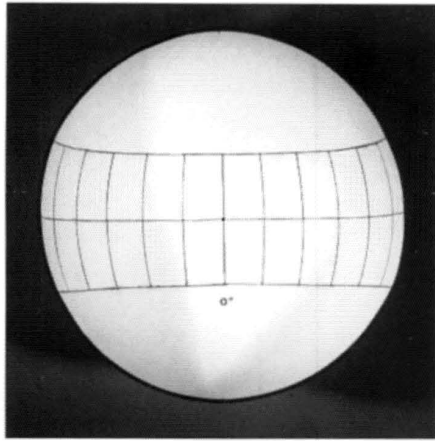
GEOMETRY OF THE HOUR LINES

The true form of the hour lines has exercised mathematicians from Claudius Ptolemy onwards^{15,16,17}, publications reaching a peak in the 19th century¹⁸⁻²⁵. Unfortunately these papers tended to be so specialised, complex and obscure that they exerted little influence on antiquaries and diallists. Things did improve in the 20th century²⁶⁻³⁰, although Drecker's classic work appeared in a set of massive volumes that major libraries are understandably reluctant to lend.

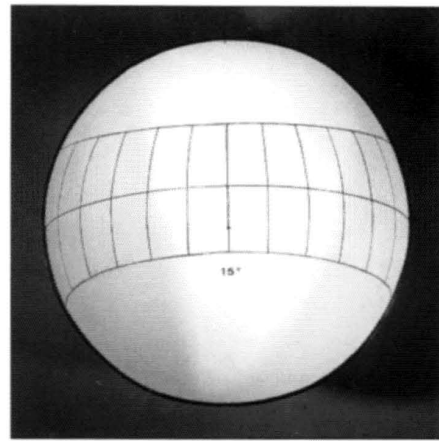
A basic qualitative understanding is, in my opinion, essential before consulting these works, and is best obtained by examining a series of hemispheria laid out for sites of increasing latitude. Two perspex hemispheres, each 25 cm in nominal diameter, happened to be available, and were painted internally with matt white vinyl emulsion. A grid could then be laid out in pencil followed by a waterproof black fibretip pen, photographed, and subsequently painted out with more coats of white emulsion to receive the pattern for another latitude. The photographs, being vertical or oblique projections on the film plane, are not so good as the 3-D models, but still very informative.

The tip of the gnomon of the hemispherium will coincide with the geometric centre of its hemispherical bowl. The equinoctial sun at noon will be at an altitude equal to the colatitude of the site, so will throw a shadow on the noon line at the same angular depth below the opposite edge of the bowl. This point may be marked with the aid of a cardboard protractor cut to fit the hemisphere. With the passage of the day, the shadow point will move across the bowl along an arc that is part of a great circle of a sphere set with its lower pole 90° to the initial mark. A drawing compass (a school type is best, for it can hold a full-length pencil or a fibretip pen) placed with its point firmly at the pole may be adjusted to physically mark-out this equinoctial path. It will be seen to be a semicircle, cutting the rim of the bowl (equivalent to the horizon of the site) along a diameter. The cardboard protractor may then be applied once again to mark points on the noon line $\pm 23.5^\circ$ from the equinoctial, and careful use of the compass will enable these solstitial arcs to be

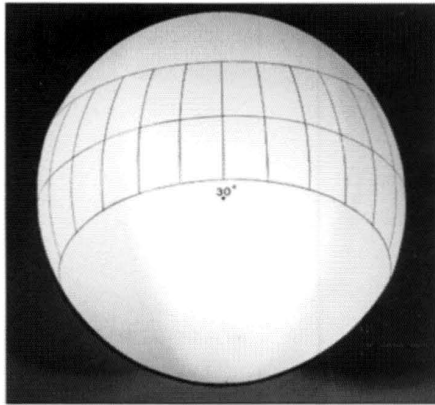
Fig. 7. Hemispheria calibrations for latitudes from 0° to 66.5°.



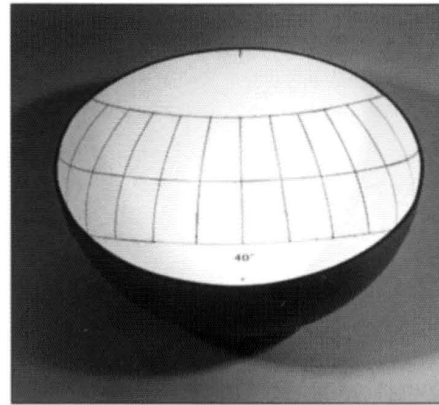
0°



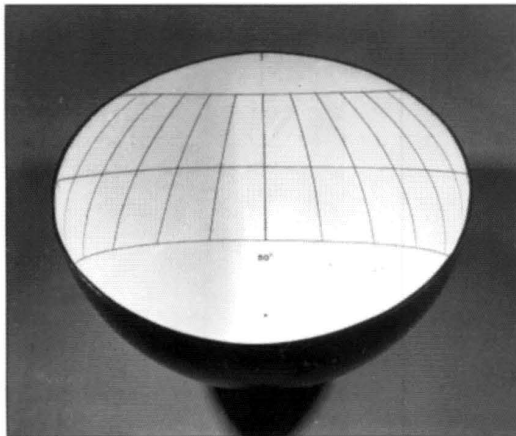
15°



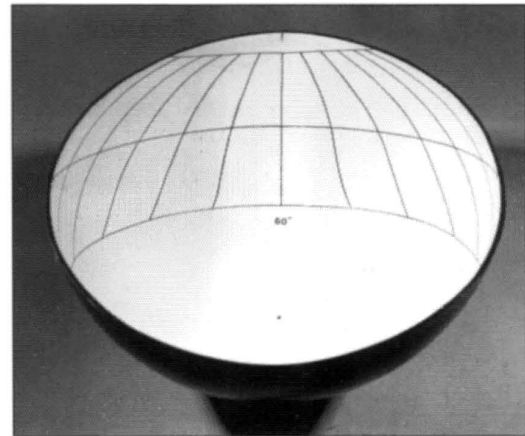
30°



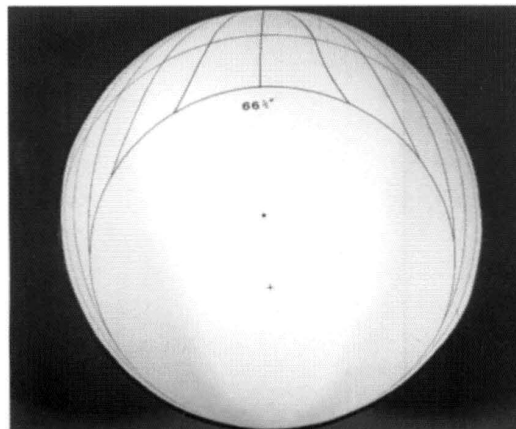
40°



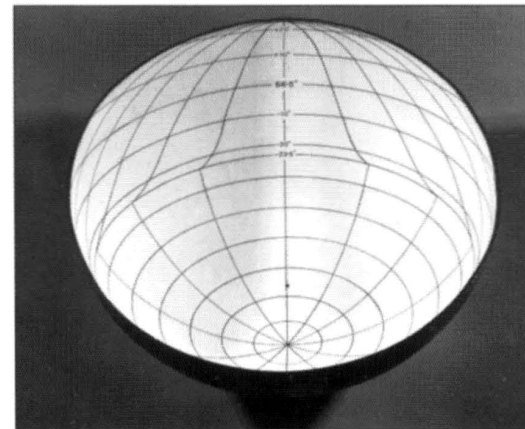
50°



60°



66.5° (Vertical view)



66.5° (Oblique view)

drawn. They will automatically be small circles of the sphere, parallel to the equinoctial, and their intersections with the rim will graphically illustrate the short period of insolation in winter contrasting with the longer period in summer.

By definition, the seasonal hour boundaries coincide with one twelfth divisions of these three parallel arcs, centred on the noon line. They may be laid out in pencil by trial and error with dividers, and should obviously coincide with 15° intervals of the protractor along the equinoctial. These triads of points may then be connected with smooth curves. The results for hemispheria for sites from 0° (i.e. on the equator) to 66.5°N (identical for the south) are assembled in Fig.7. This limit - the Arctic Circle, 23.5° from the pole - is reached because at this latitude the Sun never sets at the summer solstice and never rises on the day of the winter solstice (if atmospheric refraction is ignored). The 'seasonal hour' therefore loses its meaning - although ancient peoples never had to worry about this!

It will be seen that on the equator we have a pattern identical with the standard latitude/longitude grid, the hour lines being meridians converging on the poles. As (great) circles on the sphere they may be drawn with the aid of a narrow strip of flexible material: I used a length of steel

ribbon cut from a drain cleaner. However, as we move away from the equatorial site the equinoctial semicircle (equivalent to the celestial equator in the sky) no longer passes through the zenith (or its equivalent in the bottom of the bowl), and the difference between the absolute durations of the sunlit intervals at the two solstices increases. It does this very non-linearly⁴ (fig.8.). Geometrically, the result is that, in theory, the hour lines are no longer circles on the sphere. However, the discrepancy within a zone $\pm 23.5^\circ$ of the equinoctial is extremely small at first, and only becomes detectable at latitudes exceeding 45°. The Greeks and Romans making dials south of the Alps would have been unaware of the phenomenon.

At 50° latitude accurate hour lines first require construction with a drawing aid flexible in three dimensions: I used thick electrical wire threaded through heavy-wall vinyl tubing. By 60° the asymmetrical sigmoid nature of the hour lines becomes clearly apparent: technically they are 'curves of double curvature on the sphere'^{21,22}. The extreme situation is reached in the Arctic Circle at 66.5°, with the winter ends converging abruptly on the pole and the summer ends terminating 23.5° below. This summer solstice sun never sets, so a complete circle can be drawn in the bowl, just touching the rim at one point. Below this complete circles can always be drawn, so the seasonal hour is not applicable

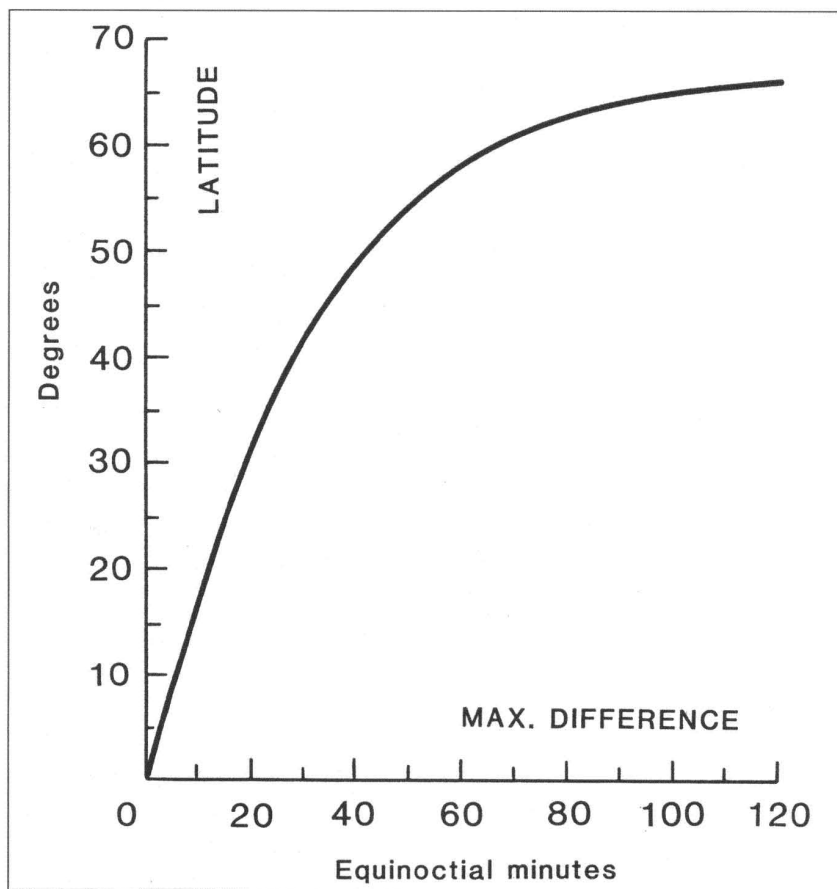


Fig. 8. Difference between the longest and shortest seasonal hour as a function of latitude.

and the theoretical pattern (although the shadow tip can never fall upon it) reverts to the ordinary latitude/longitude grid.

TO SUMMARISE:

- i) Detailed mathematical analysis shows that the hour lines on ancient hemicyclia are, in theory, **never** arcs of circles on the sphere unless the site is on the equator. Rather, they are sigmoid curves with an asymmetrical sinuosity increasing non-linearly with latitude and abruptly converging on the base of the gnomon. Even at a given latitude the shape varies from hour line to hour line.
- ii) However, for latitudes below 45° the discrepancy is so small that, for practical purposes, it may be ignored. The hour lines may therefore be satisfactorily laid out by connecting triads of points on the equinoctial and solstitial arcs with the aid of a flexible straightedge. If this construction is carried out in an accurate hemispherical bowl it will be observed that the hour curves appear to meet in pairs above the base of the gnomon: this is because their abrupt curvature close to this point is being ignored.
- iii) For sites at latitudes exceeding about 50° the hour lines should be set-out by first drawing the equinoctial, then arcs paralleling it every 5° on both sides to $\pm 30^\circ$, adding $\pm 23.5^\circ$. All these portions of circles are to be divided into equal 1/12 parts either side of the noon line, and the corresponding points connected by shallow sinuous curves. Only the portions between the $\pm 23.5^\circ$ limits are finally inscribed.

CALIBRATION IN GREEK AND ROMAN TIMES

A number of dials in the British Museum were examined with the kind co-operation of the Department of Greek and Roman Antiquities. A number of techniques appear to have been used for their calibration:

- i) The best method would have been to connect triads of points on the equinoctial and solstitial arcs, as described above. This appears to have been done with some high quality dials, for example BM 1936 3-9 1 (Gibbs 3086G). This conical dial was found in 1852 near Alexandria, at the base of Cleopatra's Needle.
- ii) Slight inaccuracy of the bowls could easily have given rise to the impression that all the hour lines constructed as above converged on the base of the gnomon. Some makers therefore inscribed them all the way to this point (e.g. BM 2547, Gibbs 1017G, illustrated in Fig.4). The parts above the winter solstice arc are

incorrect (they do not curve enough) but this did not matter very much since the shadow point never fell there.

- iii) Unfortunately, this led some less knowledgeable (or less careful) makers to shorten the calibration process by dividing only the lowermost summer solstice arc into twelve, and then joining these points to the base of the gnomon with the aid of a flexible straightedge. (e.g. BM 2548, Gibbs 1050G, Cousins³¹; and BM 2545, Gibbs 1056G, note 32.) Even in Mediterranean latitudes this gave rise to a poor dial.

THE LEICESTER HEMICYCLIUM

The city of Leicester is built on the site of a prosperous Roman town, rich mosaic floors occasionally being uncovered 2 - 3 metres down during building works and excavations. Unfortunately, only the brick remains of baths remain above ground, being known (for no very clear reason) as 'Jewry Wall'. The Roman forum is nearby, but lies beneath a major road intersection and hotel development. A museum alongside displays mosaics and other local artefacts. The town was for long believed to be called 'Ratae Coritanorum' ("Meeting Place of the Coritani") by the Romans, but the discovery of an inscribed sherd has suggested 'Ratae Corieltauvorum' might be more correct. Either way, the full name was so long and clumsy that the Romans themselves commonly abbreviated it to 'Ratae'.

A 'Leicester Time Trail' is being designed with the aid of lottery funds, so it was considered appropriate to reconstruct a monumental 'public' hemicyclium, delineated for the latitude of the city, such as might once have graced the forum. This is shown in Fig.9. Sculpted in Clipsham stone by Rattee and Kett Ltd of Cambridge, it is now installed in the above mentioned Jewry Wall Museum. The bronze gnomon is 12" long, ball-ended for public safety. Roman numerals, and visitor-operated spot lamps to produce shadows simulating different times and seasons, are provided for the instruction of the many school parties that visit the museum.

Another modern hemicyclium, installed outdoors, may be seen in Ireland³³.

THE EQUAL-HOUR HEMICYCLIUM

There is no reason why the hemispherium, hemicyclium, or any projections of them³⁴, should not be calibrated in the modern equal-hour system: in fact it is much easier. The equinoctial and solstitial arcs are drawn as before, but the hour lines are simply 15° meridians about the polar axis, analogous to the ordinary latitude/longitude grid. The

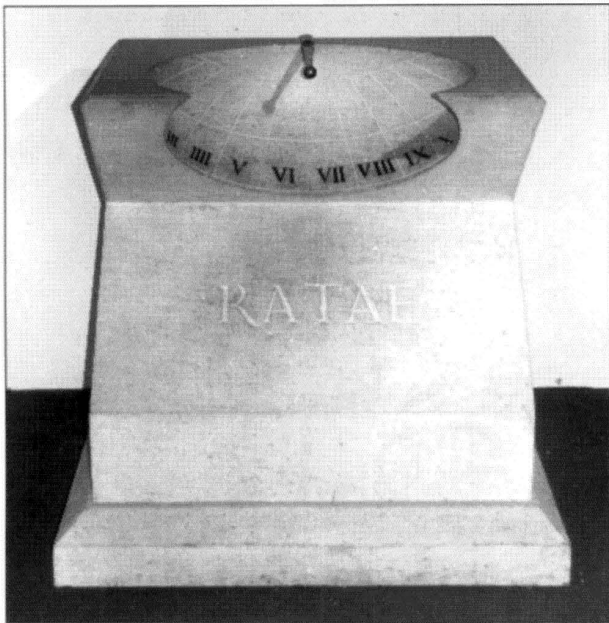


Fig. 9. The Leicester hemicyclium, embodying Roman numeration. (Lat. 52.5°N. 81.3 cm wide, 76.0 cm high, 63.5 cm deep).

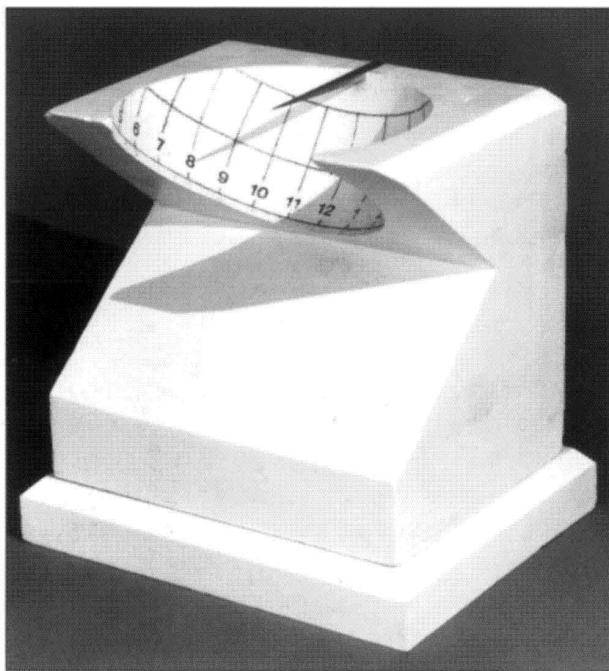


Fig. 10. Plaster model of a hemicyclium calibrated in equal hours.

result is pictured in Fig.10. It will be noted that any numerals must be placed **on** the hour lines, and it must be made clear that time is indicated by the shadow of the **tip** of the gnomon.

ACKNOWLEDGEMENTS

I wish to thank Professors A. M. Snodgrass and C. F. D. Moule, and Dr D. G. J. Shipley, for invaluable assistance with the spoken forms of greek numerals.

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6. M. Vitruvius Pollio, *De Architectura*. Before 27 B.C. Trans. F.Granger, *On Architecture* (Loeb Classical Library, London, 1934, 2 vols) II, 254-257.
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8. Sometimes associated with Aristarchus of Samos, who flourished around 280 B.C. But there is much confusion between hemispherium and hemicyclium, whether Berosus was the inventor, and whether he was a Chaldean priest, a contemporary of Alexander the Great (356-323 B.C.), or lived on the island of Cos around 270 B.C.
9. D.J. DeSolla Price, 'Automata and the Origins of Mechanism and Mechanistic Philosophy', *Technology and Culture* **5** (1964) 9-23.
10. A few other reconstructions of early dials also employ a small ball on a slender support as the gnomon, e.g. the dials on the Tower of the Winds in Athens, where ball gnomons were inserted in the empty sockets in 1845. However, although less dangerous, there is no proof that such gnomons were ever used in ancient sundials.
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12. "If you put your nose pointing to the sun and open your mouth wide, You will show all passers-by the time of day." *Anthologia Graeca*, Book XI, epigram 418. Ascribed to the Emperor Trajan, who reigned AD 98-117.
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15. Claudius Ptolemy, *Handbook of Astronomy* (the 'Almagest'). A.D. 139-161. See O.Pederson, *A Survey of the Almagest*, Odense, 1974 and appendix in Gibbs (ref.1).
16. Federico Commandino, *Liber De Horologiorum Descriptione*, Rome, 1562.

