The British Sundial Society

BULLETIN

VOLUME 18(iii) SEPTEMBER 2006

GUIDELINES FOR CONTRIBUTORS

1. The editor welcomes contributions to the Bulletin on the subject of sundials and gnomonics; and by extension, of sun calendars, sun compasses and sun cannons. Contributions may be articles, photographs, drawings, designs, poems, stories, comments, notes, reports, reviews. Material which has already been published elsewhere in the English language, or which has been submitted for publication, will not normally be accepted. Articles may vary in length, but text should not usually exceed 4500 words.
2. Format: The preferred format for text is MS Word or text files sent by email to *john.davis@btinternet.com*. Material can also be sent on CD or as a single-sided typescript, single- or double-spaced, A4 paper.
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4. The Bulletin does not use footnotes. Where additional information is required, notes should be numbered as a Reference with a superscript number. For very long notes, use an appendix.
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   Examples:

   A.E. Waugh: *Sundials, their theory and construction.* Dover, New York, (1973).
   D. Colchester: 'A Polarized Light Sundial', *Bull BSS,* **96.2**, 13-15 (1996)
   A.A. Mills: 'Seasonal Hour Sundials', *Antiquarian Horol.* **19**, 142-170 (1990)
   W.S. Maddux: 'The Meridian on the Shortest Day', *NASS Compendium,* 4, 23-27 (1997).

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Front cover: *The Mk 1 Pilkington & Gibbs Helio-Chronometer at Dillington House, Illminster is mounted on a fine lichened baluster pedestal. It is one of the first hundred made with the P&G serial No. 83 and referenced in the BSS Register as SN0064. The dial plate is well patinated but not destructively corroded. In 1998 the parts would rotate freely but unfortunately the pedestal is leaning to the west. On Mk 1 HCs "G. J. GIBBS INVENIT" is engraved on the lower rim read facing south and "PILKINGTON & GIBBS, Ltd., PRESTON." is on the upper rim read facing north. Photo: Graham Aldred.*

Back cover: *St Mary and Holy Cross, Alderminster, Warwickshire. A very well preserved example of a mas-dial, neatly carved with lines and pocks, some going above the horizontal. Photo: John Lester.*

Designed by J. Davis. Printed by Doppler Press, Brentwood, 01277 224632

BULLETIN
OF THE BRITISH SUNDIAL SOCIETY

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EDITORIAL

In the June Bulletin (p. 61) we covered the story of the possible move of the Wren dial at All Souls College, Oxford. The move was a condition of a bequest from Dr John Simmons but was declined by All Souls as it was "too onerous". The story made the national press with three items on successive days in the *Daily Telegraph*. On the day of the announcement (13 June) our member Tony Ashmore was interviewed briefly on Central TV News, explaining the importance of the dial and the need for it to be accurately aligned. This gained some valuable publicity for the BSS.

The day after the decision, the *Telegraph* wrote:

Sundials - in the right place - are the future

The Oxford don who wouldn't let All Souls College have any money from his will unless they returned Sir Christopher Wren's sundial to its original position on the chapel wall has been portrayed as a sad old obsessive, trying to put the clock back.

Actually he was ahead of his time. David Cameron may talk about how Britain should move from the analogue to the digital age, but the country should really be returning to the age of the sundial. Wren, who studied at All Souls, had a keen interest in gnomonics, writing a treatise on the subject at 15. The sundial that he designed for the college in 1658 was moved from the chapel in the 1870s, with a result that would have horrified Wren - it no longer tells the correct time.

With global warming on the increase, sundials are obviously the most environmentally friendly, aesthetic timepieces. They don't need batteries, they don't use plastic, they won't rot and rust for years after they have been discarded and they never go wrong. If Mr Cameron has the planning application for a windmill on the roof of his new house turned down, he should build a sundial instead.

As a sundial society, we can only support these views, whatever our political allegiances!

Two articles on how to make a paper sundial have recently appeared; in the *Guardian* (Saturday 27 May) and the BBC *Sky at Night* magazine for June. The first was awful, not even showing that the gnomon had to be at a specific angle, and several members wrote (unpublished) letters to correct the article. The second, for a string-gnomon diptych, was rather good. More, please!

VISIT TO THE MUSEUM OF THE WORSHIPFUL COMPANY OF CLOCKMAKERS

On Monday 19th of June a party of 10 members of the Society were treated to a personal guided tour by the Keeper, Sir George White. Sir George talked us through a series of display panels and cases, all representing distinct developments in the history of horology.

Sir George White gives an introduction to the museum to a group of BSS members.

The Company was founded in 1631 after a difficult start. The earliest clocks were large iron framed constructions that initially struck bells, with dials and hands coming later. Such clocks relied on blacksmithing skills and even though small portable clocks were beginning to appear, the blacksmith's guild strongly opposed the formation of a new guild perceiving it as a threat to their metalworking skills. After some Royal lobbying, and following a period of political turmoil, the Company was founded. However it did not have a Hall of its own in the City of London. Instead it relied on renting rooms or lodging with other Guilds. Currently it occupies a favourable location as part of the Guildhall and has an office in the Salters' Hall.

Although the Company had a very strong nucleus of makers, and Thomas Tompion started a collection of books, it was not until about 1815 that clocks and other objects were given to the Company to form the beginnings of a museum. This date enables the Company to claim that it is the earliest formal collection of clocks. Many of the clocks were donated or bequeathed to the Company. Having quite a small display area, and despite the incredible quality and importance of the collection, it does not have a large purchasing fund. Nevertheless, the Company will add modern clocks and watches where their technicality or special interest is relevant.

Sir George explained that the guild system, whilst upholding quality and apprenticeships, also tended to stifle innovation. For example, the guild in Augsburg, with rules dating back to 1550, were still pursuing the same methods and apprentice masterpieces for over a 100 years. English makers were beginning to make their own watches during 1520 -1620, although many were still imported. Reputable makers were within the London guild, tightly controlled in the City boundaries, but examples were appearing outside this area. The fire of London in 1666 hastened the demise of the control and many guild members had their premises destroyed, and those outside were able to flourish. The advent of the pendulum and the rise of provincial makers encouraged more innovation leading to the rise of English clock and instrument making in the 18th century, of international repute.

Moving from display cabinet to cabinet, Sir George described the various types of clock and the progression to the wonderful artistry and technicalities of longcase, bracket clocks, watches and chronometers. A special place is reserved for a longcase clock by John Harrison and two of his wooden movements and of course his Watch H5, of marine timekeeper fame. The trunk door of the 1728 longcase clock has one of the first applications of the equation of time. What better compliment to Sir George's enthusiasm and knowledge can there be than to say that he held our rapt attention for an hour and a half.

The museum does have a number of sundials - a few portable dials with more in store - although the most obvious was the large horizontal by Elias Allen, mid-1600s, found by Charles Aked and reported in NASS Compendium 3(2), June 96. There is some debate over whether the gnomon is original - the existing one shows no sign of the vertical style in the dial centre that is needed to

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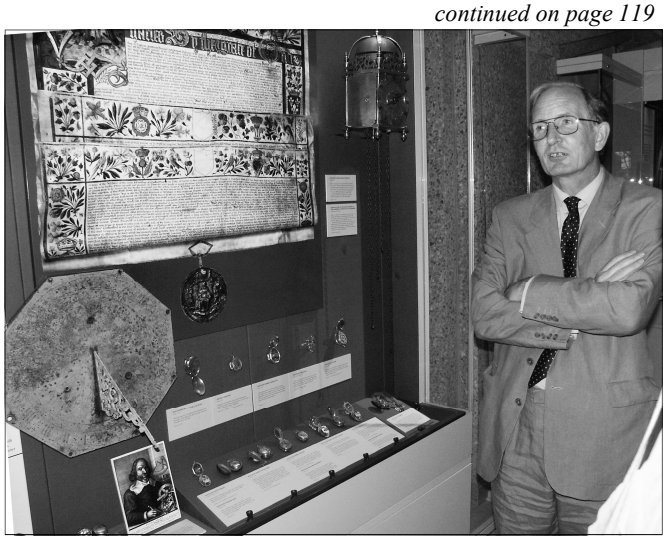


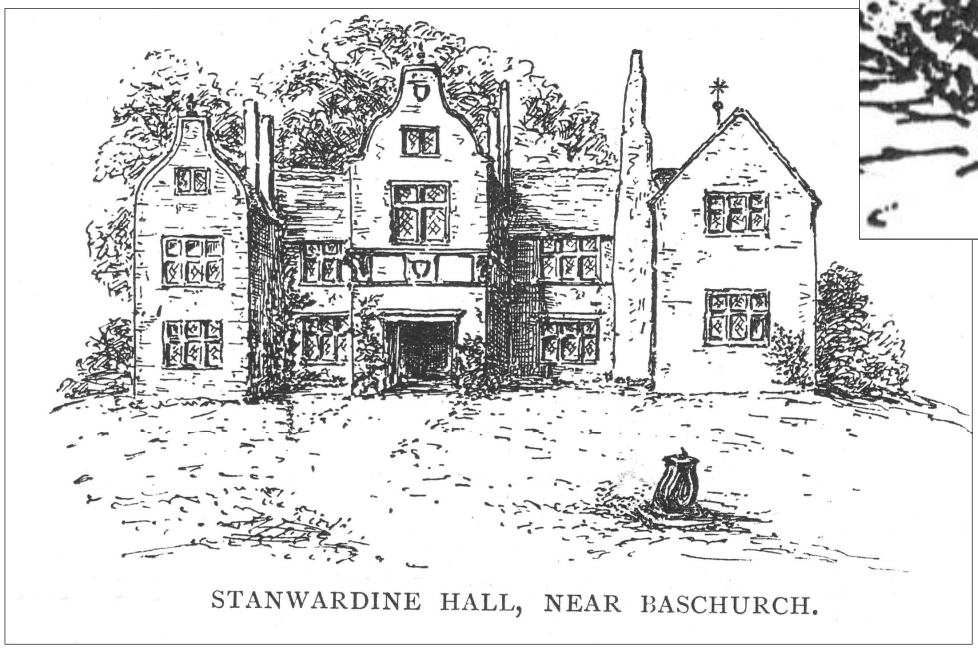
A replica of the colourful charter for the Guild, above a dial by one of its early masters, Elias Allen.