17. Christopher Clavius, *Gnomonices libri*, Rome, 1581, and *Astrolabium*, Rome, 1593.
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19. J.B.J. Delambre, *Histoire de l'Astronomie Ancienne*, Paris, 1817, 2 vols. Reprinted by Johnson, New York, 1965. Vol..II, pp458-471.
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22. W.A. Cadell, 'On the Hour Lines of the Ancients', *Proc. Roy. Soc. Lond.* **3** (1830) 18-19.
23. T.S. Davies, 'An Inquiry into the Geometrical Character of the Hour Lines upon the Antique Sundials', *Trans.Roy.Soc. Edin.* **12** (1834) 77-122. The promised work on application to actual dials never appeared.
24. W.A. Cadell, 'Answer to Prof. T.S. Davies's Complaints Respecting His Paper on the Hour Lines of the Antique Sun-Dials', *Edinb.New Phil.Journ.* **18** (1835) 166-167.
25. G. Bilfinger, *Die Zeitmesser der Antiken Völker*, Stuttgart, 1886.
26. H. Diels, *Antike Technik*, Teubner, Berlin, 1914. Reprinted Zeller, 1965.
27. J. Drecker, 'Die Theorie der Sonnenuhren', in E.von Bassermann-Jordan (edit.) *Die Geschichte der Zeitmessung und der Uhren*, Berlin, 1920. Band I., Lieferung E. Also published independently, Berlin, 1925.
28. O.Neugebauer, *The Exact Sciences in Antiquity*, 1952. Reprinted Dover, New York, 1969.
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30. O.Neugebauer, 'On Some Aspects of Early Greek Astronomy', *Proc.Amer.Phil.Soc.* **116** (1972) 243-251.
31. F.W. Cousins, *Sundials*, Baker, London, 1969. p.25.
32. It is understood that this dial, with its unusual decoration of stylized lions, will form part of the *Story of Time* exhibition at Greenwich, 1 Dec 1999 - 24 Sept 2000.
33. D. Shackleton, 'The Hemispherium, or Dial of Berosus, in Anna Liffey Garden, Lucan, Co.Dublin', *Bull. BSS* 1998 No.2, 40-41.
34. M. Lennox Boyd, 'The Holker Dial', *Bull.BSS* 1992 No.3 37-43.

To be continued as Part 2: The Conical Dial and Other Forms

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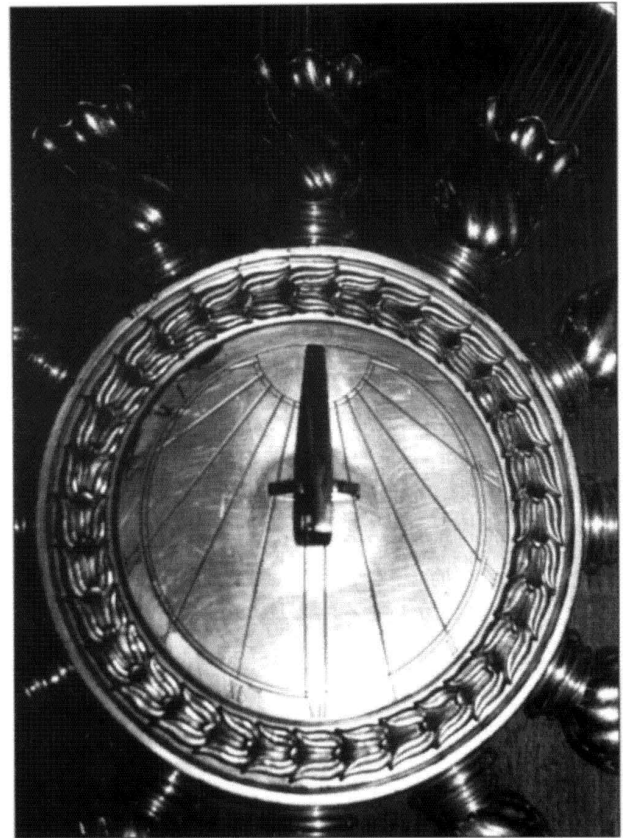
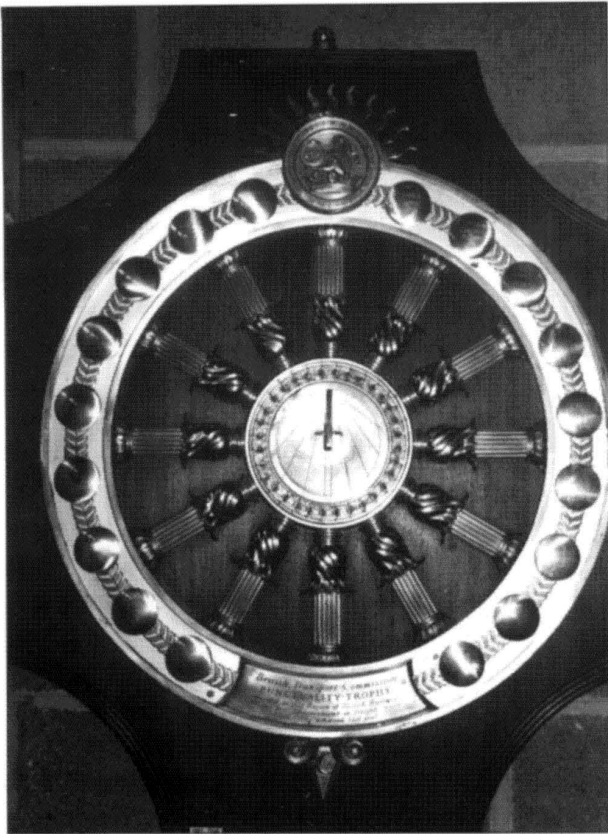
RAILWAY TIME

JOHN WALL

The National Railway Museum at York has this year opened a £4 million extension titled 'The Works'. Part of that extension - 'The Warehouse' - now houses the multitude of objects formerly held in store. For the first time they are open to public view - an Aladdin's Cave packed with national treasures and railway memorabilia. Among them, hanging on a pillar, is a large shield inscribed: 'British Transport Commission PUNCTUALITY TROPHY. Awarded to this Region of British Railways for the best improvement in freight train timekeeping last year'. The centrepiece of this handsome trophy is a silver sundial with a stylised style (if you will pardon the expression). Hour lines radiate from the root of the gnomon which are correctly labelled (in Roman numerals) from 7.00 a.m. to 5.00 p.m. Between the sundial and an outer silver ring are twelve fluted columns which radiate from the centre to simulate the hour lines on the face of a clock. The ingenious designer of what is truly a work of art has also incorporated part of the wavy corona of a golden sun at the top and a tiny silver crescent-moon at the foot to reinforce the overall theme of Time.

As a recognition of and a reward for, punctuality, the choice of a sundial for the centre is highly appropriate, for nothing could be more punctual than the sun. The annual winners of this award have their names and the date inscribed on one of eighteen silver roundels on the outer ring, except that only seven are occupied - from 1956 to 1962, when the writ of the British Transport Commission no longer ran. (It is gratifying to see that of the six Regions my own, the North-East, secured the trophy on no less than three occasions!).

There is a certain irony in the choice of a sundial for a Railway award. A sundial, of course, records time as it appears from the position of the sun - Local Apparent Time. Before the advent of the Railways every town and village kept its own 'Local Mean Time', the mean of the fluctuations of Local Apparent Time, as recorded by a clock or watch. The result was that every place on the railway network was observing its own time, according to the formula 'one degree of longitude = four minutes of time'. This localisation of time was incompatible with the assumption that 'time' was uniform throughout the land, without which



The Trophy as a whole, and the central (sundial) portion

railway timetables could not operate. It was this factor more than any other which led to the adoption of Greenwich Mean Time as the standard for the country as a whole in the 1830's. Indeed, GMT was soon referred to as 'Railway Time', especially after the introduction of the electric telegraph (invented in 1836) by the Railways, which enabled the instant communication of a uniform time throughout the system. It was the adoption of 'Railway Time' which killed off reliance on Local Clock Time, and therefore also, indirectly, the use of sundials for regulating it.

This Punctuality Trophy neatly combines two of my abiding interests—Railways and Sundials. I would be interested to learn of any functional sundials on railway property, now or in the past, and of symbolic sundials incorporated in trophies and the like elsewhere.

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BOWL DIALS - A BRIEF COMPARISON IN DEPTH

JOHN MOIR

The title above is not as anomalous as it first appears, since it is the variation in the actual depth of bowl dials that I wish to consider here. In particular, how does the hemispherical bowl dial compare, aesthetically and gnomonically, with the cut-down version, or shallow bowl dial, as I will refer to it hereafter.

AESTHETICS

As far as this contentious subject is concerned, I realise that one man's meat is another man's poison, so I will not dwell

too long on it, other than to ask the reader to consider the two dials shown in Figs 1 and 2.

Fig.1. shows a rare bronze scaphe dial by Georg Hartman Nuremburg, dated 1547; Fig 2. shows the Holker sundial designed by Mark Lennox-Boyd, previously the subject of an interesting article (Bull. 92.3). As for preference, I'd put my own money on the Holker dial, for the following reason. Although they are both objects of great elegance and fine craftsmanship, the shallow bowl exhibits an open

user-friendly hour-scale, whereas the bronze dial, with its greater depth, seems to want to keep its secrets to itself. In the world of architecture, there is an expression “Form follows function”, which has equal significance in the dialling world. If any object, in fact, functions well, then we are more inclined to appreciate its beauty.



Fig.1. Bronze Scaphe dial, 1547

GNOMONICS

The gnomonics of the hemispherical bowl dial are quite basic, and easily visualised by thinking of the associated full sphere as being the earth itself, whose centre is the tip of the gnomon. Thus the hour and declination lines are analogous to lines of longitude and latitude, which simplifies the task of delineation. Hemispherical dials, and in fact all concave dials where the nodus and rim of the dial lie in the same horizontal plane, give us an additional bonus. Even when there is no sun, we can find the times of sunrise and sunset by noting where the hour and declination lines intersect at the rim. In Fig.2., we can clearly see that the sunset is at 6pm at the equinox, for instance.

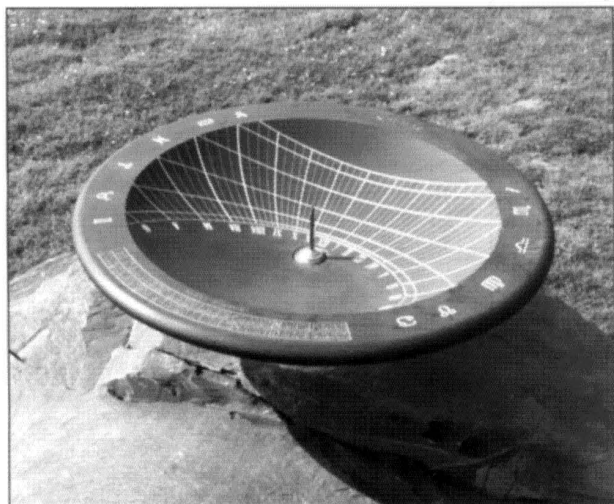


Fig.2. The Holker Sundial (photos by R. Sylvester)

The gnomonics of the shallow bowl are a little more complicated than those for the hemispherical bowl. We can think of it as one whose gnomon fails to reach the centre of its notionally extended full sphere. In Fig.3. we see the bowl dial at the Horniman Museum¹, which was delineated by Dick Andrewes. At first sight it is not entirely clear whether this is a hemispherical or a shallow bowl dial, but in actual fact it is a shallow bowl, since the gnomon's tip lies some distance below the centre of the notional sphere. No doubt there are several different ways to delineate shallow bowl dials, but I prefer the following. Having decided what hour and declination lines are needed, I convert these parameters into angles of Altitude and Azimuth of the sun.

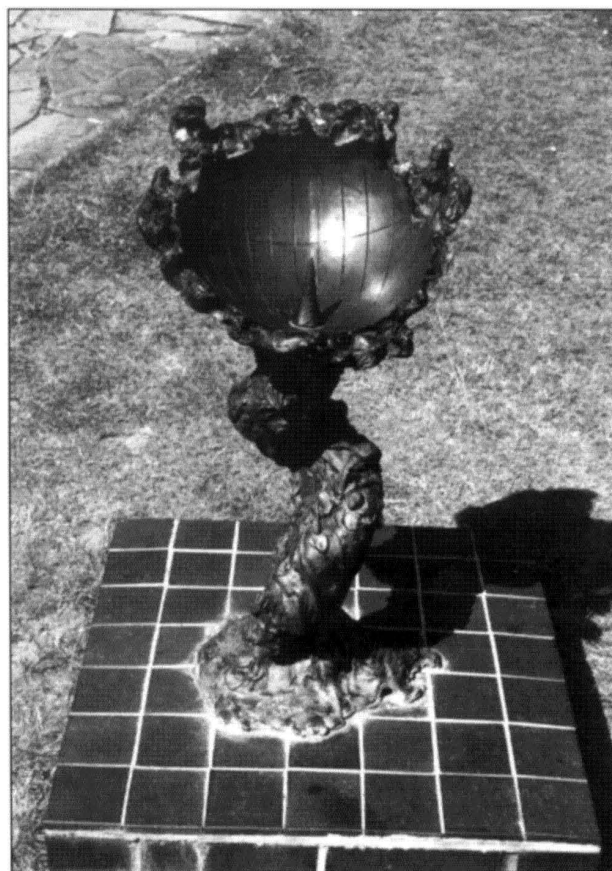


Fig.3. The Horniman Bowl Dial

There are three ways to obtain these angles;

1. by using standard spherical trigonometry formulae².
2. by using a computer programme. One such programme, by Gordon Taylor is entitled SAZ. (I believe David Young can supply the disc (DOS), for £1 inc. p&p).
3. Nautical almanacs sometimes include Alt/Az tables.

Once you have produced a table of Alt/Az figures for your own latitude they can be used as a basis for delineating various configurations of dial, including declining recliners, by applying some fairly easy geometry.

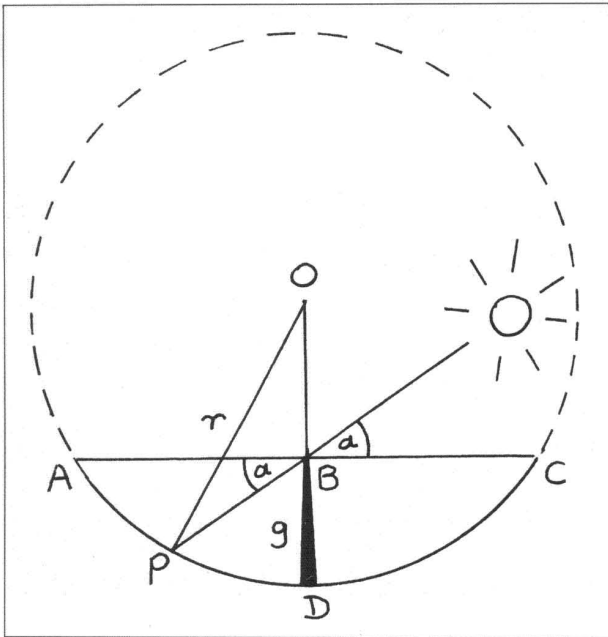


Fig.4. Shallow Bowl Dial - Cross section

Here we are concerned with the shallow bowl type and I have drawn Fig.4 to represent a cross section of the dial at any given azimuth, z.

In this diagram,

- r = radius of completed sphere, centre O.
- g = height of gnomon
- a = altitude of sun.
- ABC = plane of rim/horizon
- P = shadow of tip of gnomon

For any given altitude, a, we require to find the length of arc PD.

First, we apply the Sine Rule to triangle BOP.

$$\text{Thus, } \sin BPO = (r-g) \sin PBO / r = (r-g) \cos a / r$$

This gives angle BPO, and then angle POB, from:

$$POB = 180 - BPO - (90 + a) = 90 - BPO - a$$

Finally, since angle POD = POB

$$\text{Length of arc, PD} = 2\pi r POB / 360$$

We can now replace the "Alt" in our Alt/Az Table by "length of arc", and are ready to plot the results onto the dial surface. In practice it is useful to fix to the dial a temporary card showing compass bearings; then, using a flexible steel tape, measure the appropriate lengths of arc from the gnomon's root, in the required directions.

ACKNOWLEDGEMENT

By good fortune, several years back, my daughter lived next door to Sue and Dick Andrewes. After I showed an interest in his eye-catching declining wall dial, he took me under his wing and with infinite patience helped me to resurrect my almost forgotten school maths, introduced me to the BSS, and turned my wife into a sundial widow. Sadly Dick is no longer with us, but I shall always remember him with affection and gratitude.

NOTES

1. Unfortunately, most of the dials in the Horniman sundial trail, including the bowl dial, will be inaccessible until the year 2001 at the earliest, due to major improvements to the Museum and gardens.

2. The first formula finds z, which is then used in the second formula to find a.

$$\tan z = \sin h / (\cos \phi \tan \delta - \sin \phi \cos h)$$

$$\tan a = (\sin \phi \cos z + \sin z \cot h) / \cos \phi$$

where ϕ = Latitude

δ = Declination

h = Hour angle

z = Azimuth

a = Altitude

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A SOLAR ECLIPSE SEEN ON A REFLECTED CEILING DIAL

PAUL RAINEY

The spot of light on the reflected sundial at the Centre for Understanding the Environment (CUE) at the Horniman Museum in south London is reflected on to a sloping ceiling from a small square mirror which is, according to one of its makers John Moir, about 10 to 15 mm square. The square mirror is seen to be acting as a pin-hole because the spot of light produced by the sun on it is normally round. Figure 1 shows that near the maximum (about 97% at about 1015 Sun Time) of the recent solar eclipse the spot was, even if not a very sharp crescent, clearly no longer round. The August 11 date is shown on the dial by the position of the spot between the curved summer solstice line and the straight equinox line.

The eclipse produced much more spectacular crescent shaped sun images, Figure 2, outside the CUE building. There the pinholes were the gaps between the leaves of large horse chestnut trees in The Avenue, Horniman Gardens. In this case the distance between "pinhole" and "screen" was of the order of fifteen metres.



Fig.2. Pinhole images of Solar Eclipse, The Avenue, Horniman Gardens.

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Fig.1. Image of Solar Eclipse, CUE Ceiling Sundial, Horniman Museum.

A MERIDIAN LINE IN NORMANDY

JOHN LESTER

The little town of St.Pierre sur Dives which lies about 18km NE of Falaise is well worth visiting for its vast XIII century market hall and the church of the Abbaye de St.Pierre consecrated at the time of William the Conqueror. For those interested in dialling, the church contains an added attraction, a well preserved meridian line crossing the floor obliquely and inscribed with the signs of the zodiac. My visit to the church took place on the longest day of 1999 and just before solar noon (2pm French time). I was ready with camera poised to catch the spot of light coming from a circular aperture in a partly blacked out window as it touched the southern end of the line. The spot edged ever closer but at about three minutes before noon, clouds came over and the spot disappeared for the rest of the day.

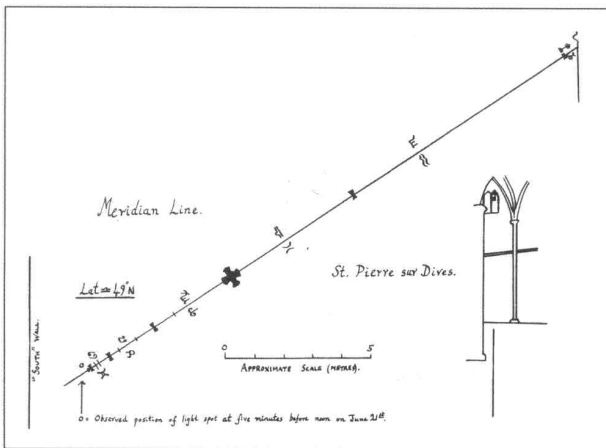


Fig.1. Diagram of Meridian Line, and sketch of window aperture

Nevertheless, after moving many chairs to and fro I was able to make some rough measurements which form the basis of the accompanying sketch. These seem to agree with the fact that the divisions between signs should increase as the winter solstice is approached.

The siting of the signs on the line looks wrong but this is because they are placed more or less in the middle of the period covered by the sign rather than at its beginning. The actual limits of signs appear to be indicated by the small cross at the southern end of the line, the centre of the large cross and the four double wedges. If this is the case, the line must once have continued up the north wall but I found no surviving trace of this. I am unable to explain the intermediate marks, not all of which I was able to record as a funeral procession was imminent.



Fig.2. Southern end of Line



Fig.3. Line: Symbols of Aquarius and Scorpio



Fig.4. Line: Symbols of Sagittarius and Capricorn

The purpose of the large cross mystified me until I re-read Charles Aked's 1997 Andrew Somerville Lecture (Bulletin 97.3) where in Fig.3 he shows part of the meridian line in Santa Maria degli Angeli, Rome, consisting of two brass strips defining the limits of Easter. It is possible that the length of the cross on the line at St.Pierre serves the same purpose.

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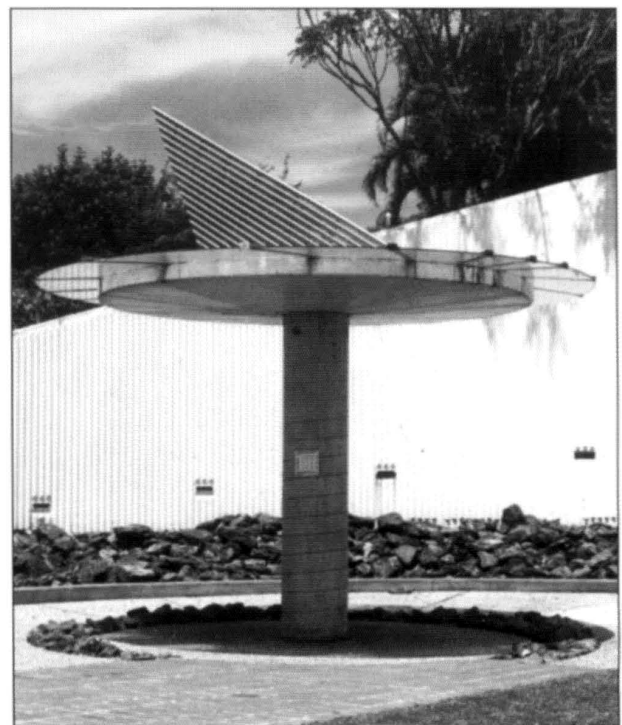
TWO SUNDIALS IN AUSTRALIA

BRISBANE

A sundial in Brisbane, Queensland: photographs from Maurice Kenn

This sundial is situated in the courtyard beside the planetarium of the Mount Coot-tha Botanic Gardens, 3 miles west of central Brisbane. It is a translucent horizontal dial to be viewed from below. The edge of the dial plate is made of frosted glass segments supported by radial spokes which form the hour-lines and carry numerals on their outer ends. The triangular gnomon is made of parallel tubes of small diameter, the upper ends pointing towards the south celestial pole. The EOT correction plate, fixed at eye level to the central support, also indicates the 12-minute subtraction required to give Queensland clock time.

Translucent Horizontal Sundial, Mount Coot-tha Botanic Gardens, Brisbane, Queensland, Australia.





EQUATION OF TIME (MINUTES)				
MONTH	DAY			
	1	8	15	22
JAN	+3	+6	+9	+11
FEB	+14	+14	+14	+14
MAR	+13	+11	+9	+7
APR	+4	+2	+0	-1
MAY	-3	-4	-4	-3
JUN	-2	-1	+0	+2
JUL	+4	+5	+6	+6
AUG	+6	+6	+5	+3
SEP	+0	-2	-4	-7
OCT	-10	-12	-14	-15
NOV	-16	-16	-15	-14
DEC	-11	-8	-5	-2

APPLY THE ABOVE CORRECTION TO THE TIME SHOWN BY THE SUNDIAL. THEN SUBTRACT 12 MINS. FOR LOCAL TIME.

The Sundial at Brisbane: Gnomon and EOT table

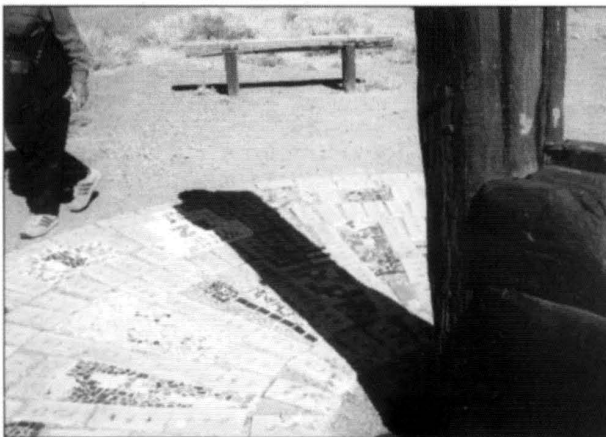
MARREE

A sundial at Marree, South Australia: photographs from Dorothy Holland

Mrs. Dorothy Holland of Sydney, Australia, writes:

'At Marree I saw this camel sundial...Marree as you probably know is at the southern end of the Birdsville Track, south-east from Lake Eyre South. [The Birdsville

Track runs 600km across the outback, north from Marree in South Australia to Birdsville in Queensland]. Marree in the 1800's was the staging post for camel trains (often with 70 camels) used to transport heavy goods to stations in the area; 1500 camels worked out of Marree in its heyday in 1900. Until 1980, Marree was a major station on the Ghan Railway to Alice Springs. The Sundial appears to be made out of railway sleepers.'



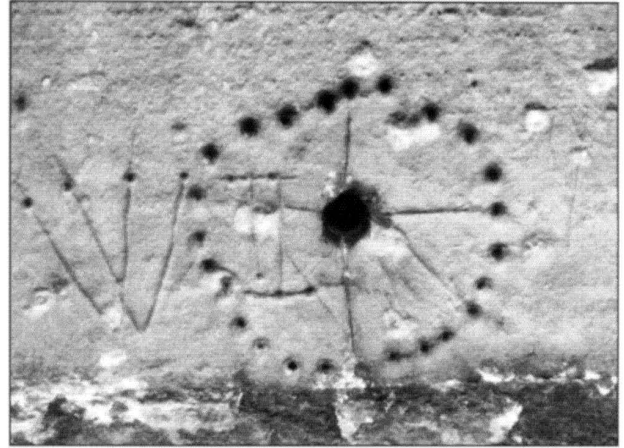
Camel Sundial at Marree

THE MASS DIAL GROUP AT SOUTHWELL 17TH - 19TH SEPTEMBER 1999

JOHN LESTER

Twelve of us met at the old and comfortable Saracen's Head with the aim of searching for Mass Dials in the neighbouring parts of Nottinghamshire, Leicestershire and Lincolnshire. Though there were old members whom we missed, notably David Young, Edward Martin and Margaret Stanier, we were able to welcome new ones. At the Friday evening briefing, teams were formed, itineraries allotted and methods of recording discussed.

The weather on Saturday lacked sunshine but remained dry, so teams were able to complete or even exceed their allotted tasks without difficulty and to return to Southwell in time for a conducted tour of the central tower of the Minster. The principal aim of this tour was to see a small sundial mounted just outside one of the windows of the clock chamber and used in former times to regulate the clock. It was photographed and recorded (horizontal, height above ground level 70 ft) before we were introduced to the mechanical wonders of the tune-ringing machine and the clock itself. After a further climb we were able to experience the chiming and striking of five o'clock in the bell-chamber; then, with ringing ears, we emerged on to the roof. Ground level was regained many spiral stairs later after a visit to the ringing chamber.

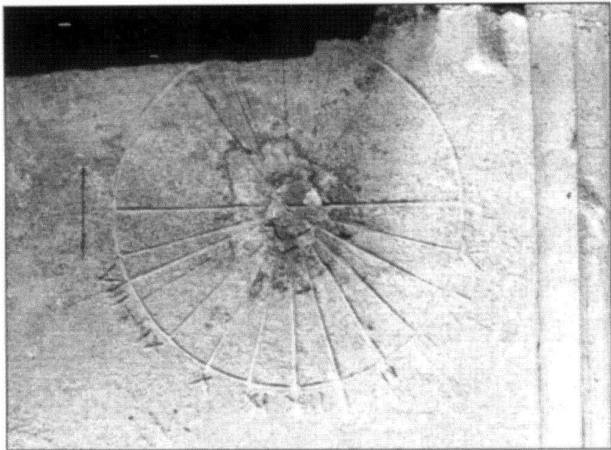


Woodburgh Church, Dot Dial, diameter 50mm

Our guide in all this was Mr Meredith, formerly Head-verger of the Minster. He returned, after dinner at the hotel, to give us a very interesting lecture on Southwell Minster illustrated by his own excellent slides. From this and his replies at question time it was clear that here was an enthusiast who really knew his subject.



The Group at Upton Hall Horological Institute



Mass dial at North Collingham

On Sunday morning there was time for visits to a few more churches before we met out at 11am for Upton Hall, headquarters of the British Horological Institute. After a group photograph taken as we stood around Mr Benoy's unusual sundial (dare one call it a refracting jamjar equatorial?) we were taken inside the building by Mr Geoffrey Evans who explained to us some of the mysteries of that avant-garde invention, the clock. The collection of clocks and watches at Upton Hall is comprehensive and its library unsurpassed. With Mr Evans as guide, our tour of the collection covered everything from the wood and iron movements of primitive church clocks to an atomic clock of our own era. At the end it was a surprise to find that we had been in the building for two hours, so engrossed were we in all that we had heard and seen.



Dial on belfry windowsill, Southwell Minster

All too soon it was time for the party to break up and return home. It had been an enjoyable and productive week-end spent in good company. In all, 55 churches had been visited of which 36 had mass dials. Sixty-three mass dials were recorded, a goodly number though few were of outstanding quality. Also 7 fixed dials were recorded. That it had all been so enjoyable and had gone without a hitch was entirely due to Tony Wood, to whom we offer our warm thanks.

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A REMOTE READING SUNDIAL

DAVID YOUNG

Since I became interested in our subject in the early eighties I had wanted to combine in some way my earlier interest in electronics with that of sundials. Having an unusual quiet period as secretary of the society in January last year, and before gardening jobs became essential, I thought I should make a start. The project I envisaged was to make a remote reading sundial with some kind of light detector, which fed into a clock-like display. I had vaguely remembered an article in one of our early Bulletins using optic fibres but I did not want to look round for any other literature as I wished to design this sundial without any preconceived ideas.

I started off by abandoning the idea of using a horizontal or vertical dial as the basis for my design and soon decided that an equatorial with its linear response of 15 degrees per hour would be the best bet. The first decision was to use a circular biscuit tin tilted to the plane of the equatorial, and

round the edge cut a series of slots at 15 degree intervals and in an inner ring a detector opposite each slot that could be coupled by a cable to a display panel. In practice, light entering by adjacent slots caused serious problems and after some rethinking I decided that radial divisions would be necessary and with my somewhat limited workshop facilities it would be better to make the whole dial in wood; after all, the only subject in school that I came top in was woodwork! Two semicircles of plywood were cut, sandwiching hardwood divisions, and painted matt black to minimise internal reflections (Fig 1). As can be seen I had limited my dial to one hour intervals giving an accuracy of +/- half an hour, and a range of from 6 a.m. to 6 p.m. I realised that the thickness of the wood divisions would be critical to give the 15 degree acceptance angle needed for the detectors. The wood I had for the divisions proved to give a much larger angle and it was at this stage that I had the idea of making this angle exactly 22.5 degrees, keeping

the 'hour' light active for 90 minutes. This would mean that a single light would be "on" from 15 minutes before each hour until 15 minutes past, so two adjacent lights on at the same time would indicate the half hours. This simple change in my original intention would double the overall accuracy of the dial at a stroke!

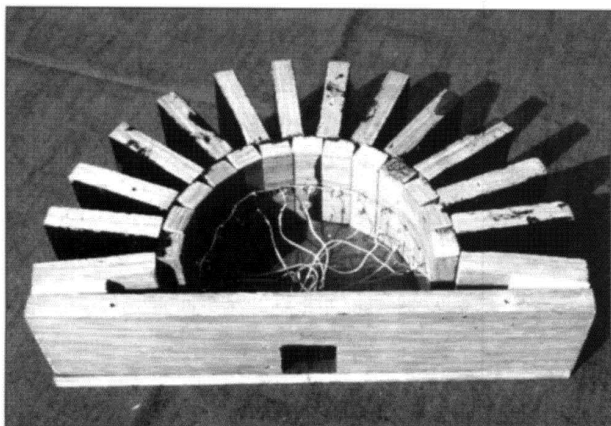


Fig.1. The Works

Some experiments were then made to determine the best type of photocell to use as a detector. After various trials, 5mm phototransistors were chosen; they were not too sensitive to ordinary daylight and being small they would give a sharper "on-off" time than, for instance, a photoconductive cell. They also exhibited a very low dark current of just a few nanoamps: important, as there would be a 24 hour a day current drain. When finally installed these were found to give occasional false indications due to reflections from the matt black surfaces of the divisions, so small filters were made from exposed photographic film to reduce their sensitivity while still positively responding to direct sunlight. All thirteen phototransistors were wired with a common anode and connected via a fourteen way cable to the display unit.

The display takes the form of a clock face (Fig 2) with twelve LED's (light emitting diodes). Each of these has its own simple amplifier using a simple transistor circuit. They are powered by a small 9 volt battery which should give several weeks' service under average conditions. However the current drain is only a few milliamps, so the addition of a small solar panel would make the dial independent of batteries.

At this time I had been trying to decide whether to configure the dial to read Greenwich time or Summer time and also whether to use red or green LED's - it was a question of which would show up the best in daylight conditions. It suddenly occurred to me that I could solve both problems at the same time - using a thirteen pole two way switch I could wire the LED's which were dual colour

types so that by the turn of a knob I could show GMT in red and BST in green !

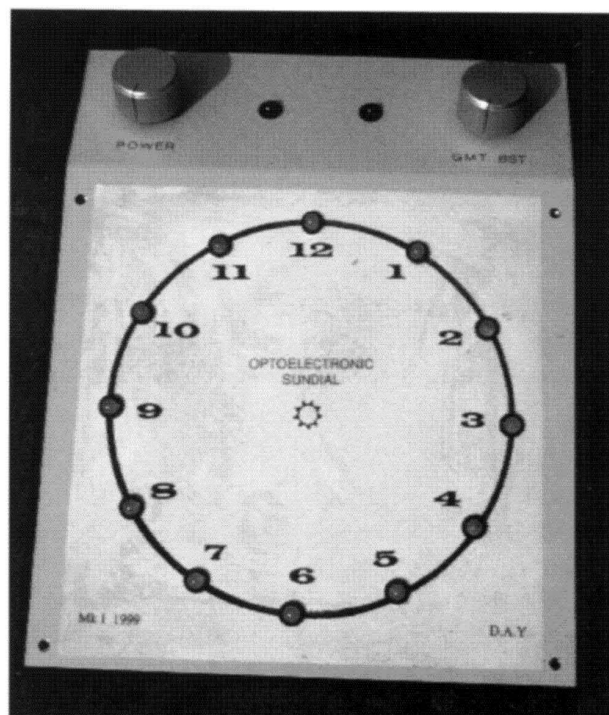


Fig.2. The Remote Display

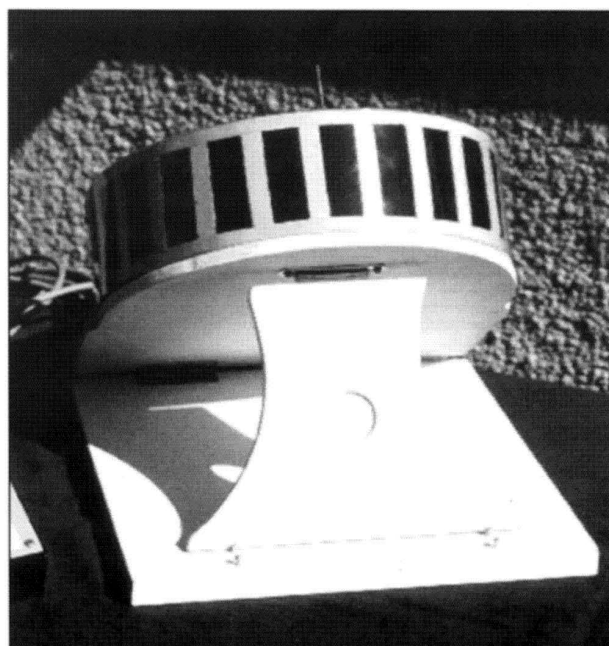


Fig.3. The Finished Sundial

Up to this time the dial had been tilted by resting one edge on a substantial book: Mrs Gatty was very appropriate and just the right thickness! Now I had to make something a little more permanent. This was done by mounting the dial on a plywood flap hinged to a solid baseboard, thus giving a simple adjustment for any Northern latitude. The intention was to screw the dial firmly on the flap, but then yet another idea came to my mind. This was to fix the dial with a single bolt at its centre so that it could be turned in

the equatorial plane. Thus, with the aid of a calibrated scale it was possible to allow for longitude and also to set the dial manually for the equation of time, making GMT and BST a reality. Cynics may say that with a dial reading to the nearest half hour this innovation is overdoing things, but it must be remembered that the combined effect of longitude and E of T could well make a difference of over 30 minutes in some parts of the country.

A certain amount of fine tuning was necessary when testing out the dial and with the display unit in the house it was necessary to find an easy way to set it to a true meridian on each test occasion. In the end this was overcome by fixing

a steel pin as a gnomon in the sloping top surface of the dial and marking out a traditional equatorial dial round it. Thus by turning the baseboard to read the correct clock time I would know that it would be pointing due south. A final coat of paint and the fixing of a strip of perspex round the edge of the dial completed the job (Fig 3). Mk II using only two detectors and accurate to 5 minutes is now on the drawing board. Whether it works will be another story!

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DIAL DEALINGS

MIKE COWHAM

The second half of 1999 has had its usual crop of interesting sales. The Autumn is a traditionally good time to bring out the better pieces, when the holidays have been forgotten, and just before Christmas.

The first large sale was at Sotheby's on 9 November. There were 15 dials on offer from the fairly simple to somewhat grander. Generally the prices realised were quite low, and some good bargains were found by the more discerning buyers.

There was a good ivory diptych dial from Hans Tröschel of Nuremberg, c1600. It was sold just above its lower estimate at £2200.

The dial that really caught my attention was signed *G. Meuris F(ecit), Bruxelles, c1690*. There are very few dials from the Low Countries, and those that are seen are usually quite early, and often by important makers. Meuris is a little known maker, and according to the catalogue notes, has only 7 instruments with his name recorded. This dial was not spectacular, but was a good example of early Flemish work. In the event it sold just below its lower estimate at £1800.

A *Le Maire Fils A Paris* horizontal string gnomon dial was sold at only £900, just under its lower estimate. Noon Cannon sundials have always been popular with collectors, although little more than curiosities. I wonder how many people actually load them with powder to hear them 'report' the noon hour? These days, I would guess that maybe a match head or two is tried by their owners, but little more. The French Cannon Dial, Fig. 1., just exceeded its top estimate at £1600.

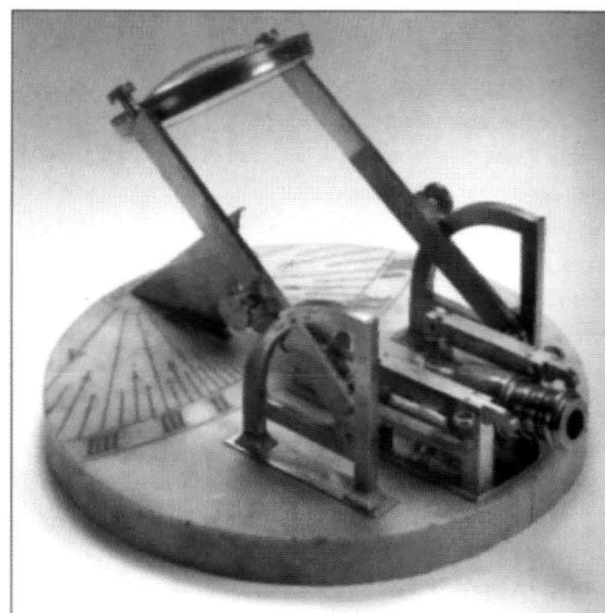


Fig.1. Noon Cannon Dial.

The Sotheby sales often closely follow the Scientific Instrument Fair, and they usually put on a special viewing of their instruments for that day, making a visit doubly worth while.

Sotheby's have recently started 'on line' auction sales, and are offering some sundials in their scientific instruments listing. Generally these 'on line' sales are for the lower priced lots, hopefully making these dials more affordable. The sale may be accessed at www.sothebys.amazon.com

A high profile sale was held by Sotheby's, New York, on 2 December. This was to sell a few items from the Time Museum of Rockford, Illinois. The majority of their fine collection, amassed over the years by the museum's founder, Seth Attwood, was sold to the Adler Planetarium

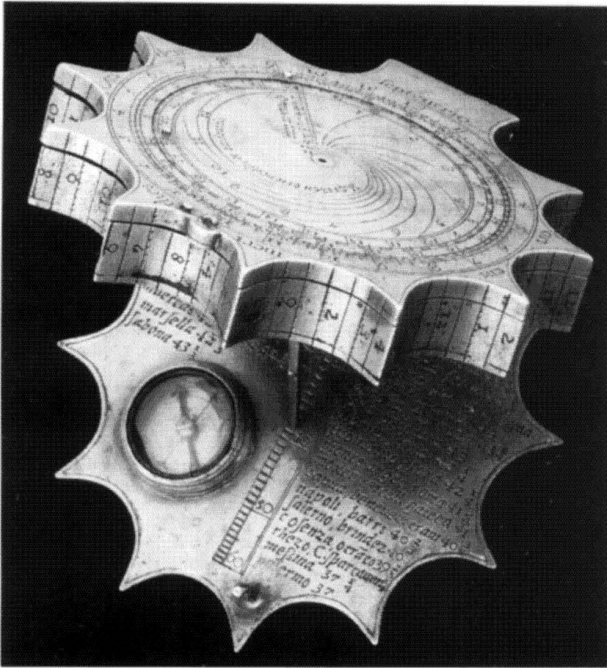


Fig. 2. Gilt Brass Star Form Polyhedral Dial.

in Chicago. They kept a few items back for public sale, some of which were quite spectacular. The collection in this sale consisted of clocks, watches, sundials, astrolabes, and other time telling instruments. There were only 80 lots, of which just 3 were sundials, plus two astrolabes. One dial of particular interest (Fig.2.) was 'A Gilt Brass Star Form Polyhedral Dial' by Peter Aggerius, thought to have been made in Madrid, c1560. It was spectacular having 11 separate scaphe dials around its periphery. Its estimate of \$40,000 to \$60,000 was considerably exceeded, the dial making a healthy \$123,500.

A 'standing mechanical equinoctial ring dial' by Richard Glynne, made for the Earl of Ilay, c1720, sold for a staggering \$1,047,500, surely a new record price for any sundial? This price also doubles the top estimate given.

Christie's sale of 9 December had some very fine dials included. Some of the lots were unsold items from their April sale, this time with somewhat reduced estimates.

A dial by *Henricus Sutton fecit 1659*, (Fig. 3.), had a broken gnomon, but was clearly of the rather rare 'double horizontal' type. It fetched £920 in spite of its condition.

An unsigned ivory diptych dial, (Fig. 4.), was an early dial of its type, (early 17th Century), being attributed to Dieppe. It failed to reach its reserve and was unsold.

An early 17th-Century ivory diptych dial from Nuremberg signed TD (Thomas Ducher or Tucher), (Fig. 5.), was a particularly fine example of its type making £6900.

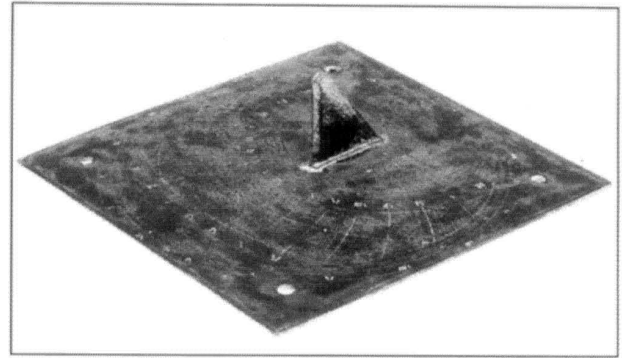


Fig. 3. Henry Sutton Double Horizontal Dial.