THE STANWARDINE HALL DIAL

JOHN DAVIS and HARRIET JAMES

INTRODUCTION

Mrs Gatty's famous *Book of Sun-Dials* includes two unusual mottoes from a horizontal dial at Stanwardine Hall near Ellesmere in Shropshire.[1] The dial is described in the first edition (1872) of the book and is also illustrated in the second and later editions: Fig. 1 is taken from the Eden and Lloyd (4th) edition of 1900. The date of 1560 given for the dial is very early for an English horizontal garden dial. Indeed, it would make it the third earliest metal garden horizontal in the country and the earliest not in a museum. In 2001/2 BSS member John Lester[2] went to look for the dial and discovered that it was missing and that the current owner of Stanwardine Hall, now used as a very imposing farmhouse, had been searching for it for some time.



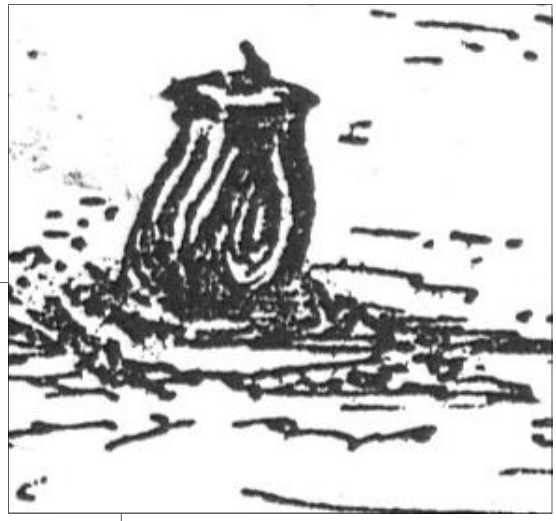


Fig. 1. Stanwardine Hall as illustrated in the Eden & Lloyd edition of Mrs Gatty's Book of Sundials. Inset: enlargement of the dial and pedestal.

In 2002 one of us (JD) came across the dial shown in Figure 2 at a house in Norfolk. The dial was dated 1560 and it was duly recorded but its significance was not immediately recognized. Then, in preparing for a paper at the 2005 BSS Holloway Conference,[3] the close similarity of the Norfolk dial and the Stanwardine Hall one was noted and further research commenced. The unique mottoes matched (give or take some minor spelling differences) and the heraldic devices were also as described. The shape of the pedestal is also very similar to that in the Gatty illustration. Thus it was quickly apparent that the dial described by Gatty in the 1870s was probably the same one as that now in Norfolk. If it could be proved that the dial really dated from 1560 then it would be an important addition to the small number of extant Elizabethan garden horizontal dials.[4]

PROVENANCE

In the early 20th century, Stanwardine Hall (Fig. 3) was owned by Mrs Ellis Brooke Cunliffe. She sold the Hall and moved to Petton Hall, only about a mile away, in 1920. She took the sundial with her and noted this fact, together with a brief history of Stanwardine, on the back of an engraved drawing of the Hall which still hangs in the dining room at Stanwardine. The dial passed via her daughter into the Fraser-Cunliffe family so that by the 1950s it was in the garden of a house at Hyde Park Gate in London. When the Fraser-Cunliffes moved to a house with a smaller garden they gave the dial, with its pedestal and some stone garden urns, to the parents of its current owners. They took the dial with them to Norfolk. This provenance, together with the match of the dial to Mrs Gatty's description, makes it very likely that the Stanwardine dial has indeed been located.

One feature of Mrs Gatty's description of the Stanwardine dial which does not seem to correspond to the Norfolk dial is that she describes it as silver whereas the green-blue patina of the Norfolk dial is strongly suggestive of a copper-based alloy, probably a brass. It seems very unlikely that a garden dial would be made in silver. A solid silver dial would quickly blacken in the atmosphere and any plating or silvering on a brass dial would fail within a few decades.

The authors are not aware of any such garden dial in existence. Mrs Gatty's description could have been copied from Bagshaw's gazetteer[5] rather than directly observed. Bagshaw wrote in 1851: *"In front of the hall is a pedestal of stone upon which is affixed a sundial: on the plate which is of silver, is a beautiful engraving and some fine tracery bearing the arms of the Corbets and the Wynns, and the date1560."*. In fact, none of the arms are of the Wynns (see below) so it is possible that Bagshaw was also wrong about the silver. However, a second description of the 'silver' dial was given by Forrest in 1924.[6]

DIAL DESCRIPTION

The sundial plate (Figs. 4 & 5) is 204 × 197 mm (approximately 8" square) and around 2mm thick. The origin of the delineation is in the geometric centre of the plate, a very common feature of dials made before around 1600.[3] The design is based on a number of concentric circles and is delineated for the hours and half-hours (with no finer divisions) between IIII am and VIII pm. There is no noon gap but it is clear from the single dot in the centre of the plate that the delineation was either for a very thin gnomon or for one with a knife edge, quite a common feature on the dials of the early makers such as Humfrey Cole (w. 1568-90) or Isaack Symmes (w. 1604-28).[4,7]

The gnomon on the Norfolk dial is shown in Fig. 4. It is about 3mm thick, has an angle of about 52.5° and has a simple geometrical pierced pattern. It does not look appropriate for a 16th century dial which usually had much thinner triangular sheet gnomons, often with a fimbriated northern edge. This suggests that it is a later replacement. An example of an early dial with a typical thin gnomon is the dial dated 1579 at Sulgrave Manor, Northants, made by 'GN'.[8]

All of the engraving on the dial is oriented to be read from south side. Along the top (in the NW and NE spandrels) is the motto:

IN+THE+HOWER+OF+DEATHE
GOD+BE+MERCIEVIL
VNTO+ME
FOR+AS+TYME+DOTH+HASTE
SOO+LYFE+DOTH+WASTE

Note that the font shown here is only an approximation to that used on the dial. A motto in the same vein,[9] also in capitals, is on two 1575 compendia by Humphrey Cole (see ref. 4 page 157).

In the centre of the dial, to the south of the gnomon, is a poem:

HE +THAT +WILL + THRIVE
MVSTE + RISE + AT + FIVE
HE+THAT+HATHE + THRIVEN
MAY + LIE + TILL + SEVEN
HE+THAT+WILL+NEVER+THRIVE
MAY + LIE + TILL + ALEVEN

This is known to be from an old nursery rhyme although the final two lines are usually given as:[10]

And he that by the plough would thrive,
Himself must either hold or drive.

The lettering and spellings of these inscriptions are characteristic of 16th century work. Note, for example, the + sign between the words, the 'W' formed by two overlapping 'V's and the ligatures for HE, NE and HR. The lines of the poem have been carefully justified despite the differences in their lengths. The standard of the engraving on the dial, both for the lettering and the heraldic symbols, is good for the period. It is, for example, much better than that of the Dinton church dial which has the numerals punched in.[11] It is possible that the engraving, particularly of the main hour numerals, was 'refreshed' at the time the gnomon was replaced although the appearance does not suggest this. There are very few known engravers of scientific instruments in the mid 16th century. Hind[12] lists 28 artistic or line-engravers in the whole Tudor period, of

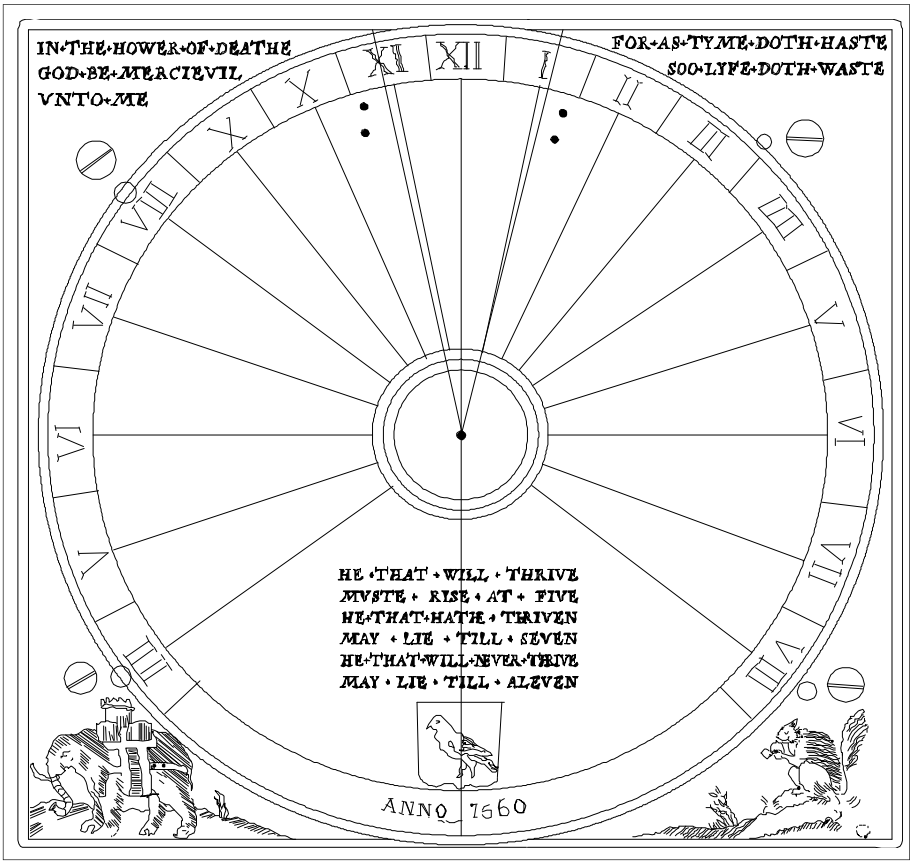


Fig. 5. Line drawing of the Norfolk dial plate by the author.