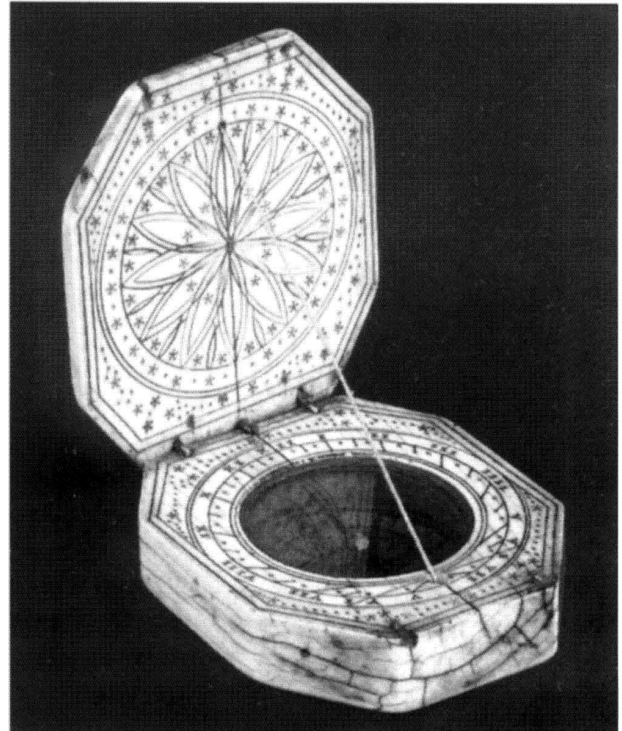


Fig. 4. Early Unsigned Ivory Diptych Dial.

Also included in this sale catalogue were some lots offered at Christie's Monaco, 10 December, being part of the collection of Delbée-Jansen. The star item there was a large 'Standing Mechanical Universal Ring Dial' by John Rowley of London, made in the 18th-Century. (Fig. 6.) Its estimate of FF500,000 - FF800,000 was comfortably exceeded, it selling finally for FF2,102,500. (approximately £200,000).

The Scientific Instrument Fair on 31 October was held as usual in the Portman Hotel, London. It is always a good hunting ground for the less expensive dials. Several BSS Members attended, and were seen buying a selection of instruments and books.

There was one dial that was missed by all. It was a magnetic compass dial, of the type that is self orienting. (Fig. 7). These dials are not uncommon, and one would expect them to carry a relatively low price tag, around



Fig. 5. Ivory Diptych Dial by Thomas Tucher.



Fig. 6. Standing Ring Dial by John Rowley.

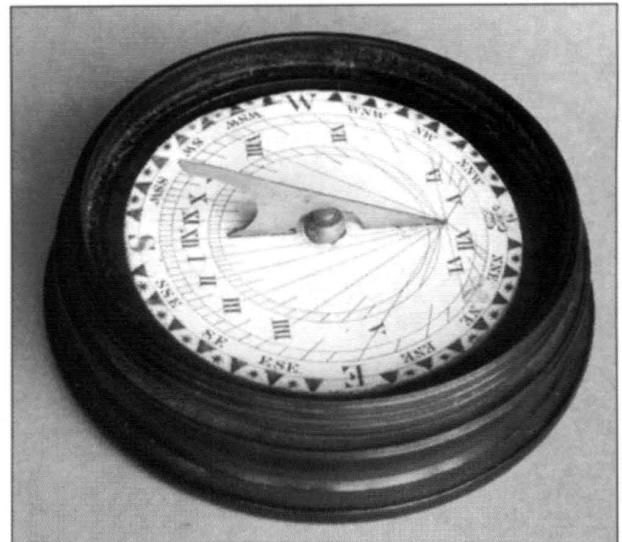


Fig. 7. Magnetic Compass Dial probably made for Rio de Janeiro.

£100. So, what made this one so interesting? Look again at the picture. Immediately it should be obvious that it was made for a low latitude, from its low gnomon angle. What is not so obvious at first glance is that the hours on its dial plate run around anti-clockwise, meaning that this dial was made for the Southern Hemisphere. Any Southern Hemisphere dial is quite rare. Its gnomon angle of 22.5° can only place it in one of three areas, Australia, South Africa or South America. The 22.5° S line however (nearly) cuts through only one city of note - Rio de Janeiro. Further evidence for this was obtained from the magnetic declination of its compass, which was set to somewhere near zero. The dial itself was probably made around 1820, and records of magnetic declination at that time show that only Western Australia or Eastern South America are possible. Therefore it is most probable that it was made in England for sale to a customer in Rio, where there was quite a large British population at that time.

FORTHCOMING SALES

* indicates that the date has not yet been finalised. It is advisable to check the date by calling the numbers given.

Christie's South Kensington.	Jeremy Collins - 0171 321 3149 13 April. Exceptional Scientific Instruments. 1 June. (17 October. Los Angeles.) 7 December.
Sotheby's	Catherine Southon - 0171 293 5209 6 April*, October/November*. Internet Auctions www.sothebys.amazon.com

Philips James Stratton - 0171 629 6602
ext 364
29 February, 20 June*,
12 September*, 5 December*.

Bonhams Alexander Crum-Ewing - 0171 393
3950
1 March, July*, November/
December*

Scientific Instrument Peter Delehar - 0181 866 8659
Fairs, 28th Fair - 16 April,
Radison SAS 29th Fair - 29 October.
Portman Hotel,
London.

ACKNOWLEDGEMENTS

I would like to thank the following for permission to use their photographs. These remain their copyright. Sotheby's London, Fig. 1., Sotheby's New York, Fig. 2., Christie's South Kensington, Figs. 3, 4. & 5., and Christie's Monaco, Fig. 6.

LUX UMBRA DEI

DOM GERALD CUNNINGHAM

On Old House Wall	No chiming bell
Surveyed by all,	Lets loose all hell!
Dom Leo's child	No sounding gun
(Superbly styled)	Affronts ear drum!
Gnomonic Clock!	Your silent work
No tick, no tock,	No monk does irk,
But Phoebus' rays	Nor youth doth wean
(On sunny days)	From study keen!
Tell hours that pass	No holiday
(So swift, alas!)	E'er comes your way.
While umbra moves	You ply your trade
To diff'rent grooves.	In autumn shade
	And winter's snow
	Or spring's new glow.
Diana's smile	In summer's heat
Does not beguile,	When clatt'ring feet
Nor starlight clear	Abroad have gone,
Bring you much cheer.	You soldier on.
The cloudy sky	Forever you
Evokes a sigh!	To mortal crew
But glad you are	Advertisement
When UVR	Of time well spent
Upon you gleams	In humble toil
In brightest beams,	Without turmoil.
And shadow fine	
Proclaims the time.	

This poem by a master at Downside School, Somerset, was inspired by the placing of a wall sundial, designed by another master, Dom Leo Maidlow Davis, on the wall of one of the school buildings. Downside has a special relationship with the British Sundial Society, as described by Jane Walker's article on page 48.

Advertisement



*A colour brochure showing a range of
dials and armillaries in brass or bronze
available from:*

CONNOISSEUR SUN DIALS

Lane's End, Strefford, Craven Arms,
Shropshire. SY7 8DE

Tel / Fax: +44 (0)1588 672126

email: sundials@ouvip.com

Website: <http://www.sundials.co.uk/connois>

EDITOR'S NOTES

DIALERS' GLOSSARY

Readers may be interested to know that the BSS Council has taken up the suggestion put forward by A.F. Baigent in the October issue of the Bulletin (Vol.11, p128) for a Dialers' Glossary. John Davis of Flowton, Ipswich, has made a start on this project.

A BOOK FROM SERBIA

We have received from our member Dr. Milutin Tadić a copy of a book which he has written, called 'Mathematical Geography in Antiquity'. It is in Serbo-Croat, cyrillic script. It is a well-produced paperback with good diagrams

and illustrations, and it is designed as a text-book for first-year students of Geography. There are chapters for example on 'Determining the size of the Globe', 'Determining the Latitude' 'The antique concepts of "climates"', and 'Cartography Projections'. Any reader to whom such a work would be of interest is invited to write to the Editor

ERROR IN ADDRESS

An error crept into the address given for Margery Lovatt, the supplier of back issues of the BSS Bulletin, in Vol. 11, p131, Oct 1999. The second line of the address should be PARNDON Mill. Apologies.

READER'S LETTERS

THE SUNRISE LINE

The answers to Dr Wall's first two questions (Bull BSS 11 iii) are both YES. In amateur radio circles the terminator is known as the grey line. The interest of these amateurs in this phenomenon is because propagation of radio signals over long distances is often greatly enhanced when both stations are on the terminator.

To help them exploit this phenomenon radio amateurs have several tools, of which the most common are these.

1. Customised great circle maps are available for any location. These show the azimuth of the terminator by month.
2. A special globe which shows the terminator at any date can be purchased. The globe contains an electric light and a method of setting the date.
3. A slide rule type of calculator is marketed under the name of The DX Edge. This consists of a Mercator's map and six transparent overlays - one for each of the first six months of the year; then they are turned upside down for the last six months. Each overlay shows the terminator and can be used to find the time of local sunrise/set anywhere in the world. However its main use is to show all the places in the world which lie on the terminator.
4. A PC based version of (3) is available.
5. The GEOCHRCN is a mechanical version of (3).

As grey line propagation may occur for a very short period

of time, less than five minutes, some amateurs solve the problem by calculating sunrise/set times for the target area.

*Gerald Stacey,
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QUEEN ANNE SUNDIAL ADVERTISEMENTS

Over twenty years ago the late Charles Aked and I were involved in a project to index and analyse horological advertisements in English newspapers of the Queen Anne period, transcribed by two American researchers, with a view to publication by the Antiquarian Horological Society. In the event, the quantity of material received turned out to be much larger than expected, and publication had to be abandoned on grounds of excessive cost. The 12½ years of Queen Anne's reign produced no fewer than 1,054 advertisements of horological interest, mostly for lost or stolen watches or watch-cases.

In order to clear the material from my files, since Mr. Aked's death I have produced a word-processed version of the entire text, including transcripts, indexes and commentary. Copies have been deposited for reference in relevant institutions, such as the Horological Students Room of the British Museum.

Only 4 of the 1,054 transcripts concern sundials. In May 1714 a 10-inch square brass dial by Culpeper was wrenched off a pedestal in Hackney by a thief who got over the garden wall; a £10 reward was offered for his conviction. In February 1712 a small dial by Rider of London was stopped on suspicion of having been stolen. A universal dial by

Samuel Watson only 2½ inches in diameter but said to be capable of showing minutes was advertised for sale in December 1711. But possibly of more interest is the following, from the *Norwich Gazette* of 17-24 April 1708: "Sun-dials for any declination or latitude, for hostels or churches, or any declining wall, with golden or black figures, well painted, durable against all weather, and drawn to perfection, by Robert Smith, in Mr.Monsey's yard near the Unicorn in St.Muries in Norwich, who desires to be serviceable to any gentlemen in city and country. Also horizontal dials."

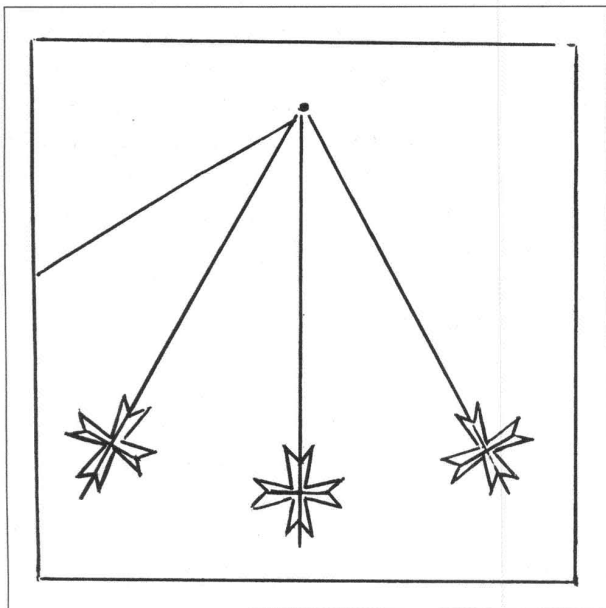
A Norwich friend tells me that 'St.Muries' was probably a misprint for St.Mary's.

*John R. Millburn
40 Stirling Avenue,
Aylesbury, Bucks, HP20 1BE.*

DESIGN OF ANGLO-SAXON SUNDIALS

In his letter to the Bulletin (11 (ii) 99) Tony Wood asked the valid question 'How was a uniform design for sundials in Anglo-Saxon England maintained in communities widely separated by distance and time?'

I think the answer may be found, at least in part, in the organisation of the Anglo-Saxon Church. During the periodic synods the bishops from wide areas, together with the clergy responsible for practical matters, probably discussed the subject of sundials when required, thereby maintaining a degree of standardisation throughout the country.



Design of Anglo-Saxon sundials

Early period sundials, such as those at Escomb, Corhampton and Saintbury, probably originated in Northumbria, but the design may have been influenced by the pre-existing Celtic Church in England. The basic feature of the original sundial, division by four with lines having cross bars, can still be seen in the late period, extended to eight or twelve divisions, although we still do not know why they were so divided.

The sundial at St Leonard's church in Stowell, Gloucestershire, (see Figure) has some of the Anglo-Saxon characteristics; namely, division into four with crosses on the lines, apparently cut on a separate block of stone. But in other respects it seems doubtful. The lines are enclosed within a square, rather than a circle or semicircle, the crosses are wedge-shaped unlike the usual cross bars, and the gnomon hole is in the upper half of the enclosure instead of at the centre. The angle of the side lines from the vertical corresponds with those for the 9am and 3pm lines on sundials showing the equal hours on a 2 x 12 hour system, for the latitude of Stowell, rather than the 45° as on an Anglo-Saxon sundial.

The line below the horizontal on the left hand side is not straight and may have been an afterthought. It is specially marked on some sundials, notably at Kirkdale, and using a horizontal gnomon may have indicated the position of the first shadow of the day at the summer solstice, thus serving as a simple calendar.

It seems unlikely that the Normans deliberately suppressed the Anglo-Saxon sundial; it was merely displaced by the scratch-dial. In some areas the Anglo-Saxon features may have been carried forward into the Norman period, or even beyond, to the Renaissance, which might explain some of the anomalies at Stowell.

(Note on Figure: The stone on which this sundial was carved is broken from top to bottom, with some pieces missing, so the vertical line is no longer visible. The surface is eroded and details of the crosses very faint)

*David Scott
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New Milton
Hants BH22 5HS*

'NEATH THE WESTERN SKY'

I read with interest Dr. John Wall's article "The Sunrise Line" (October Bulletin). It was two of the lines he quoted from that fine hymn "The Day Thou gavest" by John Ellerton.

The sun that that bids us rest is waking
Our brethren neath the western sky

that reminded me of A.P.Herbert's amusing comments on the use of the word 'western', in his book *Sundials Old and New* (Methuen, London 1967). Herbert wrote;

"The word western puzzles me still." He then went on to point out that if it is 8 p.m. at Greenwich "when the summer sun may be said to bid us rest" then "due west at New Orleans it is 2 o'clock and at New York 3 o'clock in the afternoon, when the sun except for a siesta can hardly be said to be 'waking our brethren'. Due East at Calcutta it is only 2 a.m, too early. In Sydney, though, it is 6 a.m. and in Wellington, New Zealand, nearly 8 a.m. So 'southern' would be a better word".

I find that I agree with Herbert that 'western' is strictly inaccurate, and I accept his amendment. Nevertheless there is a bit more to consider. Having rejected Calcutta time as being too early, he overlooked far eastern longitudes but still in the northern hemisphere where the local time would be one where the local population could be said to be 'waking'.

The Russian Federation has 11 time zones. If we consider Zone 11 where there is a town named Petropavlovsk,(longitude 158° 30' east, which just makes its way into zone 11 in the Kamchatka region, then there under the eastern sky the clocks would show 7 a.m. when it is 8 p.m. in Greenwich. I do not propose 'eastern' for Herbert's 'southern', because I think 'our brethren' relates better to New Zealanders and Australians than to the inhabitants of places like Petropavlovsk

So whenever I hear this hymn on radio or TV I mentally substitute 'southern' for 'western'. Now you say 'does it matter?' Well, after all sundiallers ought to be the people to get this sort of thing right!

*Claude Lack
32 The Vale
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ECLIPSE 1999

Because of totality of cloud cover, the only photo I took during the 1990 eclipse proved simply that we Brits can be cheerful in the face of adversity. (Fig.1).

My second figure (Fig.2) was copied from a book some years ago, from a photo taken during the 1980 eclipse seen in India. Taken near second and third contact, it shows that the crescent sun has sharpened the shadows in one direction, as would be expected. However, I would have thought that the more vertical fingers would be sharper, not the horizontal ones. Does this mean the picture was printed incorrectly? The numbers printed on the board would be



Fig.1: Rules for using safety glasses-First locate the sun....



Fig.2: Near second and third contact, shadows of our hands sharpen in one direction, as here demonstrated at Hyderabad eclipse camp, 16 Feb 1980

more sensibly positioned if printed on top, so does this reinforce my suspicions? I should be grateful for some light on the subject.

*John Moir
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Wanstead
London E11 2QA*

SUNDIALS AT NEW COLLEGE, OXFORD

HARRIET JAMES

There is a long history of sundials in Oxford with many splendid examples, old and new, in college gardens and on college buildings. The Museum of the History of Science in Broad Street has a fine collection of portable sundials.

At New College (founded in 1379, and not at all new) there has been a tradition of dialling on a grand scale. After a day rummaging in the college library and in oak chests in the medieval Muniment Tower I found a print of the 1670's showing a large horizontal dial planted out as part of a knot garden in the college grounds. I estimate it must have been 30ft in diameter (Fig. 1).

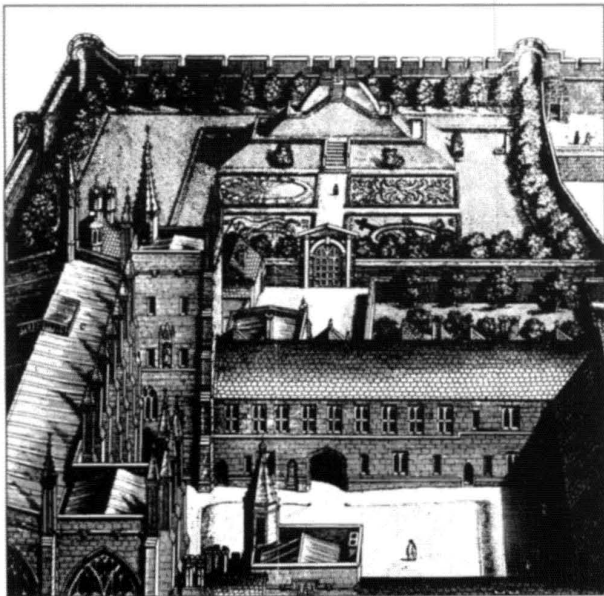


Fig.1. A print of the 1670's showing a large horizontal sundial in the knot garden.

Marvell's poem *The Garden*, published in 1680, describes something similar:

*How well the skilful Gard'ner drew
Of flow'rs and herbes this Dial new;
Where from above the milder sun
Does Through a fragrant Zodiack run;
And, as it works, th' industrious Bee
Computes its time as well as we.*

The gnomon in the print appears to have been a simple pole. The dial shows the hours 4am to 8pm. In another quadrant of the knot garden Charles I's arms are laid out with '28' visible in the lower right hand corner - presumably 1628.

William Williams' print of the garden in 1732 shows the dial again, unchanged except that 4am is written as IV instead of 1111. Now Charles II's coat of arms are next to it and the date has disappeared. The other quadrants of the knot garden appear to have been redesigned, so one might conclude that the garden fell into disrepair during the Commonwealth, and was replanted in Charles II's reign (Fig.2).

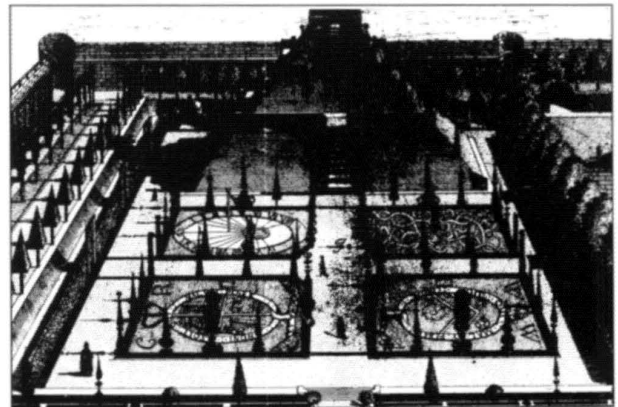


Fig. 2. A print of 1732 showing a redesigned knot garden still with sundial

The knot garden dial is mentioned by William Gilpin in a letter of 1742, but I have found no later record.

A vertical south sundial on the Muniment Tower first appears in another print by William Williams of 1733. The dial bears the date 1696 (Fig.3).

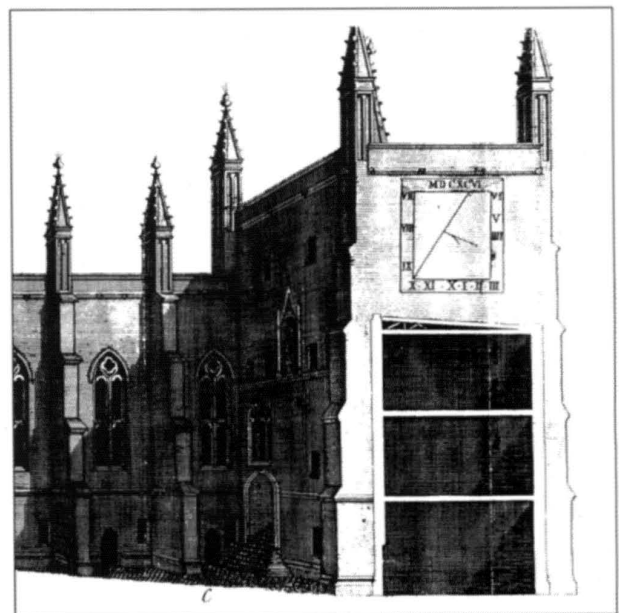


Fig. 3. A print of 1733. The earliest evidence of a sundial on the Muniment Tower with '1696' written on it.

It is shown again in prints of the 1770's, 1820 and 1850. There is also mention of a dial in the accounts for buildings in the Bursar's long book of 1676, though it is not clear which one: *Sol. To Mr Bird for mending ye diall ut per billam £1/2/0*

An additional storey to the building adjoining the Muniment Tower was built in 1674. It would have made the high south face of the tower wall more accessible for the construction of a dial. In any case, we can be certain that there was a dial in that position from 1696 to about 1850.

The south wall of the tower was mostly refaced at the turn of the 20th century when much restoration was overseen by the architect Champneys. He produced a design drawing for a stone horizontal dial for the college in 1899, perhaps after having the remains of the tower dial dismantled.

The present Warden and Fellows of New College were keen to have a dial again and commissioned me to make a replacement. I made the design as simple and as large as possible because the site is 40-50ft above the ground and can only be viewed from the ground. The dial measures 15ft x 17ft and is carved directly into the tower. The numerals are a foot high. 'MM' for 2000 is inverted to give 'WW' for Williams of Wyckham, founder of the college (Figs 4 & 5).

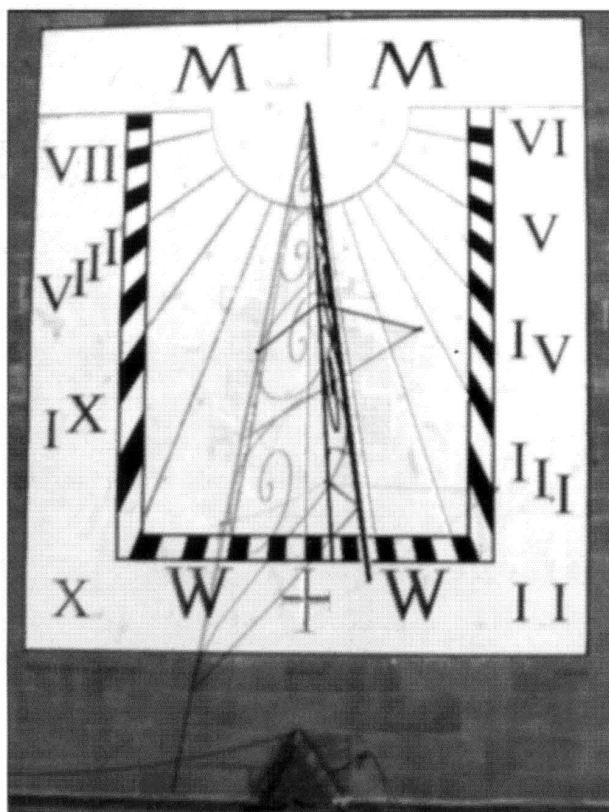


Fig.4. The new sundial on completion in September, 1999

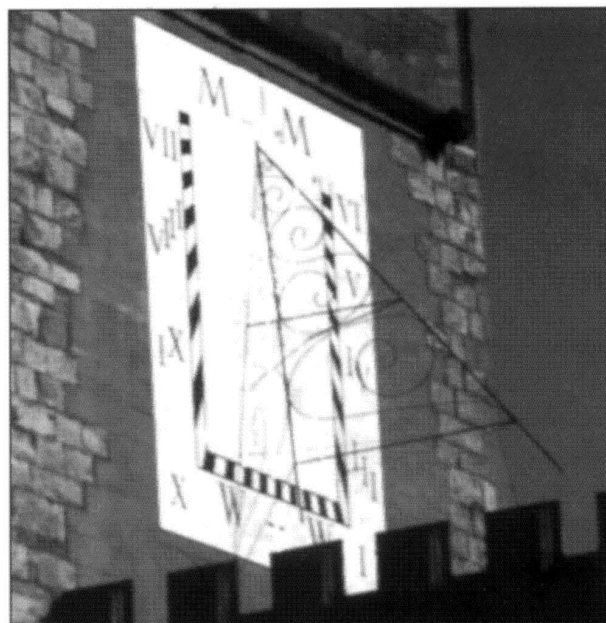


Fig.5. The new sundial on completion in September, 1999

The gnomon is 15' 6" long and was made by Iron Awe of Garsington, Oxford, from 1" stainless tube with supporting stainless scroll-work, all painted black. The scrollwork is supposed to echo scrollwork on the iron railings of the college garden below, and it also copies some wonderful gnomons on a 17th century cube dial at Steeple Ashton, Wiltshire.

The diameter of the gnomon tube was determined very unscientifically by one person holding up different thicknesses of wood while the other looked up from the quad. This was done in bright Spring sunshine when one could easily see a shadow from a 1" diameter piece of wood, but with hindsight I think something thicker would have made the dial easier for the uninitiated to read. The time is read from the middle of the long axis of the shadow of the tube.

After much discussion it was decided that the gnomon should have a wall plate running along the substyle line bolted into the wall with expanding rawl bolts, and two pairs of braces to make quite sure it could not come adrift in a high wind. This design copied a gnomon shown in one of the 19th century prints of the original dial, but it was a big mistake because as soon as it was mounted one could see that the shadows of the braces combined with the shadows of the scrollwork were appallingly confusing. *Moral: - always make a model, even of the gnomon!* The gnomon was taken down and one set of braces replaced with stainless yacht cables which are invisible from the ground - my thanks to BSS member Tony Moss for suggesting this. The remaining braces are quite useful for indicating where the gnomon bar is situated, as their shadows point from either side towards the bar's shadow

between 11am and 3pm. They also provide essential support for the weight of metal. The gnomon needed three men to carry it into the college and seven to heave it up to the tower using a pulley (Fig.6).

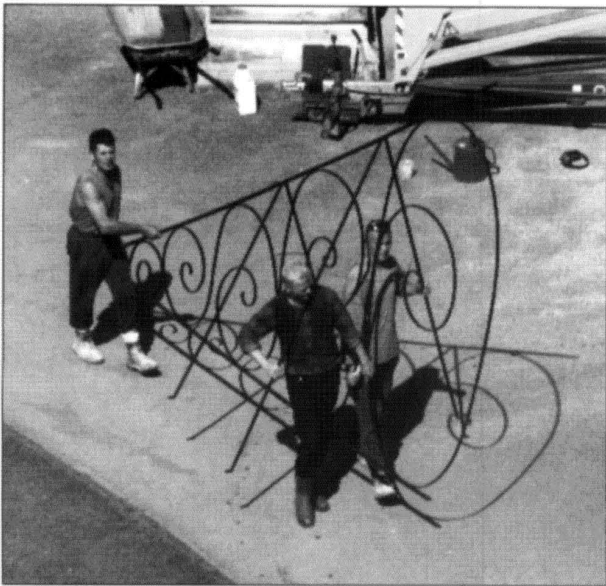


Fig.6. The arrival of the gnomon.

Before carving straight into the wall of a listed building I had to make sure I had the declination of the wall right! I am grateful to another BSS member, John Ingram, for his help. He measured the declination with the horizontal board and vertical string method, while I used a pin in a vertical board (both methods described by Waugh) and I also borrowed Piers Nicholson's meridian alidade which can be used for declination measurement as well as for laying out meridians. The results were disconcertingly varied and I came to the conclusion that although the wall was plumb (a credit to medieval craftsmen) it had a horizontal wave in it. I settled on a declination of 10° west of south and made a model. All along I was worried about accuracy because any error would be greatly scaled-up on the full-size dial.

Once a scaffold was erected I marked out the dial using a grid and a chalk line. This was a very laborious task. John Davis had just made a much larger version of his laser trigon (*Bull. BSS* 11 144-146 (1999) for marking out dials. This was exactly what was needed. He kindly came to try it out but found he *had* made the mounting so precisely to fit a 1" stainless style tube that it would not fit over the additional three coats of paint which had been added.

The gnomon was put up again by the long-suffering men of the maintenance department at the college and I was horrified to discover that the dial was four minutes slow. After much debate and a little help from Pythagoras, it turned out that the gnomon angle was incorrect. Iron Awe adjusted the angle. The gnomon was put up again, this time

with another invention of John Davis' attached - a laser attached to the style pointing downwards along its length to a plane mirror on an equatorial mount on a tripod stationed below the tip of the gnomon. The mirror was accurately positioned to be perpendicular to the polar axis (and to the gnomon when in its correct position). The laser beam was reflected back up the gnomon and onto a sighting screen surrounding the laser. A theodolite, co-mounted on a purpose-built jig, was used to position the mirror at the correct angle using the sun's position (Fig. 7).

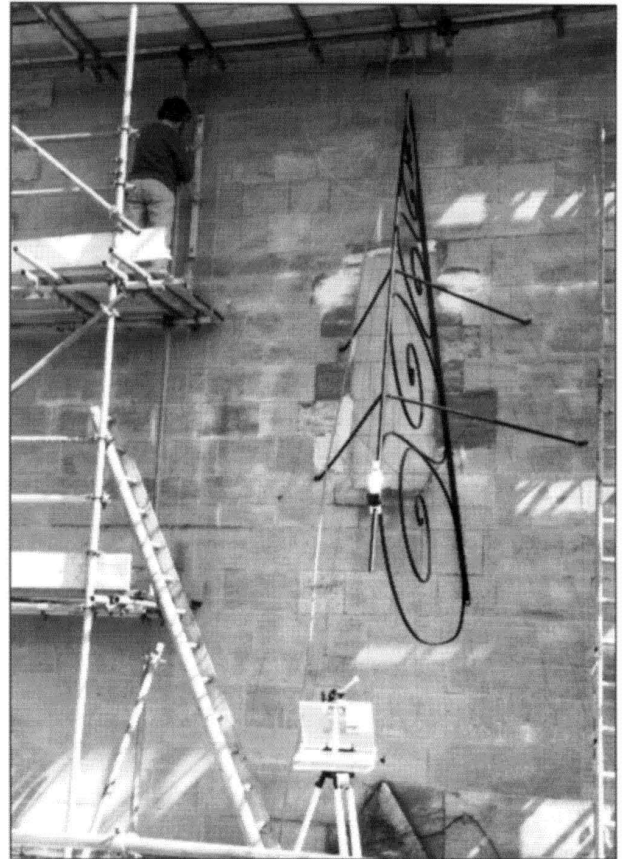


Fig.7. John Davis' invention for aligning the gnomon.

The gnomon was aligned to the pole and now tells local apparent time to within 20 seconds of time. Some readers may think this is not precise enough, but considering the problems involved I am quite pleased with this, and one can certainly not see any error from the ground. There is a plate mounted at ground level to explain the differences between 'clock' and 'dial' time.

The carving, painting and gilding of the dial took about six weeks. The white background and chequered border showing quarter hours are painted in masonry paint, the numerals in signwriter's enamel. The hour lines and noon cross are gilded.

If one climbs the tower of St. Mary's Church in the High Street there is a fine view of three dials in a row - this new dial and the vertical south dials at All Souls College and

Brazenose College. My thanks to all BSS members who gave me advice and support for the project.

Wood Villa
26 Staverton
N.Trowbridge
Wiltshire
BA14 6PB

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David Sturdy: '*Twelve Oxford Gardens*' Ark Press, London (date not known).

TWO EARLY 18TH CENTURY SUNDIALS RESTORED AT RICHMOND, YORKSHIRE

ALAN SMITH

In the market town of Richmond, North Yorkshire (Lat.54°24'N), among its many fine Georgian buildings stands a house built in 1689, on the corner of The Green, numbered 5-7 Bridge Street. The house, now a restaurant, was occupied in the early years of the 18th century by one William Hutton who had two vertical stone sundials mounted on the corner of the building, one dated 1720 and the other 1721. One we shall call the south dial facing The Green, which declines 4°12'W (as nearly as can be calculated), and the other on Bridge Street, called the east dial declines 75° 48' E. (Fig.1). Both dials were reported to me as being in a very decayed condition when I was consulted in 1997, and a visit to the site in the autumn of that year confirmed their almost hopeless state. It was with some reluctance, therefore, that I agreed with the present owner to take the matter further and attempt a restoration, so that in the summer of 1998 the dials landed up on my bench in Worsley, Manchester.

Preliminary investigation showed that the dials were in an even worse condition than I first thought when I examined them, somewhat precariously, at the top of a tall ladder! The surfaces of the sedimentary sandstone or gritstone slabs were decayed to such an extent that the stone powdered away at the merest touch, especially the east dial where about two-thirds of the surface was rotten, and even the south dial was in poor condition, especially at the top and bottom edges. Both gnomons were deeply rusted, and although the gnomon on the east dial was certainly original there is much doubt about the south facing one which appeared to be a later replacement.

Both dials, it would seem, had suffered from stone corrosion at a much earlier period, and had probably been restored well over a century ago. By the time the dials were over a hundred years old, in the first half of the 19th century, a previous restorer had found the same problem of rotting stone and had solved it by filling the cut lines,



Fig.1. The Restaurant on the Green, Richmond, N. Yorks. showing the position of the south and east-facing dials on the building of 1689.

numerals, lettering and other decayed parts with white putty, then painted the complete surface black. The details were then painted in white on the new black ground. The result of this treatment was that during the next hundred and fifty years or so the black paint partially flaked away, the stone continued to decay, but the very hard putty in the lines and numerals etc. survived and kept their coat of black paint. On the east dial this had the remarkable effect that some of the numerals stood in relief when the rotten stone

surrounding them was removed, and an added complication on this dial was that the 19th century restorer had got several of his hour lines and numerals wrong! It will be seen later that he also changed the Latin motto at the top of this dial, but to clarify everything the condition and treatment of each dial will be described separately.

THE SOUTH DIAL (FIGS. 2, 3, 4)

This dial was far easier to deal with than the east one, and its delineation was much clearer with the lines etc. showing well with old black paint on the putty filling. More of the black ground had survived at the top and in fact parts of the lettering 'W.Hutton' could be seen where the black overpainting had come off the white putty. There was some rust staining at the bottom of the slab due to corrosion of the gnomon. The remains of the black paint and all the hard putty were removed, but it was necessary to build up parts of the surface in an artificial stone, and afterwards either to sharpen up the cut lines or, in some parts, to re-cut them. This was especially the case with the lettering, where so much had weathered away. The gnomon (which as mentioned above is almost certainly not original) was carefully stripped of all traces of old paint and rust, treated with two coats of rust inhibiting primer and two further coats of high quality outdoor matt finish paint. The colour chosen was a dark grey, rather than black, to give a slightly subdued and gentle appearance, and the numerals and lines were also coloured in the same way. Because rain had leaked down the back of the dial the stone corrosion there was almost as bad as on the front, and after the whole dial had had two coats of transparent weather sealant the builders employed to dismount and mount the dials were asked to seal the dial at its edges once it was back on the wall. The artificial stone filler is not quite the same colour

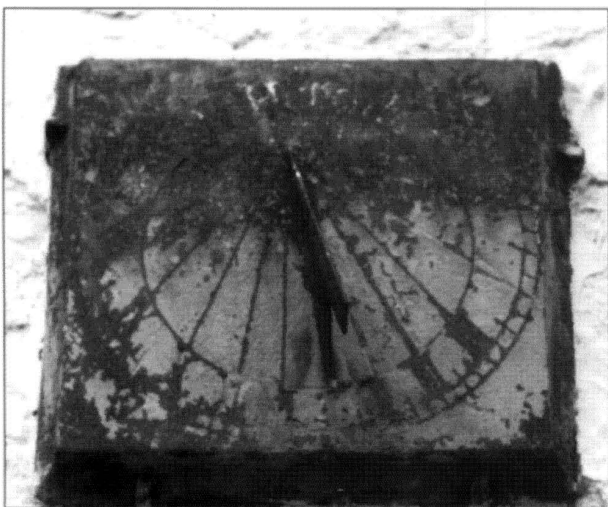


Fig.2. The S dial before restoration. The remains of the black over-painting have mostly stuck to the putty-filled lines, and the name W. Hutton is partially revealed in white putty at the top.



Fig.3. The S dial during restoration; some of the lines and numerals have been coloured in matt grey.

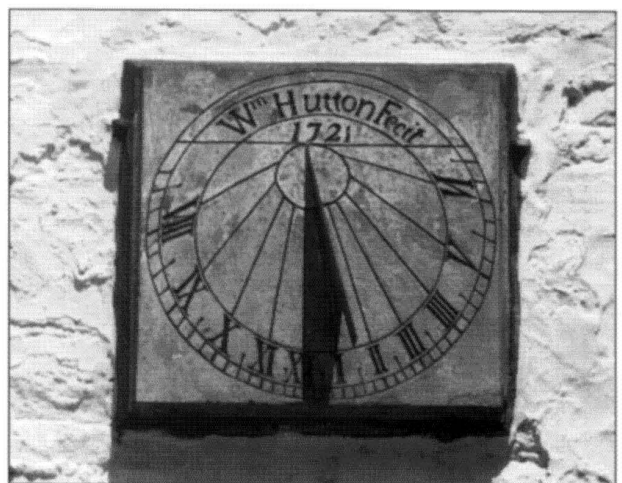


Fig.4. The restored S dial, photographed at the summer solstice 1999.

as the original stone (in spite of having a quantity of the original stone in it) but the final colour variation and texture retains the old and slightly decayed feeling suitable for an object of this age, and it should now last for very many years before needing attention again.

THE EAST DIAL (FIGS. 5, 6, 7, 8, 9)

This dial was by far the most difficult to deal with. As well as the extremely decayed surface mentioned above, the configuration of the hour lines and numerals was confusing because some were quite wrong. Only in a few places were there any original scratch lines to give real guidance, and because the root or apex of the lines lay about 2 feet outside the dial plate a great deal of calculation had to be done to set matters right, and to check the validity of what was left of the original. At this point I must express my warmest thanks to Graham Aldred (BSS Council Member Restoration) who visited my workshop many times and made numerous valuable suggestions. He also produced an exhaustive analysis of the calibrations of this particular dial. His view was that the first restorer, during the repainting which took place in the last century, confused the issue by using some of the hour lines calculated for a

different dial! However that might be, Graham Aldred's calculations, together with observable details on the existing dial, made it possible to effect a reasonable compromise which was the best thing to do under the circumstances.

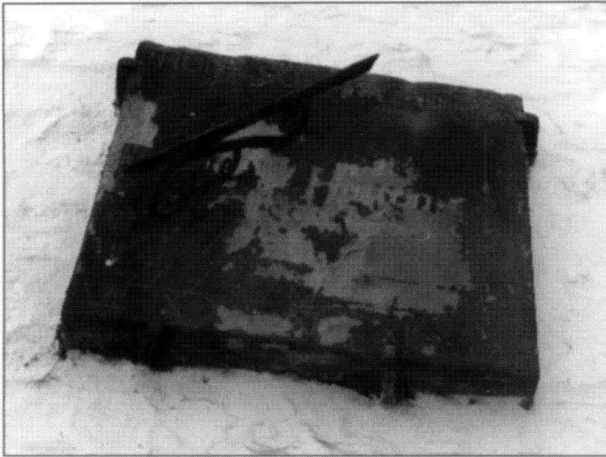


Fig.5. The E dial before restoration. Much of the black paint remained, but the centre was badly decayed and much further corrosion was discovered beneath the fragile surface.

As well as the problems of the dial markings, the Latin inscription at the top was confusing too. The painted area which survived had the inscription:

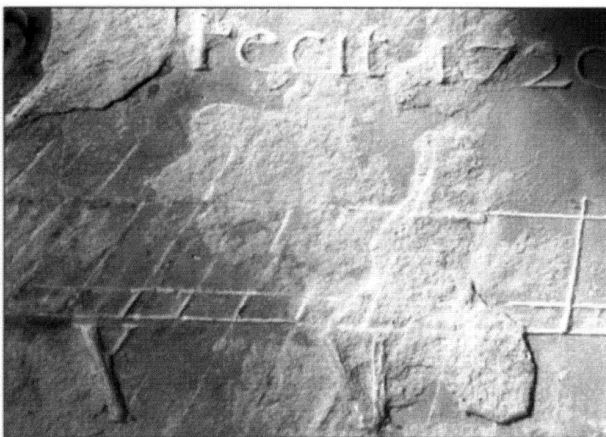


Fig.6. Part of the centre of the E dial after removing the black paint and putty. The photograph gives an idea of the total overall state of the stone dial plate.

HOPA SOLA and possibly? 1689

but after removal of the paint (after it had been carefully photographed) the words:

UT HORA SIC VITA

appeared, preserved in very hard white putty with which they had been filled. While the left-hand side had survived more or less intact, on the right the corrosion was really

serious, sinking into the stone up to about half an inch. Figs. 7 and 8 show the condition, while Fig.6 gives an idea of the overall state of the dial. A long period of work was necessary to reinstate the stone surface, followed by careful cutting of the numerals, lines, motto, name and date to complete the basic restoration. As with the S dial the gnomon (this one being original) was carefully cleaned and treated in the same way as the other, and the lines, numerals etc. were also painted in the same manner.



Fig.7. The top right-hand edge of the E dial plate, showing deep decay and the remains of the original motto.

The E dial gnomon had had a nodus point filed on its edge to mark the summer solstice and equinox, and these had been painted on the black ground when the dial was last repaired. A search was made to see if these lines had been on the original dial, but the absence of any cut lines or even scratches suggested, as far as it was possible to determine, that they were not originally there. For this reason these lines (carefully determined by Graham Aldred) were painted and not incised on the finished dial, to show that they were an addition, not put on in 1720, and the winter solstice line (Capricorn) was added to give a sense of completeness to the whole.