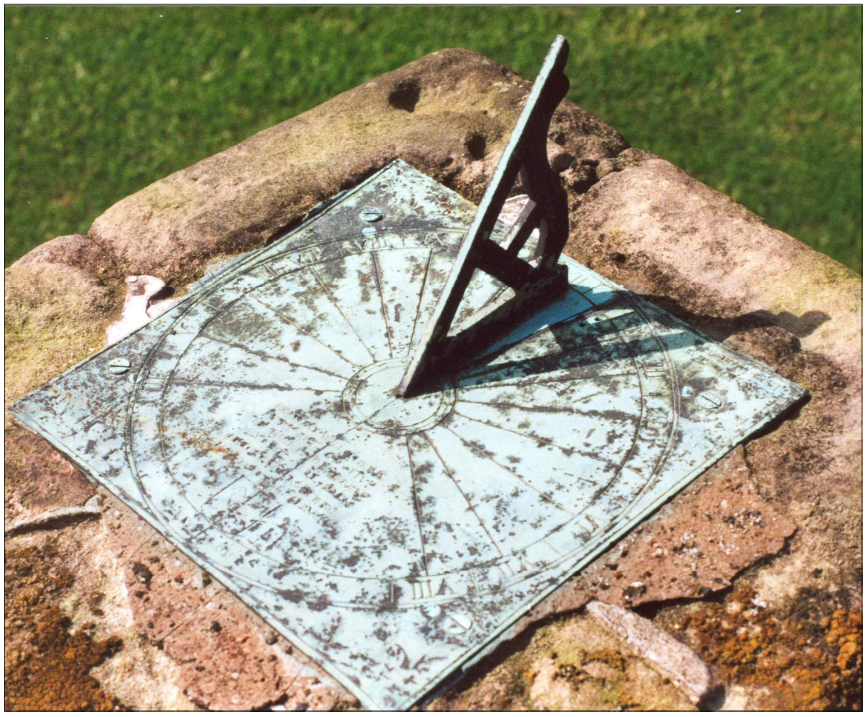


Fig. 2. The dial and pedestal currently located in Norfolk.

Fig. 3. Stanwardine Hall, Shropshire. The smaller pictures show the raven and elephant-and-castle motifs carved in the gables, and also the raven inlaid into the wooden panelling inside the hall.

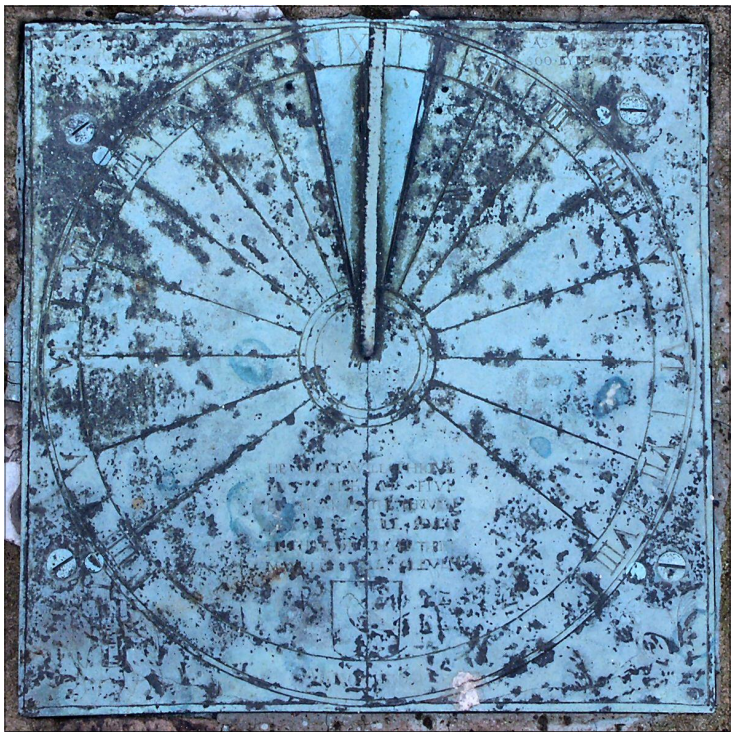


Fig. 4. The Norfolk dial plate and gnomon.

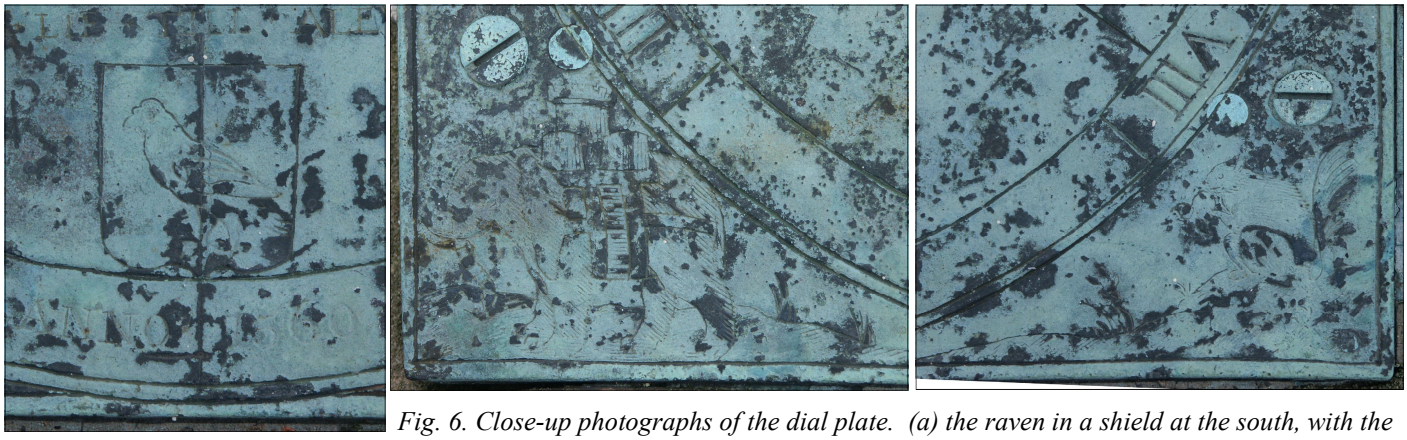


Fig. 6. Close-up photographs of the dial plate. (a) the raven in a shield at the south, with the date, (b) the elephant and castle in the SW spandrel, (c) the squirrel in the SE spandrel; note also the filled holes near the fixing screws.

Fig. 7. The replaced segment of the dial plate, shown by the different patination colour. Notice also the two pairs of holes.

Fig. 8. Close-up of the patina and corrosion products around the 'NO' of 'ANNO', seen at approximately 4× lifesize. Notice how the black corrosion clings to the edge of the engraving.

Fig. 11. Various Corbet motifs inside Moreton Corbet church. These include the stained glass windows and the carved and painted box tombs of Richard Corbet (d. 1567) and his wife Margaret.

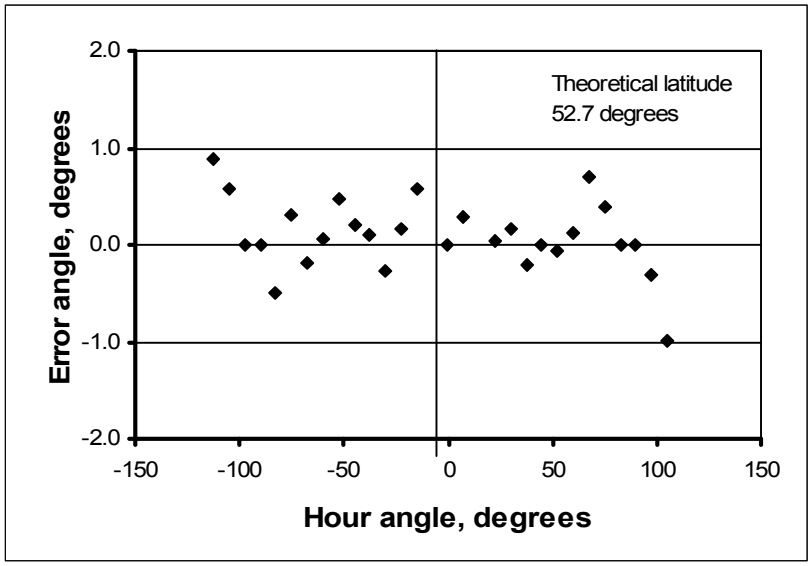


Fig. 9. Analysis of the accuracy of the hour lines.

whom four (Thomas Gemini, Augustine Ryther, Charles Whitwell and Humphrey Cole) are known to have made mathematical instruments. Clockmakers who also made instruments, such as Isaack Symmes, are not included in this list. The style of the lettering does not seem to match that of the immigrant Thomas Gemini who was known to be active in London at the date of the dial and who made the second earliest known English brass horizontal dial in 1551.[13] Gemini's very characteristic tiny miniscules contrast strongly with the exclusive use of upper case characters on the Stanwardine dial. The earliest English horizontal dial,[14] attributed to the Huguenot immigrant Nicholas Oursian (maker of the Hampton Court astronomical clock) and made in 1542, is closer in style to the Stanwardine dial.

Some similarities with the lettering of instrument maker James Kynvyn (w. 1584-c.1609) are apparent, particularly the extensive use of ligatures, but his earliest dated work is a compendium dated 1593.[4] The identity of 'GN' who made the Sulgrave Manor dial mentioned earlier is not known. If the Stanwardine dial really was engraved in 1560 then it opens the possibilities for other early developments in English engraved scientific instruments. Letter engraving in brass was already an old craft in Tudor England, such as on memorial brasses in churches. Particularly fine examples, with upper case lettering similar to that of the Stanwardine dial, are the gilt and enamelled copper stall-plates affixed to the backs of the choir stalls in St George's chapel, Windsor Castle, identifying individual Knights of the Garter. Examples for Sir William Parr and Sir Edward Seymour (1552 and 1537 respectively) are in the British Museum.

Figure 6 shows some details of the heraldic engraving. In the SW spandrel of the dial is an elephant with a castle on its back. In the centre of the southern edge is a simple shield with a raven in it. In the SE spandrel is an engraving of a squirrel *sejant*, i.e. sitting with its paws raised, eating a nut. (A squirrel is a rather appropriate symbol to have on a dial as the scientific Latin name is *sciuridae* from the Greek *sciouros* or *skia* (shade) + *oura* (tail).) These three heraldic devices are all frequently used by the Corbet family (see below). The Nicholas Oursian dial dated 1542, made for Henry VIII, has a Tudor rose and other decoration not dissimilar in style to the Stanwardine engraving.

The dial is currently screwed into a shallow recess on the top of the pedestal. Although both the capital of the pedestal and the dial are square, the two are misaligned by around 5°. The four retaining countersunk screws are brass and not heavily corroded but they cannot be easily undone without undue force: it is possible that they are leaded into the pedestal. Thus it has not been possible to examine the underside of the dial and the fixing of the gnomon. Four circular spots on the dialplate, each around 4mm in diameter and quite near to the fixing screws, can be seen because they have a slightly different tone of the blue-green patina. They appear to be earlier fixing holes which have been very carefully filled with brass of a slightly different composition. The engraved circle which forms the outside of the chapter ring has been carefully continued through these infills.

Close inspection of the dialplate shows that a narrow triangular segment, with its base from 11:00 am to 1:00 pm and its apex extending to the dial centre, has been replaced (see Fig. 7). This is clearly an old repair and it has been done with considerable skill: the match with the original dial surface is very good and the engraved numerals are continuous over the join between the old and new metal. Only a small difference in the colour of the patina, similar to that of the in-filled fixing holes, reveals the repair. It seems likely that at some time the original (thin) gnomon has been wrenched out, causing damage to the dialplate along the noon line. That this has been repaired so carefully by replacing the entire centre section of the dial shows the value and importance attached to the dial.

The repair presents another possibility for the mystery of the 'silver' dial. The repair may have been made in the early 19th century and the dial silver plated at that time, perhaps to hide the difference between the new and old brass. The industrial process for electroplating silver was patented in 1840 by the Elkingtons in Birmingham, only about 40 miles from Stanwardine.[15] The plating would have lasted long enough for Bagshaw and Mrs Gatty to have seen it but would have weathered away in the century since. Stanwardine is close to Coalbrookdale so the dial

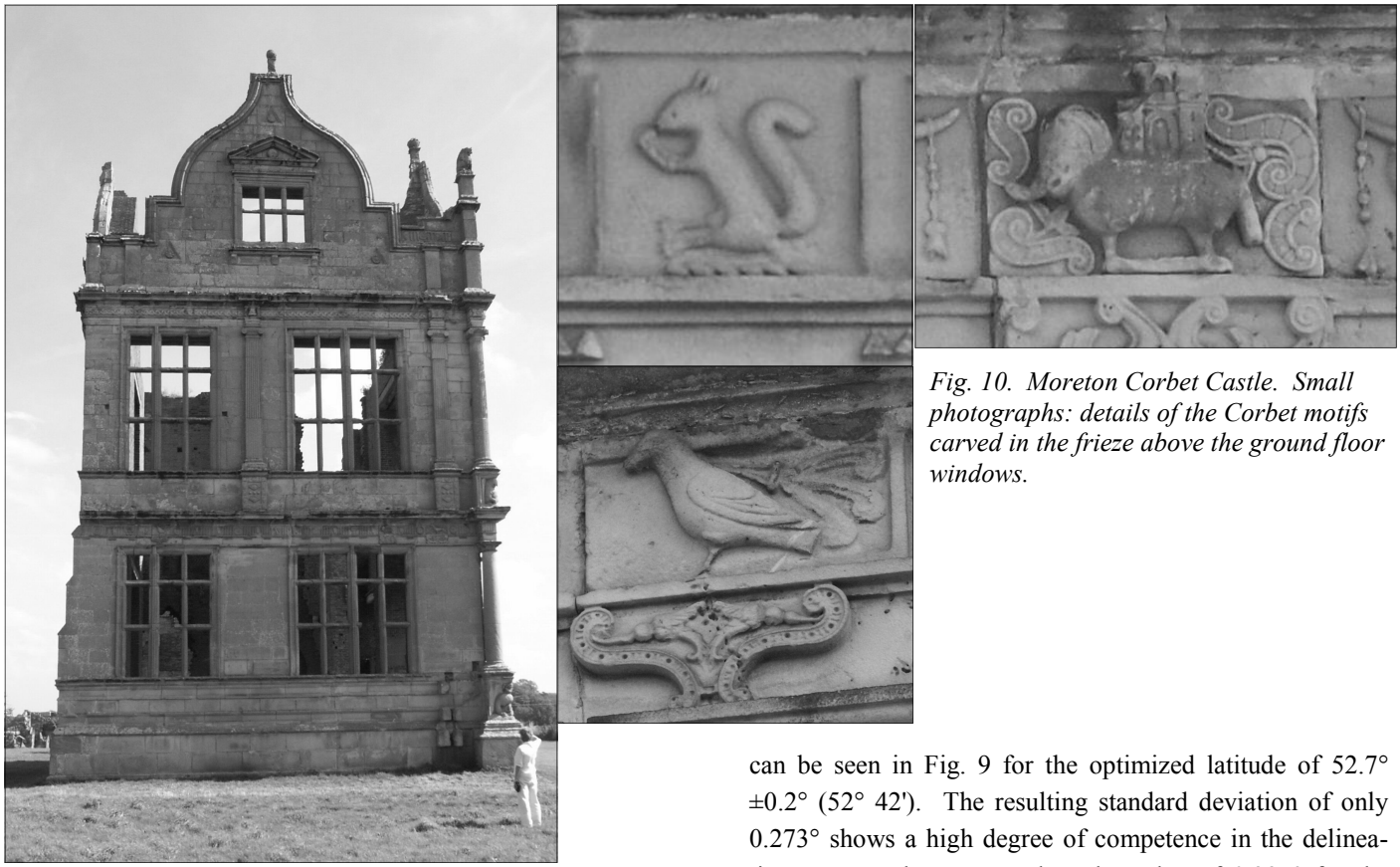


Fig. 10. Moreton Corbet Castle. Small photographs: details of the Corbet motifs carved in the frieze above the ground floor windows.

might have been exposed to the acid rain resulting from the burning of sulphurous coal during the industrial revolution. Figure 8 shows a close-up of the corrosion products on the surface of the dial. The very sharp division between the blue-green patina and the blackened areas could indicate that the latter is, in fact, the blackened silver sulphide remnants of some silver plating: they are not present in the replaced segment, perhaps due to differences in the adhesion of the layer. If the dial could be removed from the pedestal it should be possible to analyse the composition of the blackened areas by x-ray fluorescence methods.

There are two pairs of small holes (approx. 2.5mm diameter) in the original dialplate either side of the gnomon (Fig. 7). It is not entirely clear what these were for. One possible suggestion is that they were the fixings for a vertical crosspiece supporting the original thin sheet gnomon, bracing it perpendicular to the dialplate. Such a structure can be seen on the 1579 horizontal dial of Humphrey Cole currently in the Oxford Museum of the History of Science.[4] Alternatively, they may be associated with an earlier repair to the gnomon, now removed.

The delineation of the dial has been analysed by measuring the angles of all the hour- and half-hour lines (excluding those on the replaced section of the dialplate) to an estimated accuracy of 0.1° from a rubbing of the dialplate. These measured angles were compared with the theoretical values for an ideal dial drawn for a latitude which minimized the standard deviation of the errors. The error profile can be seen in Fig. 9 for the optimized latitude of 52.7° ±0.2° (52° 42'). The resulting standard deviation of only 0.273° shows a high degree of competence in the delineation. It may be compared to the value of 0.225° for the slightly later (1665) Thomas Soame dial in Cambridgeshire.[16] The design latitude is a very good fit to the actual latitude of 52° 50.9' for Stanwardine Hall (or 52° 48.2' for the nearby Moreton Corbet Castle).