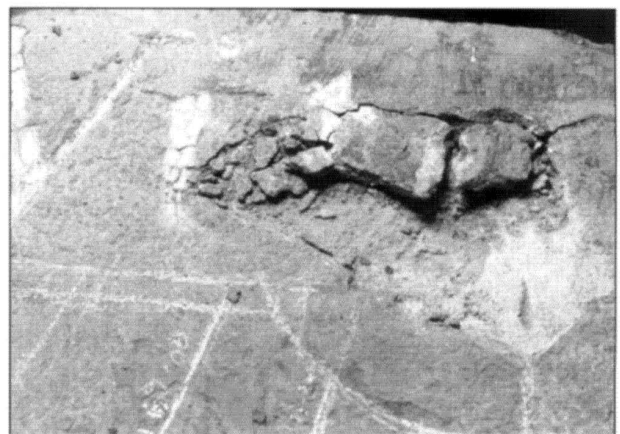


Fig.8. The original letters of the motto before removing the putty filling on the E dial, revealing the extent of the damage.

The great weight and fragility of these two dials (the E dial being 24 inches square and about 2 inches thick, the other slightly smaller) made handling difficult, and the whole job was an interesting and quite demanding experience. Now replaced on their brackets, in the autumn of 1998, and secured with cleats, they are ready to face another hundred years of life and use, and they appear tolerably like they must have been when first set up by William Hutton in 1720 and 1721.

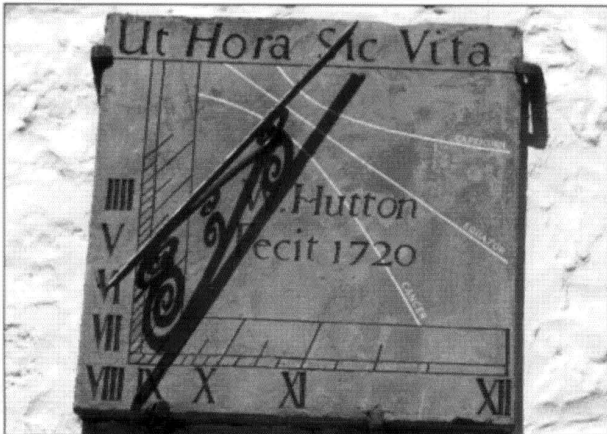


Fig.9. The restored E dial, photographed at the summer solstice.

Earlier this year (1999) I went back to Richmond to look at the dials after their first winter in the open. Seeing them again after a lapse of several months, it was possible to regard them dispassionately, and to notice the unsophisticated, almost rustic simplicity of their design and execution. In a northern town which must have been relatively remote almost two hundred and eighty years ago, this is a natural quality which one would expect, but it does not detract in any way from the remarkable degree of accuracy with which the dials were calibrated when first designed and put in place.

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SUNDIALS IN ANGLO-SAXON ENGLAND, PART 4 THE LATE PERIOD - ALDBOUGH AND ORPINGTON

DAVID SCOTT

The late Anglo-Saxon period may be taken as the latter part of the tenth and most of the eleventh centuries.

Aldbrough is 20 km north-east of Hull, in the administrative district of Holderness in Humberside, a flat, low peninsular extending south-east from the Yorkshire Wolds between the North Sea and the river Humber, terminating in Spurn Head. The church of St Bartholomew, in which the sundial stone is now mounted, has a few Saxon remains in the chancel but in the main the building is post-Conquest. An earlier church is thought to have been in danger of inundation by the sea, and a portion of it was saved from destruction for the purpose of erecting another on a site further inland. About 1080 when the present church was built, the stone on which the sundial was carved is believed to have been put up in the new building.

The stone carving, Figure 11, generally believed to be an ancient sundial, is 45 cm in diameter, projecting 5 cm from the face of the wall and chipped around the outer edge. It is mounted 5.6 m above the floor and built into the south face of the arcade inside the nave, in a triangular space

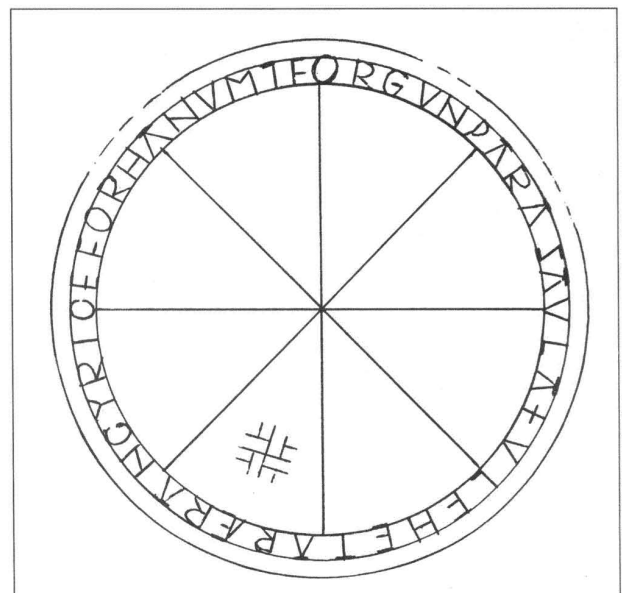


Fig.11. Sundial on display in St Bartholomew's church Aldbrough

between two arches. The inscription runs clockwise between concentric circles near the perimeter, in a mixed dialect of Old English and Scandinavian, in letters 3.4 cm

high which are unrefined Roman capitals. It reads + VLF HET ARAERAN CYRICE FOR HANVM 7 GVNPARA SAVLA, and the usual translation is + ULF ORDERED THE CHURCH TO BE BUILT FOR HIMSELF AND FOR GUNWARU'S SOUL²⁰. Ulf is thought to have been the patron or founder of the original church and Gunwaru his wife.

He may have been the Ulf mentioned in Domesday Book as owning the land in the time of King Edward the Confessor, and the earliest date for the inscription is believed to be at the beginning of the year 1066. There are several sundials with inscriptions in Northumbria, and it has been said they were popular during the late Anglo-Saxon period, for while few people outside the monasteries were literate they could recognise a name, and the founder of a church liked to see himself immortalised in stone.

The carved stone could not have functioned as a sundial inside the church, and possibly was not intended for practical use. In the days of Ulf sun worship was still a living form of heathenism, and the radial lines could have been a pagan sun wheel as found on Bronze Age stones in Denmark and Ireland. Stone slabs inscribed with circles divided into octants, almost identical to the Aldbrough stone, have been found paving the streets of ancient Greek and Roman cities. They have been mistakenly identified as planar sundials, but are more likely originally to have been wind diagrams or gameboards; the Graeco-Roman planar sundials had a completely different arrangement of lines²¹. Since the inscription on the Aldbrough stone mentions a church, it seems most probable that the inscription was intended to express a Christian belief.

The circles may have been intended to depict the day-night period divided by the radial lines into eight parts, which was also a possibility for the sundial at Darlington and others surviving from the Anglo-Saxon period. The radial lines have been seen as two superimposed crosses forming a Chi-Rho monogram, a Christian symbol representing the Trinity²². It takes its name from the first two letters of the Greek word for Christ; the Greek letter 'Ch' is like our modern X and the 'r' like our P. Uniting the X and the P gave rise to several variations, one of which was similar to the radial lines on the Aldbrough sundial.

The curious mark in the lower left segment has been described as crossed parallel lines forming a kind of swastika, representing the sun in its course through the heavens. It has been illustrated elsewhere in four different positions, according to the orientation of the sundial, in the belief that the stone block was circular and could be rotated into any position. But in 1961 when the surrounding plaster

was removed 'it was discovered that the circle projects forward from a large rectangular block of stone set horizontally into the wall'²³. This makes only two possible positions for the symbol, assuming that the block is oblong and not square and intended for vertical mounting. It has been suggested that it was made for horizontal use, when all lines on the sundial except one would at sometime in the year receive a shadow from a vertical gnomon, and the inscription would be legible, which at 3.6 m it is not. Ulf's church may not have been of stone as assumed, but may have been a timber structure, with the large block on which the sundial is carved placed on a stone plinth near the entrance.

Orpington is today in the Greater London area 21 km south-east of the city centre, but in the eleventh century it was deep in the Kent countryside. The first reference to land at Orpington being in the possession of the church seems to be in 1052 when an estate was given to the monastery of Christ Church at Canterbury, some 70 km to the east. Two churches were recorded at Orpington in Domesday Book, almost certainly built before the Conquest, and both having links with Rochester, 25 km to the north-east, where the bishop's seat for the diocese was situated.

In 1958 the ancient church of All Saints at Orpington, which had served the parish for 900 years, was enlarged by removing most of the south wall of the nave and inserting three large pointed arches, and from there building out the nave and aisles of a new church. When the south wall was being dismantled, an eleventh-century Anglo-Saxon sundial was discovered, carved on a block of stone which had been used to support the frame of a fourteenth-century window.

The stone block, believed originally to have been square, had been trimmed to an oblong shape and mounted with the sundial facing into the wall²⁴.

The sundial, Figure 12, is one of the finest to have survived from the Anglo-Saxon period. It is now displayed on a western pier in the arcade which separates the old church from the new, in more or less the position where it was found. The sculpture which incorporates the sundial was originally a complete circle 61 cm in diameter, but just under a quarter had been cut away to shape it for re-use as a building stone in the fourteenth century. It was carved in relief to a height of 9.5 cm from the face of the rectangular stone block, and the sundial which is cut within the circle consists of radiating lines spaced 45° apart with cross bars at their ends, subdivided by lines without cross bars. The fourteenth-century mason cut a slot in the top half of the trimmed block, presumably to accept the window frame,

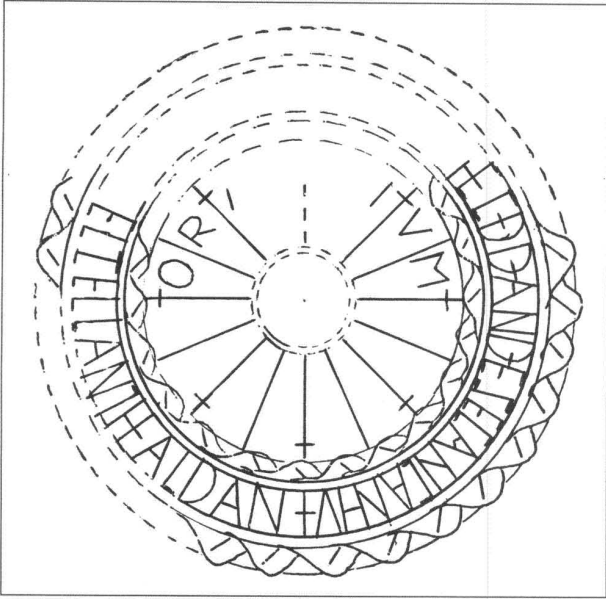


Fig.12. Sundial on display in All Saints church Orpington for it was skilfully made to a wedge shape with the narrow opening on the exterior surface, for locating and securing the window²⁵. But in cutting the slot he probably caused the central area of the sundial's surface to chip away inside the circular plain moulding, a part of which has survived. The radial lines seem to have been terminated by the moulding and if there had been a fixed gnomon it must have been a slender one. But it seems possible that a portable gnomon on a circular base was placed within the inner circle, assuming that the sundial had been designed for use in a horizontal position.

The sundial is surrounded by a border 15 cm wide, enclosed within rings of cable moulding carved in relief and running in opposite directions, and between them a flat band 5 cm wide has on its surface an inscription engraved in Old English. The surviving portions read ECD DAN DE SECAN CAN HV + and EL TELLAN 7 HEALDAN, which has been translated as FOR HIM WHO KNOWS HOW TO SEEK (IT) and TO TELL (OR TO COUNT) AND TO HOLD. On the sundial disc set between the radial lines at the top are the first and last letters of an inscription which reads OR(...)VM, which was probably ORALOGIVM the Latin name given at that time to all time-measuring instruments. These fragments suggest that the complete texts described the sundial's function of counting and keeping the hours, of benefit to those who knew how to read it²⁶.

Stone sculpture by its sheer size and weight usually remained close to where it was manufactured, but this sundial may not have been made for Orpington. It seems too sophisticated for a small rural church. Rochester was the seat for the bishopric in which Orpington lay during the eleventh century, and the sundial could have been made for

the cathedral church or the bishop's palace. Perhaps it was not used for long, if at all; for it shows little signs of weathering and may have been cast aside by the conquering Normans as a piece of despised Anglo-Saxon work; although in fact some aspects of the late Anglo-Saxon civilisation were superior to those of the Normans.

The stone block on which the sundial was carved may have remained undisturbed for a long time, and then in the fourteenth century taken from Rochester to Orpington with other building materials for work which included the new window. We do not know what passed through the mind of the mason, or the bishop from whom he took his instructions, when they disfigured this fine piece of eleventh-century sculpture. If recognised as a sundial it was probably considered as obsolete, for in the fourteenth century church services were regulated by a different device, the so-called mass clock, and of course there were reports of a new invention - the mechanical clock - which rang bells automatically at regular intervals throughout the day and night and was independent of shadows. Clearly the builders of Orpington had no sense of heritage. But perhaps we should be thankful, because by placing what remained of the sundial facing into the wall it was undisturbed for a further 600 years, when it could so easily have been lost forever.

I have hoped in these articles to discover the role played by sundials in Anglo-Saxon England, by examining in some detail examples covering the whole period. It has been possible, at least, to suggest alternatives to the prevailing view that they were primarily time-measuring instruments. The pre-Christian perception of time may have been different from our own, which is simply that of a duration capable of being measured in equal intervals. The people of this period may have thought of time as having a religious or magical quality which influenced events, capable of being controlled by suitable ritual action²⁷.

Writing in the nineteenth century Haigh suggested that the early Anglo-Saxons divided the day-night into periods which they called tides. He also suggested that the early sundials marked these divisions, although later writers did not agree on whether the lines with cross bars marked the beginnings and ends or the middle points of tides. No doubt the pagan Anglo-Saxons had names for parts of the day long before the arrival of sundials or the Old English word 'tid' for time or season. It seems unlikely that the lay population, even after conversion to Christianity, adopted sundials to mark divisions of the day. The dials were too few and too small to be read except at close range, and in any case people had no need for such devices. Their day was probably divided by observing the position of the sun,

combined with an intimate knowledge of Nature and the behaviour of wildlife.

For contemporary evidence about divisions of the day in the early Christian period we are dependant on Bede, and indirectly on St Benedict of Nursia in Italy. In Bede's eighth-century *History* he makes reference to a day as consisting of twenty-four equal but unnumbered hours, but he also prepared a table of shadow lengths from which it was possible to determine the numbered seasonal hour from one to twelve between sunrise and sunset. Bishop Wilfrid in the seventh century introduced into England the fifth century Rule of St. Benedict which stipulated seven times in the day for celebrating Divine Office. In England these were set at daybreak, sunrise, the ends of the third, sixth and ninth hours, sunset and nightfall. No doubt Bede's shadow tables were used to determine the third, sixth and ninth hours, corresponding to Terce, Sext and None. The lay population may have used morningtide, noontide and eventide to name the parts of a day, gradually adopting the names Terce, Sext and None for the mid points, but not attempting to number hours from sunrise to sunset.

For sundials, only the broadest date ranges are possible; but it is convenient to recognise an early and a late period. In the early period the literate communities in monasteries may have used sundials, although none were found on known monastic sites. Non-monastic churches such as Escomb and Corhampton seem to have used wall-mounted sundials symbolically: the movement of the shadow over the radial lines illustrated the passage of time rather than attempting to measure it, and the associated sculpture echoed the Christian message.

In the period after the Danish wars the lay population probably continued to divide the day by their long-established methods, and the revival of monastic life may have incorporated ideas from the continent, including placing the 'canonical hours' at different points in the day. Pittington was not a monastic church, as far as we know, but its sundial is divided into six which may reflect the prevailing times for principal services, and it is difficult to explain in any other way why it is so divided. The non-monastic churches, such as Darlington, may have continued to use sundials as symbols, but in this instance depicting the universe as it was then believed to be with the earth at the centre.

By the late period heavy bells had been installed in churches, in the square towers built to house them, and sundials may have been used to regulate the ringing times for services. The sound of bells would have penetrated into the countryside and given rise to a greater awareness of

time, so that sundials did now indirectly have an influence on divisions of the day for ordinary people. Late period sundials were divided into eight or twelve, (as distinct from the early period when they were usually divided into four) probably to give finer divisions between Terce, Sext and None rather than to number the hours in the day.

But it must have been evident to the thoughtful observer, at least by the eleventh century, that the 45° lines on a vertical sundial did not mark the mid-morning and mid-afternoon points throughout the year, as direct observation of the sun would show. The Orpington sundial, if mounted horizontally, would show correctly by the lines with cross bars sunrise, mid-day and sunset at the solstices and equinoxes, and the mid-points could be determined by inspection. Similarly the corresponding points for other parts of the year could be found by interpolation. Perhaps this is the meaning of the message contained in the inscription 'For those who know how to read it'

The Normans may have found a different solution: the priest at each church would make a small hole in the south-facing wall, at eye level and usually near the entrance, and when needed would insert a short stick to form a gnomon. The required points in the day were determined by direct observation of the sun's position, when a line was scratched over the shadow, giving convenient markers for subsequent days. This could explain the sometimes irregular appearance of the lines and the differences between individually cut mass-clocks. The Anglo-Saxon sundial divided the daylight period into separate parts, albeit unequal ones, whereas the Norman mass-clock marked specific points in the day without attempting to measure the intervals between them.

Symbolism may still have played its part in the late Anglo-Saxon period but in a different way. The sundial at Aldbrough has an inscription which may have satisfied the vanity of the church's patron, and the sophisticated sundial at Orpington may have been considered as fitting for the dignity of the office of a bishop. Sundials had become status symbols.

The obscure nature of the subject of these articles, with little evidence and taking only six examples, means that most of what has been written is conjecture. It has been suggested that we may never know how Anglo-Saxon sundials were used, but some as yet undiscovered dials may still come to light. Also, clues from seemingly unrelated fields, such as the study of the Anglo-Saxon people and the events of their times, may yet solve some of the mysteries.

ACKNOWLEDGEMENTS

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BOOK REVIEWS

CADRANS SOLAIRE EN SAVOIE

Paul Gagnaire. Published by *Société Savoisienne d'Histoire et d'Archéologie*.

Pp191, black and white photographs, diagrams in the text, 4 pages of colour photographs; thermal bound with laminated cover.

(The front cover design, from the publishers' archives, shows an attractive sundial which was restored in 1971 and can be found on the church at *Aime*)

Paul Gagnaire has done for Savoie what Gotteland and Camus did for Paris - produced a most attractive book which both lists and describes 238 sundials to be found in the provinces of *Savoie propre, Tarentaise and Maurienne* in the *Savoie* region of France. In his introduction Paul Gagnaire tells us that the collection was started in 1986 at which time he searched in vain for any reference to the sundials of Savoie in the local libraries. In the intervening years, of course, some dials have disappeared and others have been created. In chapter II we learn that 14 of the 82 dials which carry dates were constructed after 1951; the art of gnomonics is, it seems, alive and well in Savoie.

The author does not claim to have written a complete work on dialling but, for the uninitiated, the first chapter deals with classification, dial furniture, sundial time, the equation of time, latitude, longitude, the celestial sphere, sunrise and sunset with useful diagrams and some extracts from tables.

Chapter II then gives a breakdown of, the *population gnomonique* of the *Département de Savoie* by province, ease of access, location (church, public building, private

house), materials used, and date of construction. Dials, varying from the simplest time markers to the most complicated mathematical and scientific instruments, were recorded in 101 parishes.

A list of mottoes together with the locations where they occur gives considerable food for thought as they are subdivided into religious, philosophical, patriotic, optimistic, poetic etc..

The most important part of the work is in Chapter IV, the Catalogue. The dials are listed alphabetically by *commune*. The information given includes all that can be said or measured about a dial as in the *B.S.S Register of Fixed Dials* together with some black and white photographs and diagrams. The chapter concludes with a quick reference table in which all the previous information is presented in a convenient form for dial hunters.

The Catalogue is followed by eleven short chapters on individual dials of particular interest. Historical information is given, questions are put and theories discussed. I liked the book from the moment I opened its envelope - sometimes a book has the right combination of size and weight and you want to take it with you - but it was these eleven chapters which had me unfolding the maps of south-eastern France and calculating times and distances.

The author concludes with 3 sections on the history of time keeping in France starting with the monastic rules, leading to canonical hours and a critical examination of these. The use of Italian hours in *Savoie* during the years when it was

part of the kingdom of *Piemont-Saraigne* is explained. So also are the events leading to the introduction of *L'heure légale* using the Paris meridian in 1891 and the change to the Greenwich Meridian in 1911.

An extensive bibliography acknowledges, among many others, Charles Aked, Christopher St. J. H. Daniel, and the B.S.S. Register of Fixed Dials. My only quibble, from a visitor's point of view, is that a distribution map with dots showing the locations of the dials would be a great help, especially as the geographic divisions into *province*, *département* and *commune* can be confusing to the foreigner. I have visited Savoie and may well have passed by some of these dials without so much as a glance in my 'pre-B.S.S.' days. Finding all 101 sundial-owning communes in this delightful region of small towns and villages could be a pleasant way to pass a week or two but perhaps the 11 'star' dials would be sufficient for one visit. We shall certainly be going back there as soon as time permits, armed with *Cadrans Solaire en Savoie* and a large scale map from the French Tourist Office.

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SUNCLOCKS: PAPER SUNDIALS TO MAKE AND USE

JVT Publications, 5549 Camus Road, Carson City, NV
89701 USA; Pp56, \$12.95

This book is a very useful introduction to sundials. It explains the basics of dialling and gives a glossary of terms. It has a full explanation of the difference between sun time and clock time, with illustrations from the USA. There are instructions on how to find true north, and thus to set up a sundial. The main part of the book consists of paper models of horizontal, vertical and equatorial sundials to cut out and make.