HISTORY

According to the historian Richard Gough, writing in 1701,[17] Stanwardine Hall (Fig. 3) was built on the site of an older moated house by Robert Corbet I (d. 1593), son of Roger Corbet of Shawbury. Robert Corbet gained the Stanwardine property, and several others, when he married Jane Kinaston in 1560 (the date of the dial). He was the younger brother of Sir Andrew Corbet of Moreton Corbet Castle. The 'new' Stanwardine Hall is generally believed to have been built over the period 1580-88 and thus is some twenty years younger than the dial. The gable ends of the hall feature the raven and the elephant and castle which have been heraldic emblems of the Corbets for many generations. Note that the French for crow (or raven) is *corbeau*. The Corbet family is thought to have come from Normandy with the 1066 invasion. The raven is thus a symbolic representation of the Corbet name. It is also inlaid into the wooden paneling of the Hall, together with the date 1588 and the initials C RI, standing for Corbet, Robert and Jane. The elephant emblem is thought[5] to have originated from the Scottish family of Olliphant which the Corbets defeated in the medieval period. The squirrel symbol engraved on the dial has not so far been found at the Hall. Stanwardine Hall remained in the Corbet family until 1700 when it was

sold (or possibly lost as a result of a wager on a snail race![18]) to Sir John Wynn(e) of Watstay. It remained in the Wynne family until c.1818 when it was sold to become part of the Petton estate. The only visible sign of Sir John Wynne's ownership of the hall is a carving in the stone wall of a room above the kitchen which reads: "Sr I W / Knt & Bat / 1713" (i.e. Sir John Wynne, Knight & Baronet).

The ancestral home of the Corbets is Moreton Corbet Castle,[19] situated about 10 miles south east of Stanwardine Hall. This medieval castle (Fig. 10) was extensively updated by Sir Andrew Corbet's son, another Robert (1542-83). Sir Andrew died in 1578/9 and there is a carved stone reading 'SAC 1579' to commemorate this above the main entrance. Robert Corbet II continued his father's work on the castle until he died of the plague in 1583.[20-22] Robert was educated at Clare College, Cambridge (entered 1559) and in 1561 his great-uncle Reginald arranged for him to be admitted to the Middle Temple, where the arms of three Corbets are displayed in stained glass.[23] He was a favourite of Elizabeth I, a courtier and diplomat of the highest influence, and as such he travelled extensively throughout Europe. On one early trip he was accompanied by the young Phillip (later Sir Phillip) Sidney. (Sir Phillip Sidney's home, Penshurst Place in Kent, has two stone multiple dials which probably date from this period. Very recently, a brass horizontal dial made in 1585 for Sir Phillip Sidney's father, Sir Henry, was rediscovered at Penshurst.[28] It is currently undergoing further research.) At that time the new classical architecture, modelled on the buildings of ancient Rome, was becoming popular and Robert wanted to bring it back home to Shropshire. So, using engravings of architectural details, an impressive new house was built as a single south range incorporating the much-adapted 13th century building and constructed over part of the old castle.

The work on this new Elizabethan wing at Moreton Corbet, which included a large formal garden, was continued by Robert's brothers after his death in 1583. The garden was in the form of a 130m square earthworks and included a mound at its centre.[24] A survey[25] of the castle in 1588 includes a description of the garden which contains the words: *in medio cuius gardini sunt diversa solaria in uno saxo sculpta….* This translates as: 'in the middle of this garden are several sundials carved in one piece of stone' and can only be the description of a stone multiple dial. It is worth mentioning that the famous 4-foot stone cube dial at Madeley Court is only about 14 miles from Moreton Corbet and is dated to about the same period.[26] It is possible that the missing Moreton Court dial was to the same pattern and, perhaps, by the same hand. Whatever the case, it reinforces the view that the Corbet family were keen on sundials. Another inventory[27] of the contents of the castle was made in 1623 but unfortunately it does not extend to the garden and there is no mention of sundials.

During the English Civil War the castle was taken over by the Parliamentarians and afterwards abandoned by the Corbets, although it still remains in their ownership. It is now a ruin and is administered by English Heritage. The stone frieze around the Elizabethan wing has various symbols and emblems carved in it and these include the raven, the elephant and castle and, in this case, the squirrel of the Corbet family (Fig. 10). It is also notable that the lower levels of the castle are made of the local Shropshire sandstone which seems to match that of the Norfolk sundial pedestal.

Moreton Corbet church is adjacent to the castle and has many tombs and references to the Corbet family, right through to the 20th century. Many of these, including the stained glass windows and two pairs of striking painted box tombs, feature the squirrel, raven and elephant and castle (Fig. 11). In the town of Shawbury, about a mile from Moreton Corbet castle, the local pub is called the Elephant and Castle and has this sign in its stained glass windows.

Another artifact from Moreton Corbet Castle exists in the form of a carved wooden four-poster bed. Now in the Rowley's House Museum in Shrewsbury and on loan from the V&A, it also features an inlaid raven and the inscription 'RC 1593', thought to be for either Robert Corbet's son or brother, both Richard.

CONCLUDING SPECULATIONS & REMARKS

It is possible that the Stanwardine dial is a Victorian 'fake' but it seems unlikely that a forger would have been so careful with the engraving style but so careless with the shape of the replacement gnomon. Also, surely they would not have made the extensive repair. Assuming that the dial really does date from 1560, it is possible that it was originally located at Moreton Corbet Castle or at the 'old' Stanwardine Hall. It is not clear which of the Corbets it would have been made for; Robert I, Robert II or Sir Andrew. It would have fitted in well with the grand Elizabethan houses being planned for Stanwardine and Moreton Corbet. It is not known when the extensive repairs to the dial were made. Mrs Ellis Brooke Cunliffe thought sufficiently highly of the dial to remove it from Stanwardine when she moved so it is possible that the repairs were made in her lifetime.

The dial gives a fascinating insight into the abilities of early diallists to delineate accurate dials and to produce good quality pictorial engravings. There can only have been a handful of engravers capable of this in England at the time.

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9. The motto on the Humphey Cole compendia reads:
   AS TYME AND HOVRS PASITH AWAYE
   SO DOETH THE LIFE OF MAN DECAY
   AS TIME CAN BE REDEMED WITH NO COSTE
   BESTOW IT WELL AND LET NO HOWR BE LOST
10. 'Lost Lyrics of Old Nursery Rhymes' website at www.rhymes.org.uk
11. C.St.J.H. Daniel: 'The Dinton Church Sundial', *BSS Bull,* 14(iv), pp 150-154, (2002).
12. A.M. Hind: *Engraving in England in the Sixteenth and Seventeenth Centuries, part I – the Tudor Period*, Cambridge University Press, Cambridge, (1952).
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15. http://en.wikipedia.org/wiki/Electroplating#History
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26. C. St. J.H. Daniel: *The Multiple Sundials of England*, unpublished monograph (1993).
27. 'Inventory of Moreton Corbet Castle and the effects of Sir Vincent Corbet deceased (14 May 1623).' Shropshire Archives SRO 322 Box 59.
28. We are grateful to David Brown and Viscount De Lisle for alerting us to this dial.

ACKNOWLEDGEMENTS

It is a pleasure to thank the following people for their help in writing this paper: David Bridge, William Bridge, Neil Foster, John Lester, Mike Shaw, Mike Cowham, Paul Remfry, Marion Roberts (Shropshire Archaeological & Historical Society), Lesley Whitelaw (Middle Temple archivist), Sarah Davis (Shropshire Records Office), Simon Oakes (Society of Archaeological Historians of GB), Barbara Coulton, Christopher Daniel, George Huxley.

TIME TO MOVE

Many members may use a radio-controlled clock to set their sundials. These clocks rely (in the UK) on a radio signal broadcast from Rugby, started by the Post Office in 1927 and now continued by BT.

Since 1950, the National Physical Laboratory (NPL) has been responsible for providing the high-accuracy 60kHz signal to Rugby. Now, a new contract for broadcasting the signal has been placed with a communications services company VT Communications and the transmission will be moved from Rugby to Anthorn, on the west coast of Cumbria, in March 2007.

The longwave timesignal is accurate to within one millisecond of Universal Time (UT). Local atomic clocks at Anthorn will be locked to the master NPL caesium fountain clock at Teddington in south west London. The NPL clock, with an underlying accuracy of 2 parts in 10^{12} , is one of just five worldwide which contribute to the world time standard Coordinated Universal Time (UTC).

The signal, often referred to as 'The time from Rugby' will in future be known as 'The Time from NPL'.

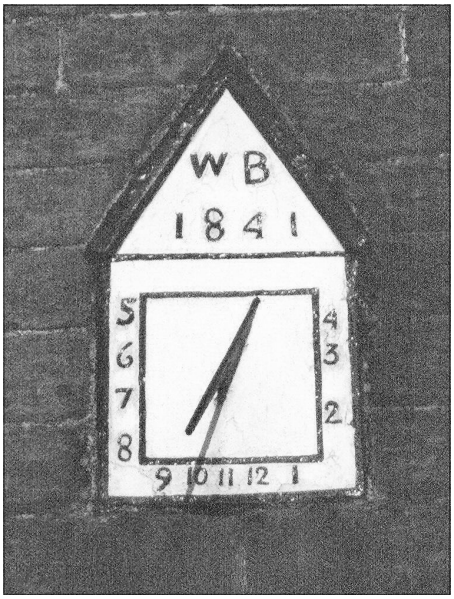
TIME AND PLACE

JOHN WALL

There must be many members of our Society who keep a catalogue of local sundials, as I do to support a slide show titled 'The Sundials of Ryedale'. The tally so far is 62. Sources of information to pinpoint local sundials in situ are many, including historical records, word of mouth and, of course, the Society's Register. However, I have found that a very fruitful source is cartography, and in particular the Ordnance Survey maps of my home ground – hence the title of this article. Among other names they have yielded Sundial Farm in the village of Cawston. The romantic Yorkshire custom of inscribing the initials of a newly wed couple on the lintel of the door of their new home has been adapted as part of the furniture of a sundial on the lintel

Fig. 1. Sundial Farm, Cawton Village, near Hovingam, North Yorkshire.

Fig.2. (right). Dial House, Hutton le Hole, Ryedale. Named for the sundial over the porch that incorporates the initials of the newly-weds for whom this was their first home.



itself – I.R. and O.W. – together with the date, 1804. There is a similar sundial on a farmhouse in the picture postcard village of Hutton le Hole in the North Yorkshire Moors. Again, the letters W and B appear as part of the furniture, no doubt the initials of the first newly married residents who took possession in 1841. Not surprisingly, this residence has been known as Dial House ever since.

There is another Sundial House in the village of Gillamoor to the north of Kirkbymoorside. It could hardly bear any other name for immediately in front, by the side of the road, stands a unique and very elaborate sundial. It is unique because the equation of time

Fig. 3. Dial House, Gillamoor Village, North Yorkshire. The sundial was originally within the garden wall, which has since been put back to give the public greater access.

is inscribed on the bevelled top of a circular stone column that in its turn carries a pillar dial with four faces, surmounted by a globe. It was designed in 1802 by a local schoolmaster, John Russell, and erected in the front garden of his home which has been known ever since as Dial House.

A word of caution, however. Names can be misleading. Dialstone House appears on the map in a remote part of the Hambleton Hills just north of Sutton Bank in North Yorkshire. Alas, when I visited, no sundial came to light. It transpired that the Hambleton area has been associated with horse racing since the early 17th century. Racegoers would have used either the Hambleton Inn or the Dialstone Inn. The unusual name for the latter is derived from the dial or weighing machine used to weigh-in the jockeys. In the wall adjacent to Dialstone House, now a farmhouse, is a large flat stone on which the weighing machine stood. So a degree of caution is called for – there are dials other than sundials.

In the same vein, on walking down Lendal (Street) in the City of York I was intrigued to note that a ladies' outfitters bore the simple title 'Sundial'. Greatly daring I entered and asked the assistant 'Why Sundial?' Answer – because the hour numerals on a sundial neatly correspond to the notation for

sizes of ladies clothes! On the other hand it is evident that the modern 'Sundial Hotel' in Northallerton is named for the sundial in its forecourt. Bearing in mind that the hotel was opened by no less an eminent politician than 'The Right Honourable Sir Leon Brittan, British Commissioner to the European Communities. On 17th June 1989', it is a pity that the eponymous sundial is a small off-the-peg affair barely 10 inches in diameter, simply inscribed 'Sunny Hours'.

Fig. 4. Hotel Sundial, Northallerton, North Yorkshire.

These reflections have been prompted by my recent purchase of a quite rare, out-of-print *Ordnance Survey Gazetteer of Great Britain* (Second Edition 1989). This remarkable volume includes 'All names from the 1:50,000 (two and a half inches to one mile) Landranger Map Series'. As a tool for seeking out sundial-related place names it is invaluable. Each entry includes the name of the place, its county, grid reference, latitude and longitude, feature code, and the number of the sheet in the Landranger Series. The scale of 1:50,000 is large enough to catch in its net a number of Dial Farms, as well as the more specific Dial Hall, Dial House, and Dial Post farms. Dial Close, Dial Green, and Dial Hill would repay further investigation to rule them in or out of our catalogue of sundials.

There are a number of places that, if they do not possess a sundial, certainly ought to have one installed. Among them are Sunrise Farm in North Yorkshire, Sun Rise in Warwickshire, Sunrise Estate in Cornwall, and at the other end of the scale, Sunset in Hereford and Worcester. So also the many places that incorporate Noon in their title, from Noon Folly Farm and ranging through Noonhill, Noon Nick, Noonsbrough, Noonstone to Noon Sun. I was disappointed to find that there are no places that incorporate Meridian in their title. (However, the advent of the new Millennium may have changed the situation). The nearest approximation is 'Meriden' in four locations. Perhaps some member of the Society who is fortunate enough to live somewhere on Longitude 0° would care to rename his home 'Meridian Manor', and install a commemorative sundial in his garden there? (It would be interesting to discover how many members have named their residence Sundial House, or some such title. Perhaps this article itself may stimulate other members to do likewise?)

As yet there is no Gazetteer for the 1:25,00 Pathfinder and Outdoor Leisure Series. At twice the scale of the Landranger Series it would net four times as many possible place names than it's 1:50,000 counterpart.

From Ordnance Survey maps we turn to street maps and atlases of our major towns and cities. Most of these are accompanied by an Index/Gazetteer that should yield at least one sundial-related name. The Greater London Street Atlas published by the AA and the similar A-Z Directory are happy hunting grounds, in which 'Seven Dials' takes pride of place. In the first instance this is the name of a junction of seven streets and thoroughfares just to the west of Covent Garden. In the 1690's a pillar sundial was designed and constructed by a leading stonemason, and placed at the meeting point of the seven highways. That being so, and given the name 'Seven Dials', one would have thought that the pillar would have been surmounted by seven dial faces, each one facing its corresponding street. That cannot now be verified since the original 'Seven Dials' has been removed elsewhere. (A story circulated that it was demolished by a mob in 1773 searching for buried gold, but it is now thought to have been removed to rid the district of 'undesirables' who congregated round its base.)

It is probable that the original had six and not seven dial faces because, although there are three thoroughfares that continue across the intersection that together provide six 'spokes' – Earlham Street, Monmouth Street and Mercer Street – the odd one out is Shorts Gardens in the angle between Monmouth Street and Earlham Street. It would have been problematic to position a seventh dial to face this street, without destroying the even spacing of the other six. There is an alternative theory that 'Seven Dials' refers to the six dial faces, the seventh 'style' being the pillar itself.

In the 1980s it was decided to erect a new pillar dial at the London site, using the original drawings held at the British Museum. The actual dial stone, which weighs a tonne, was designed, carved and gilded by Caroline Webb. It was erected in 1989 and it is reported that the six dials are accurate to within 10 seconds! (Details from *Sundials of the British Isles*, edited by Mike Cowham, Cambridge 2005.)

The neighbourhood of Seven Dials for long had an unsavoury reputation. It is mentioned briefly towards the end of Charles Dickens' *Nicholas Nickleby* when the eponymous hero and his sister 'had so much to talk about, that it was not until they had plunged for a full half-hour into that laby-

rinth of streets that lie between Seven Dials and Soho … that Nicholas began to think that they might have lost their way'. Although Agatha Christie's crime novel *The Seven Dials Mystery* refers initially to the dials of seven clocks, the 'Seven Dials Club' that lies at the heart of this detective story takes its name, appropriately, from the sordid neighbourhood in which it is located. To my knowledge, although there are undoubtedly multiple sundials elsewhere with upwards of two faces, 'Seven Dials' in London is the only one to be incorporated in a place-name.

Seven Dials is by no means the only sundial-related place-name recorded in the Greater London Atlas and the A-Z Directory. 'Sundial' itself is recorded only twice, in Sundial Avenue, and Sundial Walk in Kensington Gardens just to the south of Kensington Palace. As with the Ordnance Survey Gazetteer there are many streets that deserve to have a sundial sited there, if they do not already have one. They include Sunrise Avenue and no less than six streets that incorporate 'Sunset' – although not as yet 'Sunset Boulevarde'! In one respect the AA Gazetteer and A-Z Directory score over the Ordnance Survey in recording three 'Meridians' where the siting of a figure-of-eight analemmic or modern noon-marking mean-time sundial would be highly appropriate.

In conclusion, sundial-related place names is a fascinating and rewarding study. My final plea therefore, for the benefit of posterity, is that members of the Society whose homes are liable to be named on an Ordnance Survey map should christen them 'Dial House' or some such equivalent. That would greatly assist those of us who continue to search out dials in situ for sunny generations to come.

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Postscript

By coincidence, our member Norman Darwood of Southampton has recently sent me a postcard from the Sun Dial Motel, Panama City, Florida. So sundial placenames are not just a UK sport! Ed.

READERS' LETTERS

ROMAN NUMERALS

If you examine Mrs Crowley's sundial drawings you will find examples in Devon, and more commonly in Cornwall, of dials on which the Roman numerals from VI to IX are apparently the wrong way round. The dial at St Ive (not St Ives) show this phenomenon – see photograph. Even the Berry family made dials like this (at Braunton and Bittadon) and it is always regarded as an error ("the Vs are upside down" to quote the Register). Burge[1] discusses this and he also considers it a mistake. The anomaly occurs so often (10 examples amongst the drawings and there may well be many more[2]) that it is surely we who are mistaken. These old diallists were not ignorant, they knew perfectly well what they were doing, which was to use what I have come to think of as 'the anticlockwise convention'. In this, the component letters of each numeral are read from inside the chapter ring in a consistently anticlockwise direction. It is a logical system and, I am sure, was at that time regarded as an alternative and entirely legitimate way of doing things though it later became outdated. It is time we stopped thinking there is only one right way of doing anything!