For horizontal and vertical dials there are 8 different models, calculated for latitudes from 26 deg. to 48 deg. which covers the whole of the contiguous United States. The models are printed on thick paper, with clear instructions for how to cut and assemble them. The design for each latitude is slightly different, and there are some ornamental features, so they are suitable for colouring-in. The equatorial dial models have 8 different bases using the same dial plate. This approach means that there is no need for any calculations; the user just selects the sheet for the nearest latitude, cuts it out and assembles it.

As a quick, uncomplicated way of getting acquainted with the basics of dialling, this book would be hard to beat.

While aimed specially at 10-to-14-year-olds, the book would be equally useful to adults newly interested in sundials.

It is to be hoped that this book will be so successful that it will be possible in the next edition to introduce sheets for, say, 51 and 54 degrees, so that it would be suitable for users in Northern Europe as well as those south of the latitude of Paris. It would be helpful to users to have a list of further sources, so that their interest, once kindled, could be developed further.

Piers Nicholson
Epsom, Surrey

FROM SAILS TO SATELLITES: THE ORIGIN AND DEVELOPMENT OF NAVIGATIONAL SCIENCE

J.E.D. Williams (OUP, 1994)

This book is not about sundials but many members of the BSS are interested in the navigational sciences. The author, who appears to be a retired aerial navigator, starts his account in the pre-navigation era when men sailed the seas without even maps. He leads on to classic astro-navigation, radio-based systems, gyroscopes, inertial systems and finally satellite systems

The problems of aerial and marine navigators are described. So also is the impact on the development of navigation systems of the military need to find positions with high precision, for launching missiles.

The book can be read at two levels. Those who just want an overview can skip the technical details. Others can revel in the joys of the Schuler pendulum!

Gerald Stancey
Oakham, Rutland

JOURNAL REVIEWS

COMPENDIUM, JOURNAL OF NASS, VOL.6 NO.3

The September issue of 'Compendium' opens with a delightful poem by Tony D'Arpino of San Francisco: 'The Stars at Noon'. Here are some lines:

'It's said the poet can reach where the sun cannot,
That there is a bed of stars we cannot see at noon
And every moment of time is a monument of shadows
Like the bees among the black and white flowers..'

Don Petrie, in a well-illustrated article 'An Historical Canadian Sundial' describes two sundials connected with the early history of the town of Guelph, Ontario, founded by John Galt in 1827, on the bank of the River Speed. Galt and his group felled a sugar maple tree on the river bank, then drank (in whiskey) to the prosperity of the future town. The stump of the tree was to mark the centre of the town. The cardinal points of the compass were inscribed on the levelled and planed stump, for use by the town surveyor. Later a sundial was placed on the stump and served for many years as the town clock. It 'stood as a memorial of the founding of the town and was held in high veneration'. The town prospered. In the 1850's a certain Scottish master-builder and stone mason, William Kennedy, built a substantial stone house 'Sunnymeade' occupied by several generations of his family. He carved a horizontal stone sundial of Guelph limestone, which was set in a circular flower-bed in the driveway. The original is now stored within the house for safety and a replica stands on the same site. The arabic numerals are carved directly onto the stone, and the solid brass gnomon supported by sigmoid buttresses is also a replica of the original. In the John Galt Gardens in Riverside Park, the founder is commemorated by a sundial on a granite plinth carved with bark to resemble the original maple tree stump.

A.M.Loske has written a detailed description with good photos of the huge equatorial sundial at Frankfurt built by L.M.Loske in 1951 and standing on the bank of the River Main. The equatorial ring is 3.45m in diameter. Roman numerals give local solar time, and arabic numerals give the time for 15° E, the standard time for Germany. On the outer face of a small ring below the equatorial, there are the names of 200 towns worldwide; this ring may be rotated by hand, to show solar and legal time at each place.

M Catarina and C. Lucarini have an article 'Sundials without gnomons' made out of CD discs. Fred Sawyer writes on 'Shadowless Sundials' in which the sun's position is given

by its reflection in a series of mirrors. Are diallists getting too clever and minimalist, I wonder?

Steven Woodbury's 'Sightings' section is always good value. In this issue we have photos of a couple of noon marks: one an obelisk outside a bank in Orlando FL, and one as an outdoor sculpture on the campus of the Durham, NC, School of Science and Mathematics.

COMPENDIUM, VOL.6 NO.4

The December issue publishes Part II of an interesting article 'Shadow Plane Sundials' by W. Maddux, M.Oglesby and F de Vries, of which Part I came out in the September issue.

A number of readers must be familiar with the shadow-plane dial which consists of a sphere (often made of stone) with axis parallel to the earth's, and hours marked around the equator at 15° intervals. A semicircular flat ring-segment is mounted with pivots at the two poles and can be rotated until its shadow is minimal. It will then be lying in the sun's hour-plane and the hour can be read on the equatorial band. Shadow-plane dials were described also in Gary Rolfe's article in Bull. BSS 98.2 page 12; the author built spiral stacks of blocks arranged so that each numbered block in turn would receive full sunlight on its face.

The authors of the 'Compendium' article have produced a number of ingenious designs using this principle. I particularly liked a set of small rectangular blocks rather like dominoes, placed on edge parallel with the hour lines of an ordinary horizontal dial. The time is given by the hour line whose block casts the narrowest shadow.

Steven Woodbury has gathered into his 'Sightings' two horizontal dials: in Reston, Virginia (a good one) and in Caspar, Wyoming, a poor one made for a latitude of 22°N in this town at 43°N. He also found a good vertical in Denver, Colorado, on an office block which had been built as a school. The original architect had objected to the inclusion of a sundial in his design, but was persuaded to accept it because of its educational value.

The aesthetic aspect of sundial design is well served by John Carmichael's article 'Sundials in stone and brass'. The author makes gnomons out of stranded brass cable, (made as weight cables for clocks) fixed at the centre of the

dial face and held taut by a weight suspended over a brass hinged lever fixed to the north edge of the dial plate. This type of gnomon does not obstruct the view of the dial face, and is so thin that the a.m. and p.m. hour lines do not have to be offset to allow for the gnomon's width.

D. Collin, of Calais, France, has published Part I of 'The theory of the Vertical Declining Bifilar Sundial'. Bifilar Sundials were introduced to BSS members by Fred Sawyer (Bull.BSS.93.1 p.35) and by F. de Vries, (Bull.BSS.93.3 p.40). Two threads placed at right-angles to each other at different distances above the face of a horizontal dial, or in

front of the face of a vertical one, cast shadows onto the dial face. The intersection of the two shadows marks the hour. D.Collin's article describes the theory of the laying out of such a dial, on a vertical declining dial face. One hopes that the flurry of 6½ pages of diagrams and equations (and presumably more of the same in Compendium, Vol.7), will produce, by the end of Part II, a sundial which is aesthetically pleasing, or scientifically interesting, or (preferably) both.

M.S.

A VISIT TO THE FARNBOROUGH NOON SUNDIAL

JOHN INGRAM

Douglas Bateman, designer of the Farnborough Noon Sundial, arranged a visit for members of the Society to see this important new dial, on 23 September 1999, the autumnal equinox. The dial, designed to be seen from inside the building, is set out on a central glass window in the entrance hall of the Cody Building at the Defence Evaluation and Research Agency, DERA, (formerly the Royal Aircraft Establishment), at Farnborough, Hampshire. As it is a restricted-access site, the visit was a unique opportunity, as we shall see.

The visit was well-planned in the best traditions of the service, with comprehensive joining instructions complete with helpful maps of the district. We all arrived in good time, to be greeted by Douglas Bateman and staff members, and by refreshing coffee in the staff restaurant. We got our bearings and had tantalising glimpses of the dial as we passed through the main entrance hall of the building, (Fig.1). The weather was unpromising with low scudding clouds from the south-west, building up for possible rain by lunchtime.

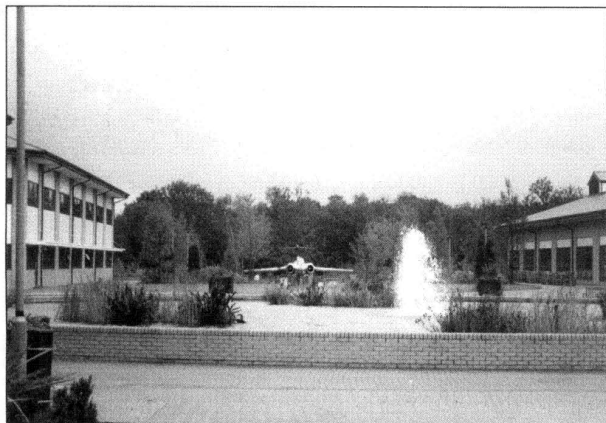


Fig.1. View from the Cody Building of the Terrace and lake; a retired Farnborough Buccaneer aircraft guards the gate in the distance.



Fig.2. The gnomon showing the supporting struts, with the shadow indicating its shape. The blinds on the side windows are an energy conservation system, rising and lowering, opening and tilting as the sun goes in and out.

After coffee we were conducted to the Whittle Lecture Theatre, where we were addressed in turn by Dr. Ian Stone who officially welcomed us and described the work at DERA, followed by Phil Alner, the Chairman of the DERA Astronomical Society, who gave us a fascinating account of the activities of the Society, star sensors, satellites and the restoration of the DERA 6" Coudé telescope.

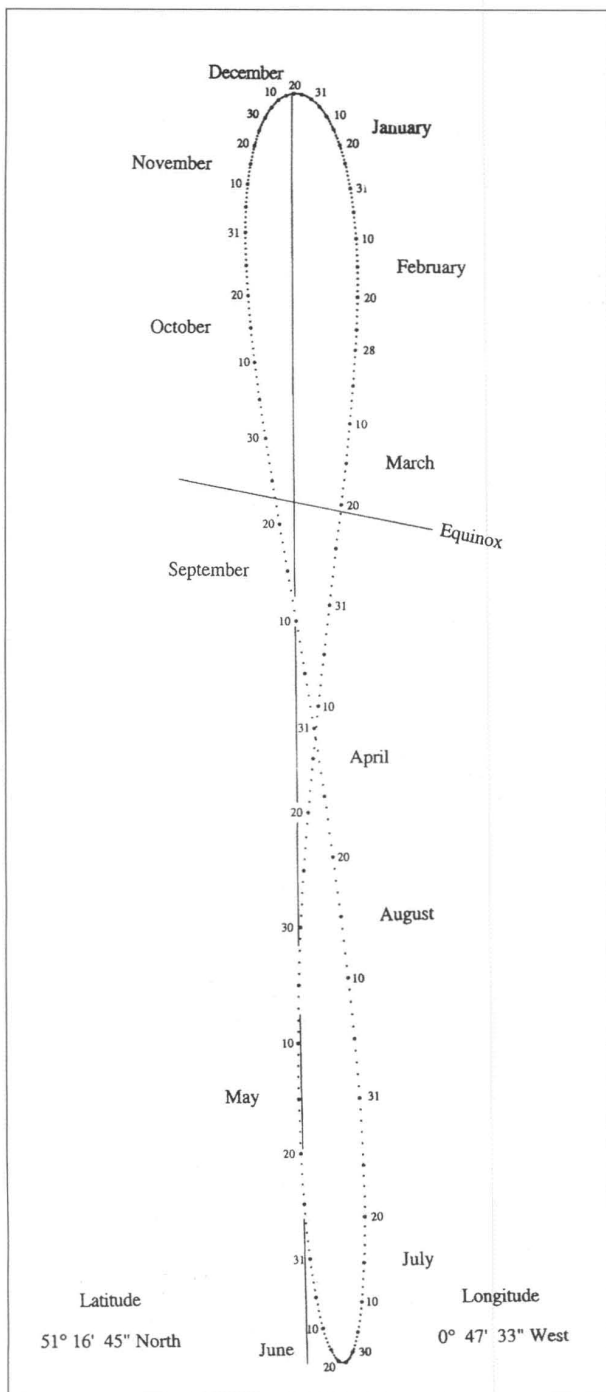


Fig.3. The DERA Noon Sundial (DERA Booklet).

Douglas Bateman himself completed the briefing by describing the design, manufacture and installation of the Noon Sundial. Some members may recall his talk about the dial on a previous occasion, at the BSS Conference at Newton Rigg, Cumbria, in April 1997. (See Bull. BSS 97.3, p54). The dial is installed in a double-glazed window which declines 13.5° west of south; the analemma is 1.8 metres tall, and it is a functional scientific instrument representing the principles of observation, analysis and application. It records three separate pieces of information: local apparent noon, mean time noon, and the date. The gnomon is an

elliptical steel plate suspended on struts outside the window; (Fig.2); it is calculated to generate a circular shadow at the equinox, with central hole giving the spot of light which traverses the dial. The designer described the design-process which led to the presentation of the lettering and figure styles, the date-marks and calendar, and the approximations and roundings, calculated to be exact for the final year of each leap-year cycle, (Fig.3). Again we were fortunate in the choice of year for the visit, 1999. The 29th of February is omitted from the dial face, but this makes very little difference. The attention paid to every detail of the design is impressive. An excellent booklet, available in the entrance hall, fully describes the function of the dial. Douglas says it is in its umpteenth reprinting and DERA is missing out on a commercial opportunity!

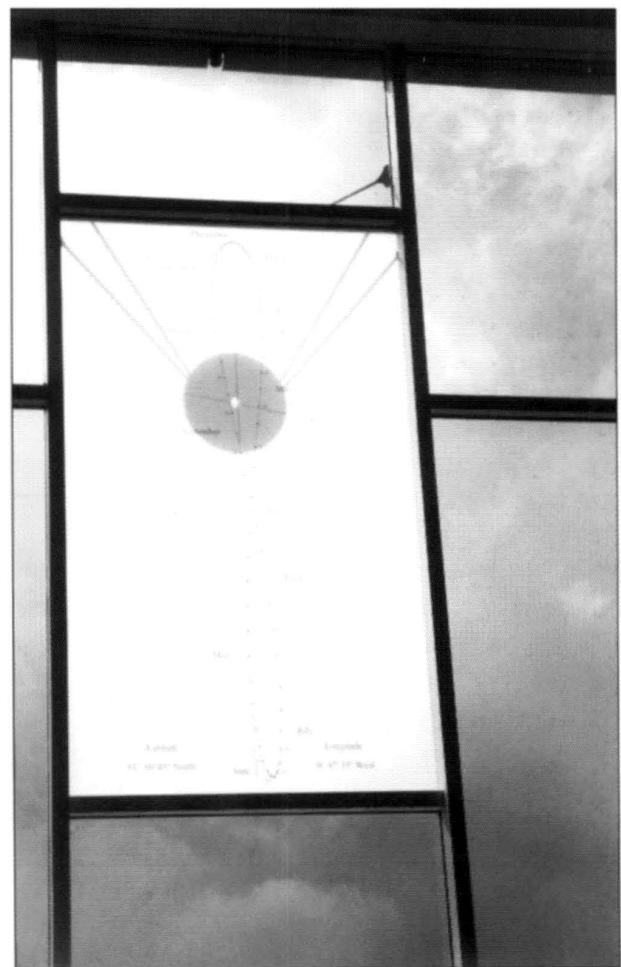


Fig.4. Three minutes to local solar noon at DERA, Farnborough, Hants, on 23 Sept. 1999. At noon the sun was obscured by cloud.

After the talks, the time was nearing 1p.m. BST, local apparent noon. We made our way to the balcony of the entrance hall to view the noon transition. The weather was still very cloudy. On the balcony we found that a delicious and comprehensive buffet lunch was to be served, complete with a centrepiece, a horizontal-dial-capped Quiche

Lorraine! (Unfortunately the gnomon appeared to be more like 45° than Farnborough's 51°N!). (Fig.4). We could hardly relax though. Would the sun shine through? It seemed that there might just be a chance. Then, at 3 minutes before local noon, we were treated to 30 seconds of sunshine, with light spot accurately on the equinox line. From then on it was all a success, with many congratulations to Douglas for his timing.

After lunch and coffee, and before we departed to see the Coudé telescope on our way home, the Secretary of the Society David Young proposed a very well deserved vote of

thanks to Douglas Bateman and his colleagues for a quite exceptional and memorable visit to this unique noon dial. We hoped that Douglas will write a full account of the dial for a future issue of the Bulletin.

[Note: Permission was given for the photographs. Photography is not normally allowed at this site]

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THE TOTAL ECLIPSE OF THE SUN AS SEEN FROM BULGARIA 11TH AUGUST 1999: A PERSONAL ACCOUNT

ROBERT SYLVESTER

My wife and I decided that England had little to offer when it came to seeing the eclipse. Consulting a map showed us that Bulgaria not only offered a chance of clear skies but also almost maximum duration of totality. The obvious thing was to book a cheap holiday at one of the Black Sea resorts which placed us near the central line.

The eclipse was spectacular. It was my first total one and could not have been better. On the day of the eclipse we were taken by bus (and endured a hilarious talk by a courier who really had no real idea about eclipses!) to Rusalka, where the steppe meets the Black Sea. A few other astronomically-minded people from England had obviously followed our example, but we were certainly not crowded out. The main international scientific parties were based a few miles further north at Shabla. Being at just south of the Danube delta put us almost on the central line and we had well over two minutes of totality.

We saw the predicted phenomena (but no shadow bands): pinhole crescents on the ground from gaps between leaves, cessation of crickets chirping, cooling of the air and a breeze blew up. As the eye is very tolerant of variations in light level, there was no awareness of the diminution of light level until very near to totality. We then experienced an eerie sensation which gave short, sharp shadows (all characteristic of an unobscured, high sun) but very feeble light. In fact, the shadows were undoubtedly sharper than usual as the small amount of sun visible was approximating a point source.

At the beginning of totality, a cannon was fired and its noise reverberated over the steppe. Venus was clearly seen but the

sky did not go totally black. There was a gasp from the crowd when the all-too-brief appearance of the 'diamond ring' effect appeared, then a sliver around the Moon's limb brightened to herald the end of totality. An optical set up of telephoto lens and converters gave me an excellent view during totality of solar prominences and corona. The corona showed a depth of light variation which would be impossible to record on film. As I had only a tiny tripod to mount the camera on, the image was whipping in and out of the viewfinder giving me tantalizing, brief glimpses, but not steady enough for photography. The two minutes passed all too quickly.

Upon reading reports later, we noted that some cloud was present at both Bucharest and northern Turkey, so our cloudless choice in Bulgaria was a good one. In the hotel that evening, Euronews showed anorak-clad folks sitting in the rain in southern England. Our journey had been all worth while.

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A TRIP TO THE N.A.S.S. CONFERENCE AT HARTFORD, CT, U.S.A. 1999

TONY MOSS

Some fifty people attended the Annual Conference of the North American Sundial Society which was held in the Hilton Hotel at Hartford, Connecticut, from Friday 8th October until midday on the following Sunday. Although not a member of NASS at the time (I am now), it seemed like a golden opportunity both to enjoy the Conference and also to put faces onto the names of long-time e-mail friends and dialling correspondents brought together by Daniel Roth's Sundial Mailing List.

While notifying the time and place, Fred Sawyer, President of NASS, had asked for offers of conference papers. My recently completed series of photographs depicting the various stages in manufacturing a new gnomon for a 19th C Irish sundial by Yeates of Dublin was accepted as the basis of a paper. In our next e-mail exchange Mike Shaw revealed that he and Heather also intended going to Hartford where he was to present a version of his 'Our Calendar' talk, given to the BSS 1999 Conference.

It would have been a tragic waste of a tedious flight to visit New England in the Fall only see the inside of a hotel; so I arranged to travel the previous weekend and meander down to Hartford from Boston in a hire car. The Shaws intended to follow on from the Conference with their local tour. One excellent use of the Sundial Mailing List is to ask the local members for directions, or to suggest things to be included in an itinerary. The main sundialing suggestion came from Fred Sawyer who said that the fine sundial at Pomfret School would have been included in the Conference Dial Tour had it not been too far away from Hartford. Pomfret lay within my line of meander, which also took in the Waltham Watch Company exhibits in the Museum at the Charles River Museum of Industry on the western outskirts of Boston.

The staff at Pomfret School were delighted when I visited their remarkable sundial. The Classics master translated the inscriptions for me. Attempts were made to locate the head of Science who knew all about the multitude of tiny sundials contained within the carving, but he was teaching. The dial is a re-delineated replica of the Turnbull Dial at Corpus Christi, Oxford, presented to Pomfret by William Ross Proctor in 1912.

Mystic Seaport on the coast was a worthwhile diversion to see two dials by Albert Waugh on the Planetarium building

and his armillary sphere at the entrance. My meander ended with the Museum of American Clocks at Bristol West Hartford. Now I know how they did the 'tuppence a foot carving' on cheap clocks. Boiled oak was fed through a 'rotary scone cutter'! By contrast the collection houses some very fine specimens from the smallest watches through longcase to working tower clocks, together with the tools that made them.

And so to the NASS Conference which began with Thursday evening registration.

"Mac Oglesby! - is this really you!" "Good heavens! That's Geoff Parsons from BSS over there!"

There was much greeting and chatter interspersed with light refreshments and setting up displays around the comfortable Conference Room. BSS members would recognise this part instantly.

The papers on Friday morning included:

'Connecticut Dials' by Larry Jones illustrated many dials within reach of Hartford.

'A Cylindrical Fresnel Mirror Sundial' by John Redford - a 'half-barrel' with mirror staves!

'Our Calendar' by Mike Shaw, who proved that humour can cross the Atlantic!

'Sculpture' by Robert Adzema illustrating some of his large public dials.

'An Edo-era Hidokei Design' A Japanese paper sundial by Fred Sawyer complete with DIY example.