1. L. Burge: *Cornish Church Sundials*, Short Run Press Ltd., Exeter (2002).
2. The full list is: Devon – Bittadon, Braunton, Clawton. Cornwall – Quethiock, Liskeard, St Ive, St Martin by Looe, Braddock, Boconnoc, Lansallos. (Burge adds Menheniot, Maker, Botus Fleming - but he is wrong about the last.)

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WIGMORE GRANGE

A picture on p.59 of the June issue of the BSS Bulletin (18 (ii)) shows the dial from Wigmore Grange as illustrated by Eden & Lloyd (Mrs Gatty). It reminds me that this dial was copied and marketed by the Birmingham firm of Pearson-Page in the mid 20th century. Several of their catalogues clearly show this dial, their model 4208. It was made in eight sizes, 6in, 8in, 10in, 12in, 14in, 15in, 16in & 18in. Although a round dial is illustrated it was also available on request in square or octagonal form. This dial is one that Pearson-Page produced by hand engraving so they were able to make these to suit 'your latitude or locality'.

continued on page 117

THE RECREATION OF A NEGRETTI & ZAMBRA VERTICAL DIAL

BEN JONES

There are five dials by Negretti and Zambra in the 2005 BSS Sundial Register. In June 2005 a further dial came to light in Devon. It was a slate vertical declining dial, probably installed in the 1880s.

Fig. 1. The pieces of the original slate dial, as exhibited at the Newbury meeting, September 2005.

Unfortunately the steel screws that held the dial in place had rusted away and it fell from its niche, breaking into small pieces (see Fig. 1). The owner of the dial wanted it repaired or replaced. With the pieces being so many and so small we soon agreed that the best solution was to make a copy. The fragments are now safely stored in the owner's house so the original dial has not left the site.

The hour lines and numerals were V incised and narrow. Other lines had been carved with a U shaped gouge, which suggested that the dial had been gilded originally. A little piece of gilding had indeed survived under one of the brackets that held the gnomon in place. Using a gouge may be good for gilding but it makes the lines quite shallow. As the new dial was not to be gilded it was decided to make the numerals and lines slightly bolder and deeper and all V incised. Without its gilding the old dial had not been that easy to read.

The gnomon is odd in that it has a 'knife edge' style. This means that from about 11am to 3pm the shadow is cast not by the style but by the side of the gnomon. We did consider making a new conventional gnomon and putting in a noon gap on the new dial face. But as the gnomon could be repaired and kept in service this quirk of the original design was kept. Also in its favour the gnomon had the name of Negretti and Zambra neatly engraved on one side so it would have been a great shame to lose it. The fall had bent the gnomon and the long unsupported end had drooped over the years too. Tony Moss very quickly straightened it all out.

From the fragments of dial the sub-style and some of the hour angles could be approximated. They were all pretty much in agreement with the actual declination of the wall and the gnomon angle. So it seems a fair bet that the dial had been in its original location.

Figs. 2 & 3. The recreated dial, installed to replace the original.

The finished dial can be seen in Figs. 2 & 3. Carving all the lines took a while but was a straightforward job. I set out the hour lines using a unit square. The inscription at the top of the original dial was 'Negretti & Zambra, Opticians, London'. The original letters were really badly spaced, something else I did not copy exactly. There was some discussion about how to indicate that this new dial is a replacement for an earlier one. I took advice from fellow BSS members and the general consensus of opinion was that the addition of a date with the new maker's name was all that was needed.

Setting up scaffolding and then waiting for the sun to shine are the main problems with installing a dial. There were great

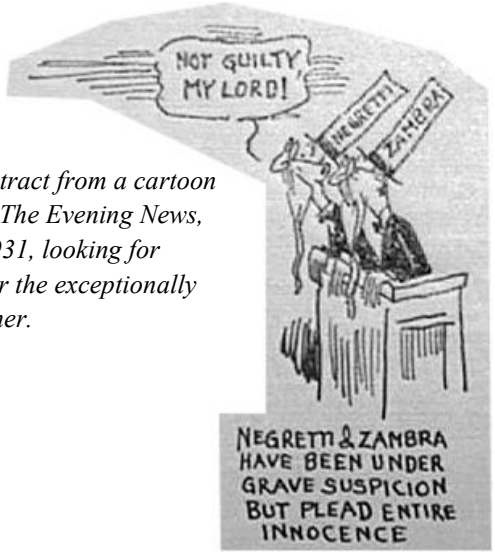

Fig. 4. Extract from a cartoon printed in The Evening News, 21 May 1931, looking for reasons for the exceptionally cold weather.

difficulties with the company who supplied the scaffolding, but once it did arrive there was a run of sunny days. The original dial had fixings through its face, one screw in each corner. The new dial was installed in a similar manner but using stainless steel screws into stainless steel angle brackets that were fixed to the inside of the niche. If there are any problems with the dial it can now be taken down and refitted relatively easily. Straightening out a drooping gnomon in another 125 years time perhaps.

Henry Negretti (1818-1879) and Joseph Warren Zambra (1822-1897) were Italian scientific instrument makers.[1] They worked independently in London before setting up together as Negretti and Zambra in 1850, specialising in meteorological instruments.[2] The partnership continued until 1948 when it became a limited company: in 1964 its factory moved to Aylesbury.[3] Although both Negretti and Zambra were dead by the end of the 19th century they were clearly well known and respected members of the scientific elite, appearing often as elderly gentleman in cartoons as late as 1931, such as the one in Fig. 4.

Of the five N&Z dials in the 2005 Register, three are brass horizontals, one is a marble horizontal and the fifth is a Pilkington and Gibbs heliochronometer. A further P&G heliochronometer stamped with name of Negretti & Zambra is currently for sale[4] and at least one other is known in a Devon garden. In addition, we know from his diaries[5] that the Argentinian pioneer, sportsman and gentleman Alfred Benitz visited N&Z to order a sundial when on a tour of England on 9 September 1859, returning on 23 September to collect the dial. It was said to have been installed at El Rincon, though what type it was is unknown; the date is too early for it to have been a P&G. The Devon slate dial described here is currently unique and raises the question why a customer would go to a meteorological instrument maker to have an ornamental slate sundial made.

ACKNOWLEDGEMENTS

Thanks to Graham Aldred and John Davis for their general advice and to Tony Moss for straightening out the gnomon. Additional material by John Davis.

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4. see: http://www.jardinique.co.uk/antique/antique_sundials.htm
5. see: http://benitz.com/

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ADDENDUM

A very similar 19th century dial to the one described above was sold by Christies, South Kensington, in their auction

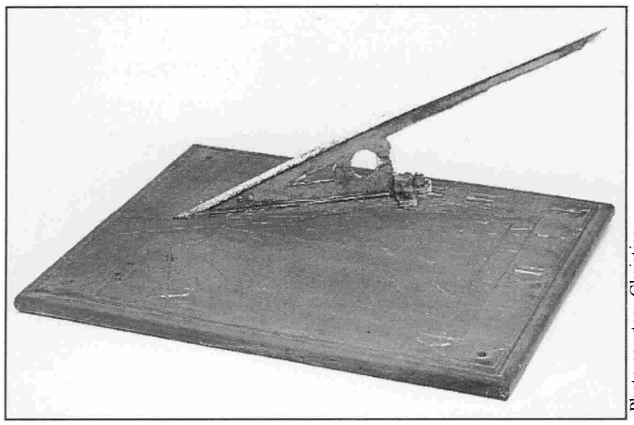

Photo courtesy Christies

of 1 February 1996. The 23"× 30" slate dial was signed by BARKER & SON, Clerkenwell, London. It made £247.50. Like the Devon dial described by Ben Jones, the lines had traces of gilding. Note, too, the similarity of the gnomon, particularly the strap holding the lower end to the dialface. Since Francis Barker was a well-known dialmaker (he wrote the technical chapter in Mrs Gatty's *Book of Sun Dials*) it seems likely or even probable that this firm made the Devon dial for Negretti & Zambra. Certainly, there is a long history of dials being 'trademarked' with a name which is not that of the actual maker.

Ed.

MY, MY, MY, THE DIALLER
a bit about Tom Jones

PETER RANSOM

I saw the light on the dial that I found upon ebay
I saw the flickering shadows of love on her plate.
She was a sundial
With Tom Jones the maker I wanted it out of my mind.
My, my, my, the dialler
Why, why, why, the dialler ...

In 2004 I splashed out on a horizontal dial that attracted me by its quality. I corresponded with the seller to obtain a few detailed pictures of various parts of the dial and pass on some biographical details of the maker, Thomas Jones. I entered a bid and although the dial did not make its reserve I was later given the opportunity to buy it at my final bid since I had shown an interest in the dial maker.