'Finding the declination of a wall' by Allan Pratt using his own simple instrument.

'A New Diallist's Companion' by Tom Kryche

'A Sun Vial' an internal tube altitude dial - by Larry Boblaye.

'Solar Flair' - a remarkable innovative design in bronze by Fritz Stumpges, and finally an introduction to the handsome new NASS website by Bob Terwilliger.

After lunch we were introduced to:
'Shadow Plane Dials' by Mac Oglesby who presented each member with a full working model.

'Faith in Time: Sundial and Religion' was vividly presented by Sarah Schechner.

'Sun Aligned Sculptures' by Kate Pond showed fine examples of her public dials.

'The Reutte Sundial Competition' by Claude Hartman illustrated his prize-winning design.

'The Branford Sundial' by Susan Farricielli illustrated the installation of an unusual equatorial.

'Staying Focused' by Bill Gottesman & his remarkable curved-in-width mirror strip dial.

'Sunset Phenomena' by Roger Bailey gave a crisp analysis of the underlying theory.

'Sun wheels for the 21st Century' by Judy Young showed the 'DIY Stonehenge' she is building.

'The NASS Angel': the latest of Fred Sawyer's innovative dials designed as a Conference souvenir.

Friday ended with a formal dinner set out in the conference room.

Saturday was tour day by 'bus. The weather began overcast with a threat of rain which quickly gave way to sunshine. In sequence we visited:

The semi-cylindrical equinoctial and an 'exported' English monastic polyhedral dial at Trinity College Hartford.

A vertical south dial at the First Church of Christ in Wethersfield

An unusual horizontal designed to suggest a boat anchor at a Newington library. (Fig.1)

'Sheng' - Robert Adzema's sculptural design at Tan Art Centre, Central State University.

A massive cube dial by R. Newton Mayall at Cigna Corporation, Bloomfield (gnomonless)

The standard time equinoctial at Loomis Chaffee School, Windsor. (Fig.2)

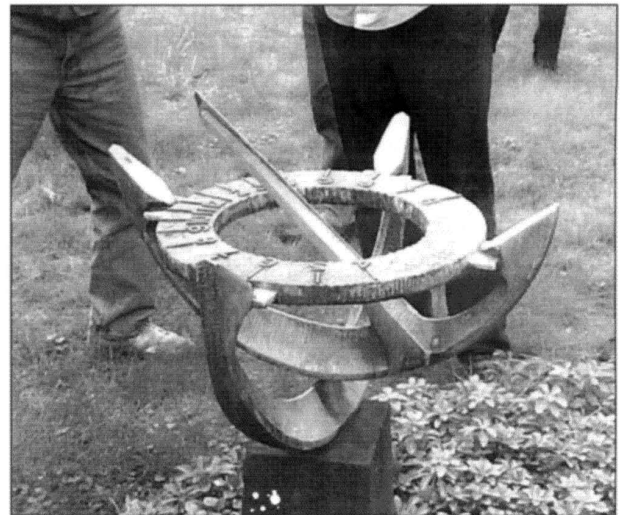


Fig.1. Horizontal Dial designed to resemble boat anchor, Lucy Robbins Well Memorial Library, Newington, CT.



Fig.2. Standard Time Equinoctial Dial, Loomis Chaffee School, Windsor, CT.

An excellent lunch in a converted water mill was followed on the terrace by Fred Sawyer's introduction to the Dent Dipleidoscope and then on to the University of Connecticut, Storrs, to see the Albert Waugh memorial garden with the recently-restored pillar dial he designed, Fig.3. (Why do 'restorers' always seem to replace gnomons upside down?) We then visited the archive collection where his books and papers are stored.

Sunday morning began with the Annual General Meeting followed by a paper by Harold Brandmaier on an analemmatic dial built at a summer camp.

'How Long is my Shadow?' was Roger Bailey's approach to designing another analemmatic dial. 'Under the Sun - Outreach' by Sara Schechner described sundial workshops



Fig. 3. Albert Waugh's Pillar Dial, University of Connecticut, Storrs, CT.

with children. This was followed by short papers on 'Sundial Sculptures in Stone and Brass' by John Carmichael in which he described many of his processes in detail. My own talk on making a new gnomon for a 19th C dial followed. Claude Hartman gave more examples of his creative approaches in 'A Flowerbed Dial & Skylight Dial'. Then came Mike Shaw on 'Plastic Pipe Dials' and 'The Diallists' Companion', then finally Harris Morrison on 'Marketing Portable Sundials'

All three of us Brits brought away enduring memories of three days spiced with learned discourse, nut-and-bolts 'know-how', and the special pleasure of being welcomed into the stimulating company of like-minded ladies and gentlemen. So who's for San Francisco next year?

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DAVID YOUNG BOWS OUT

It seems hardly possible to me that it was over ten years ago that the Society was born at a meeting at my home on 5th May 1989. At that time we had not yet found a name and did not quite know whether it was going to be a Society, Association or Club. We also did not know whether we would be able to attract enough members to make a start, although in the event, numbers rose to over 150 in the first year. Charles Aked took on the job of editor of our journal. In those early days this meant taking his typescript to the local photocopy shop, stapling the pages, stuffing them in envelopes and spending another hour or two at the Post Office sticking on stamps.

Tragically, Andrew Somerville, our first Chairman and inspiration to us all, died in June 1990 Christopher Daniel took his place and I took on the role of Secretary to the Society. In the succeeding years the expanding Council has endeavoured to guide the Society in the way that Andrew would have wished: that is, to treat our subject seriously but in a light-hearted manner. I hope we have succeeded.

During the last ten years the Society has continued to expand in many ways, and I have received many letters from members thanking the Council and myself for the work we have done to make the Society the success it has been. Now, in my turn, I would like to thank all members for their help and encouragement. For it is not only members of the Council or those who regularly attend our meetings to whom I am grateful, but also to the majority who pay their subs and (I hope) read and enjoy the Bulletin; for the Society could not exist without them. I hope to continue to be of service to the Society, but I am content that with Douglas Bateman as Secretary the British Sundial Society will be in good hands.

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THE DOWNSIDE CONNECTION

JANE WALKER

It was the kind of call I often receive as Education officer to the B.S.S.

"Help! I've made a sundial and it doesn't work - I think it's a mathematical problem". The caller usually gets 10 minutes or so of friendly chat and offers to put a cheque in the post at once if he can have a copy of *Make a Sundial* by return. This time though the caller was a monk from Downside Abbey, home of that well known recorder of dials on Somerset churches, Dom Ethelbert Horne. Naturally the Dom's name came up for discussion and my caller, Father Leo, then mentioned the Gatty Bequest, a collection of books on dialling which had lain untouched in the abbey library for some fifty years. The name Gatty was, of course, enough to have us offering to bring the book over; Downside is no more than 15 miles away, and a visit was arranged without delay. As well as a monastery, Downside is a school for Catholic boys where Father Leo teaches classics.

When we arrived, on Saturday afternoon, we first spent some time on the proposed dial, a vertical decliner to be made of teak in the monastery workshops and placed in a prominent position in the school quad. It was Father Leo's project and he was already familiar with Waugh as well as having dipped into the books of the Gatty collection. The monastery workshops are very well equipped and the combined efforts of Father Michael who is in charge of the carpenter's shop and Father Leo who, we discovered, has considerable skill in carving letters on wood, would result in a handsome dial. Our offer to return on the first sunny day to check the declination of the wall and to delineate the dial, with a declination line for St Gregory's Day March 12, was readily accepted. We were then taken to the library where we climbed to the fifth floor and to the Abbot's collection. In an alcove of polished wood were 59 books (arranged on three shelves) which had belonged to the Gatty family and were bequeathed to the Abbey in 1940. No doubt, at that time, an abbey library in the Somerset countryside appealed as a place of safe-keeping.

We spent the next three hours dipping and delving among 16th, 17th 18th and 19th century books, some in manuscript form, some printed on vellum, some beautifully bound, others almost too fragile to handle.

Almost all the books had been in the possession of Charles Tyndall Gatty who was resident in Venice in the 19th century and who wrote his name on the title pages as well

as making copious notes in the margins. The books were printed in Latin, Italian, French, Spanish, German and medieval English. Fortunately, Father Leo, who spent the afternoon with us, was able to translate most of these languages and, as many of the authors were also monks, was able to tell us something about their lives and traditions. A few of the books contained 'pop-up' models of dials made from the pages of earlier books. One 16th century monk had cut up a 14th century manuscript to make a gnomon.

We could accomplish little on that visit except to produce a tentative listing of the books and it was some months later before we returned with our treasurer, Nick Nicholls, and Elizabeth Wiggans, a librarian with experience of cataloguing ancient books.

As well as the books themselves, the history of bequest is interesting. A search of Downside's Old Boys Register revealed two boys with the surname Scott-Gatty, one who had attended from 1971-76 and the other from 1940-44. The elder of these had a local address and a phone call brought us the information that Charles Tyndall Gatty, whose name appears in many of the books, was the son of Mr and Mrs Alfred Gatty. He was born in 1851, had become very 'high Church', lived in Italy for much of his life, and was still alive in 1918.



There are four references to sundials 'in the possession of Charles T. Gatty F. S.A.' in *The Book of Sundials*, 1900 edition, which was revised by the daughter of Mrs Gatty, Horatia F.K. Eden, the sister of Charles Tyndall Gatty. In her preface she mentions that Mrs. Gatty's Father was the Rev. Alexander J Scott, D.D., Vicar of Catterick.

The dial at Downside was completed in 1997 and a photograph appeared in *Country Life* for October 1997. In 1998 Elizabeth Wiggans, with the permission of the Abbott of Downside, was commissioned by the BSS to compile a Bibliography of the books in the Gatty Bequest and this will be published by the Society.

In October 1998 members of the B.S.S Council were able to see both the dial and the books when a visit to the Abbey was combined with a council meeting in Somerset. B.S.S members who would like to visit the abbey library should make a request in writing to The Abbot of Downside, Stratton on the Fosse, Bath, BA3 4RH.

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ALBERT AND THE EQUATION OF TIME

COLIN McVEAN

One day in mid-February Albert woke to a brilliant sunny morning which made even London look attractive. He lived practically on the Greenwich meridian and he had recently made himself a horizontal dial which he had installed in his garden. After breakfast he thought he would look round his patch, which he did, timing himself by the sundial. Leaving himself sufficient time by the dial to catch his bus he set off, only to see the bus disappearing up the street.

The next day was Saturday when he did not work. The sun was out again so he took his watch out to check the dial which he found to be some twelve minutes slow. He was a member of the B.S.S. but he did not want to admit his ignorance and determined to find out what was amiss.

He was able to secure the necessary books from the library and the first thing he discovered was that there was something called The Equation of Time. This caused him some unease but he persevered and found that there was something called The Apparent Sun and another one called The Mean Sun. He looked up 'apparent' in the dictionary which said it means 'manifest' or 'palpable'. He thought that the sun was certainly manifest but was not so sure about palpable. He discovered that the apparent sun was not a good time keeper. People often referred to the sun as He, but Albert thought it more resembled a gorgeous and wayward woman, unreliable, given to fits of violence and rage. She could tempt you out then call up fearful storms, soak you to the skin and kill you off with pneumonia as it did Cezanne.

Then he thought sadly that the mean sun rather resembled himself, always doing the same thing at the same time. His kind neighbour Mrs Smith often told him that she set her

clock by him as he passed her window on the way to work. He could see that this kind of timekeeping would not exactly do for timing a moon mission.

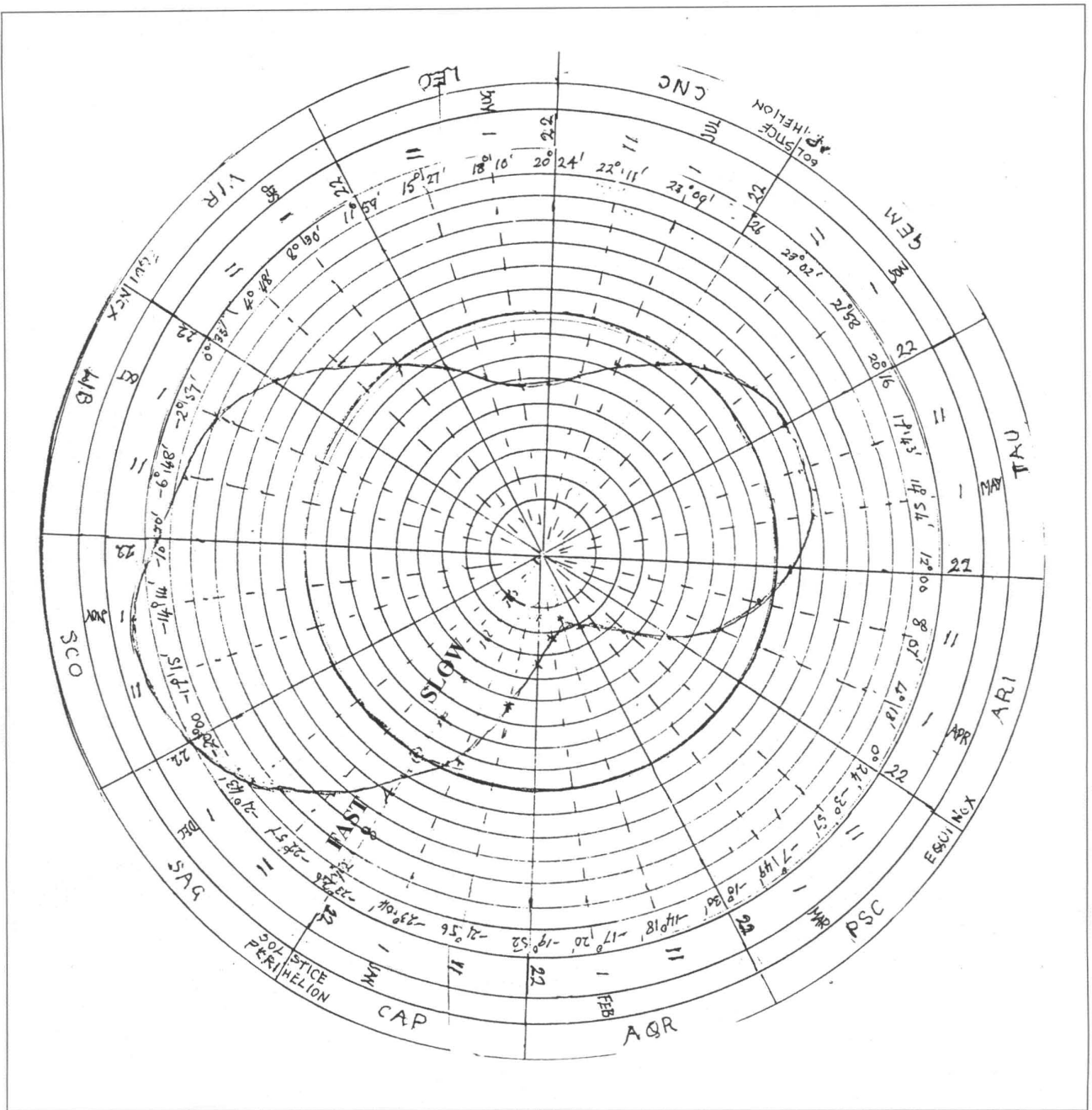
He discovered that the sun could be ahead of the clock as well as behind it and that it went faster at the solstices and slower after them. He found that the earth went round the sun in an ellipse and that it went faster when it was nearer the sun.

When the earth was nearest the sun it was said to be at Perihelion and when it was farthest away it was at Aphelion. Ap and Peri Helion might well be a Welsh couple, thought Albert. He could see that if he walked round a tree when he was close to it he would get round it more quickly than if he were further away. So the same would apply to the earth.

Reflecting generally on Time, Albert thought how much it apparently varied. School terms seemed endless whilst the holidays were over in a flash. The librarians stamped his books for a three weeks' loan but he suspected that there was something fishy about it as his books were always late.

Now he began to see daylight and understand how you would have to adjust the equation of time for whatever longitude you were on. If you were East of the Greenwich meridian the sun would be earlier and it would be later West of Greenwich. Then he made out a graph showing the variation of time against the declination of the sun, its place in the zodiac, the equinoxes and the solstices. This is what he drew.

*Gearings, London Rd
Fairford, Glos. GL7 4AW*



A graph showing the variation of time against the declination of the sun.

A HORIZONTAL DIAL WITH EQUATION-OF-TIME BUILT IN

JOHN SINGLETON

This dial is an alternative to the combination of a standard Horizontal and a correction curve for the equation of time.

The proposed dial is shown in Fig. 1 (London version, $\varnothing = 51.5^\circ\text{N}$). It has hour marks which may be regarded as unfolded analemmas, but also represent the sun's rays, or his beard. Dots may be added at quarter-hour intervals.

Concentric rings cover the calendar months in sequence, and the gnomon is a slender rod (inclined at angle \varnothing), which doubles as the nose of the sun. This is attached at the centre point of the circles.

*Old Coach House,
Salcome Road,
Newbury,
Berks, RG14 6ED.*

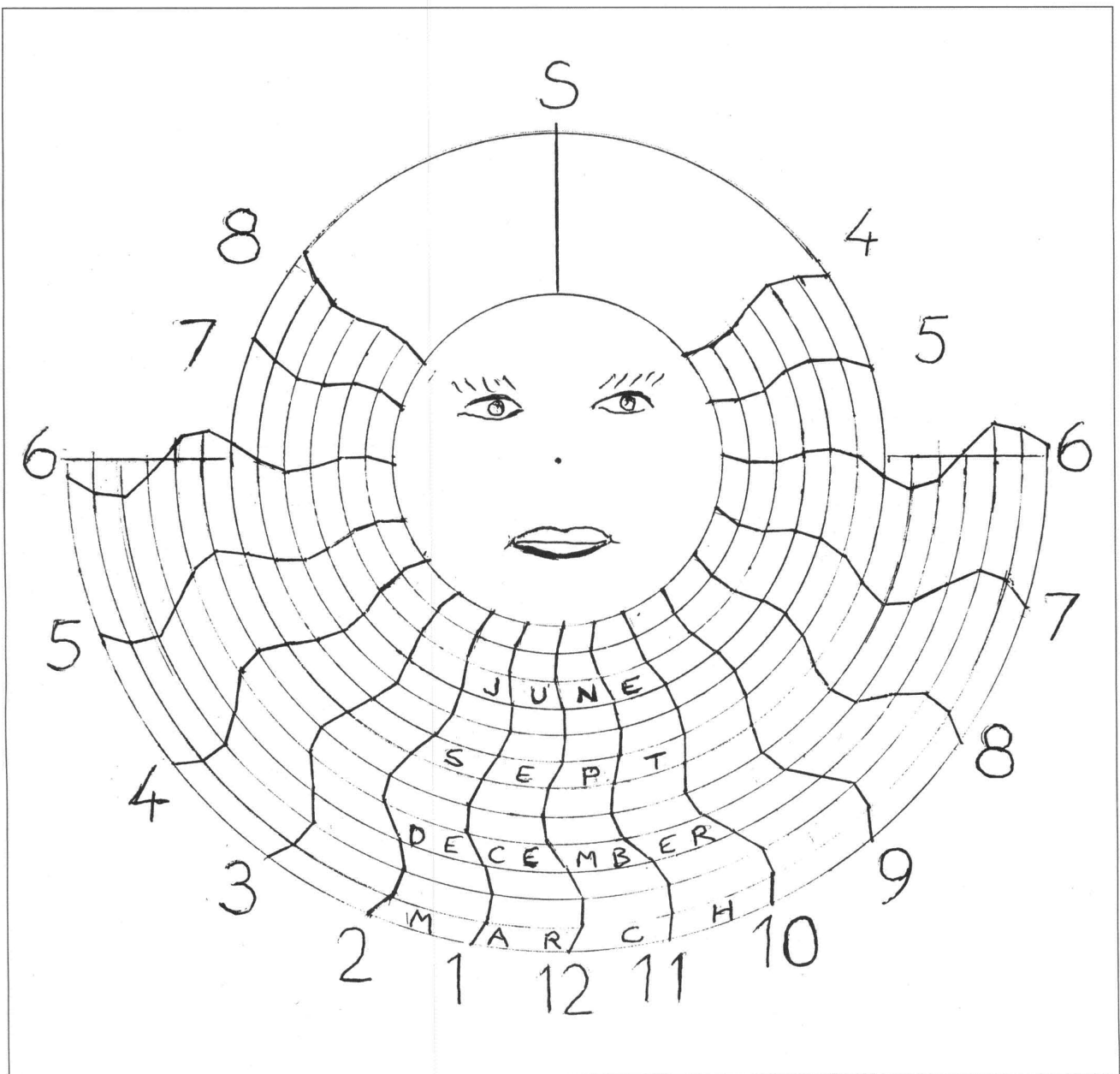


Fig.1. Horizontal Dial with the EOT built in.

QUOTATIONS

From John Aubrey's 'Brief Lives'

Henry Briggs (1561-1630)

'He was first of St.John's College in Cambridge. Sir Henry Savile sent for him and made him his geometry professor. He lived at Merton College, where he made the sundials at the buttresses of the east end of the chapel with a bullet for the axis'

(This sundial still exists and is in the BSS Register.)

Samuel Foster (?-1652)

'Was professor at Gresham College, London: where, in his lodging, on the wall of his chamber, is, of his own hand drawing, the best sundial I verily believe in the whole world. Among other things it shows you what o'clock 'tis at Jerusalem, Cairo etc. It is drawn very skilfully'.

St. Augustine of Hippo(c. A.D. 354) had a friend who said of Time:

'Time comes from the future which does not yet exist, into the present which has no duration, and goes into the past, which has ceased to exist.'

(So why do we make sundials?)

(Thanks to J.M. and C.McV. for these quotations)



Heliochronometer of Dunchurch - Goodbye!

We will not see you this year

(Photos by G. Aldred)

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