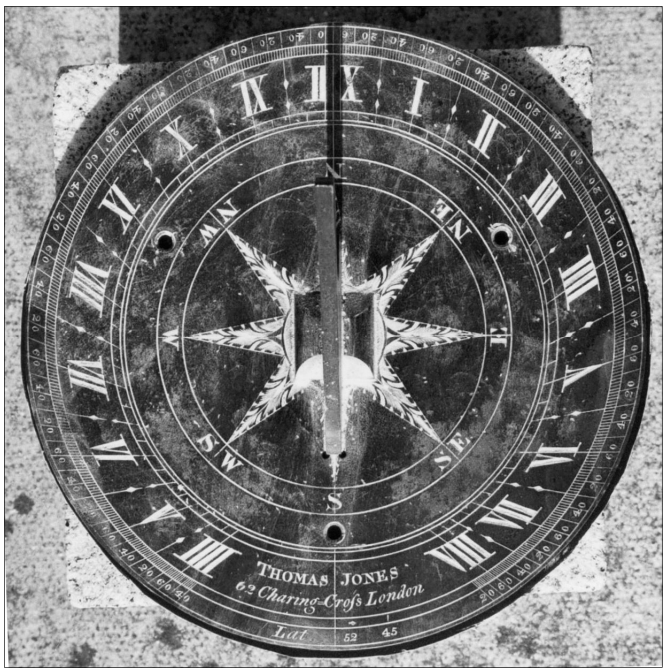

Fig. 1. The bronze sundial by Thomas Jones with talc to pick out details.

The dial plate is 9" (229 mm) in diameter and 3/16" (5 mm) thick. The centre contains an eight point compass rose and the gnomon, complete with two small gnomon holes at the gnomon root which some people think were guide holes to help lay out the dial (there was a big discussion on the sundial mailing list last year about these types of holes). There are three screw holes, one due south of the gnomon root and the other two equally spaced at 120° to the centre (the underside of the plate has a small hole at its centre). The gnomon gap is 3/16", corresponding to the gnomon thickness and the shadow of the gnomon fills it perfectly at noon. The hour ring runs from IIII to VIII with the innermost of four annuli divided into the quarter hour, the next containing the Roman numerals and half hour lines. The third annulus is divided into 2-minute divisions and the outer ring has 10-minute divisions with the 20, 40 and 60 ones marked as such. The hour ring is interrupted by the maker's name, Thomas Jones, and his address: 62 Charing Cross London. The outermost ring is broken by the latitude: Lat 52º 45' and the gnomon angle agrees with this when measured using my plastic angle vernier scale. The dial is in remarkable condition – it cannot have spent much time outside considering its excellent patina.

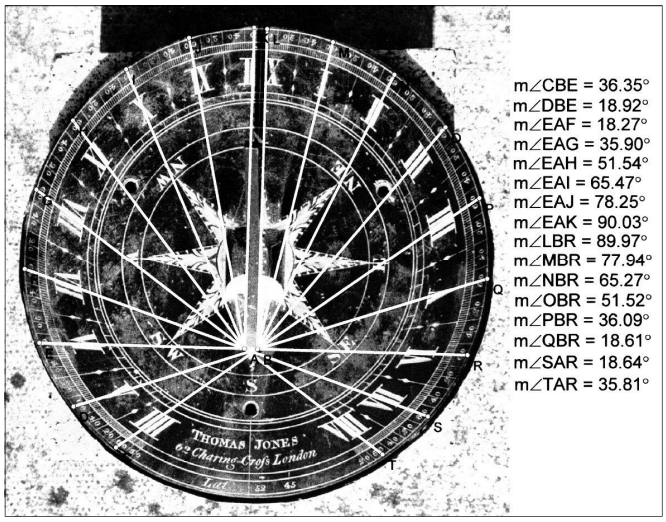

Fig. 2. The dial plate plus hour angles.

The angles measured all agree within 0.3° of the calculated angles. To get this degree of accuracy I took a digital picture from vertically above the dial plate then used that as the background on a dynamic geometry software package (Geometer's Sketch Pad). This allows me to draw lines from the corners of the gnomon origins to the appropriate hour positions on the time ring. The software then measures these to two decimal places – beyond the accuracy needed to convince me that Jones must have individually calibrated the dials that were made in his workshop. I have used thicker lines in the Fig. 2 to show the angles measured – the software 'sees' the lines as having no thickness when it measures the angles.

The angles between the 6am line and hour lines are given below, together with the calculated angles in degrees.

am	4	5	6	7	8	9	10	11
calc.	-36.0	-18.6	0	18.6	36.0	51.5	65.3	78.0
act.	-36.3	-18.9	0	18.3	35.9	51.5	65.5	78.3

The angles between the 6 pm line and hour lines, again with the calculated angles in degrees are:

pm	1	2	3	4	5	6	7	8
calc.	78.0	65.3	51.5	36.0	18.6	0	-18.6	-36.0
act.	77.9	65.3	51.5	36.0	18.6	0	-18.6	-35.9

Fig. 3. The signature and latitude on the dial.

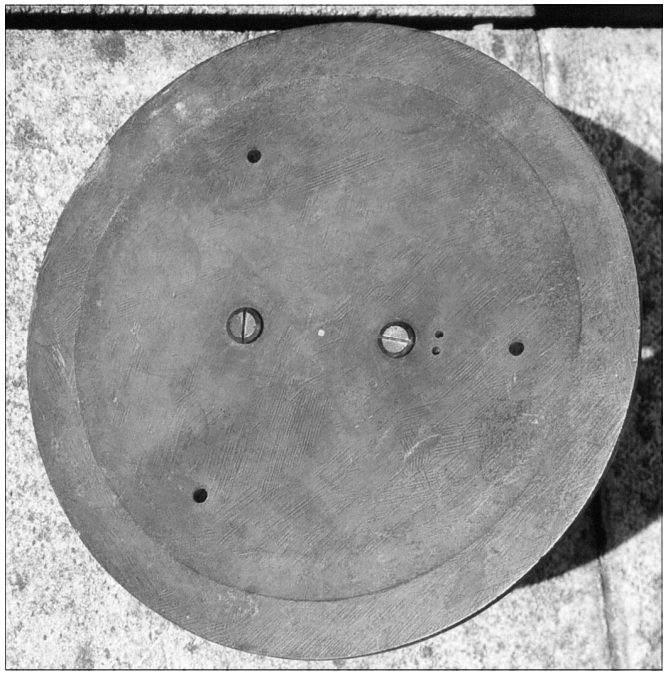

Fig. 4. The bottom of the dial showing the gnomon screws either side of the central hole, fixing screw holes and two gnomon holes to the right of the second gnomon screw.

Thomas Jones was an optical, mathematical and philosophical instrument maker. He was born in 1775 and died in 1852. He operated from three known addresses in London in his career: 120 Mount Street, Berkely Square (1806), 21 Oxenden Street, Piccadilly (1811-1814) and 62 Charing Cross (1816-1850). He became a Fellow of The Royal Society in 1835. His work is known by a number of instruments. I have been able to track down the following:

Date	Instrument	Notes
1811	Sectorgraph	Jones obtained a patent for this dividing instrument. He described himself as 'of Piccadilly' and published a
1817	Barometer	Published *A Companion to the Mountain Barometer* (Tables), together with *The Description & Use of the Englefield Mountain Barometer*
1818	Microscope	Henry Kater uses Jones' instrument to measure the distance between the knife edges on which his pendulum swung and describes him 'of Cockspur Str.'
1820-2	Kater's Pendulums	Jones constructs these 'under instruction from their in-
1825	Hygrometer	Kater reads *Description of an improved Hygrometer by Thos. Jones* at The Royal Society
1833	Double reflecting circle	
1833	Quadruple	Made under the direction of Captain W F W Owen
1838	Owen's artificial horizon	Designated maker
?	Marine barometer	In the Science Museum, London

E G R Taylor[1] also states

"On an undated surveying quadrant in private hands, Jones describes himself as 'Astronomical, Mathematical, Optical & Philosophical Instrument Maker of 62 Charing Cross', and the adjoining Cockspur Street approach may have been named as a gloss on this. The Oxenden Street premises were later occupied by W. Crawley. Jones had worked with Ramsden in his younger days. Ramsden had also supplied instruments to Captain Kater. A number of Jones's instruments survive, including a 'coming up glass', a naval telescope on the principle of the heliometer."

Jones was also one of the best London wheel & stick barometer makers of the time. He was instrument maker to the Duke of Clarence. Jones also worked closely with Captain Henry Kater (1777-1835) and made a number (if not all) of the invariable pendulums that Kater used to establish the intensity of gravity at places around the world. For more details on Kater and his work see http://www.usyd.edu.au/su/macleay/kater1.htm

Last year I noticed a pantograph by Jones for sale by auction. A pantograph is a scientific instrument used to enlarge, copy or reduce technical drawings. The length of it in the case was 85 cm; unfortunately this went at a price beyond my budget! The label shows Jones considered that being a pupil of Jesse Ramsden was worth mentioning.

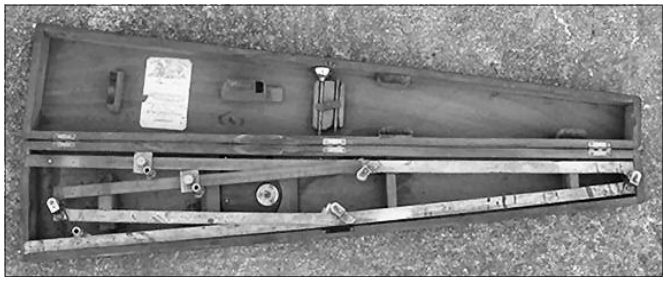

Fig. 5. A pantograph made by Thomas Jones.

Fig. 6. Thomas Jones' label on the pantograph.

Thomas Jones' instruments can be seen in a number of museums including The History of Science Museum at Oxford, Longleat House, Whitby and the National Maritime Museum. I would be particularly interested to hear of any sundials readers discover!

She stood there shining
I felt Tom Jones in my hands and he lived once more
My, my, my, the dialler
Why, why, why, the dialler
So before they come to make me more poor
Forgive me the dialler I just can't afford any more
Forgive me the dialler I just can't afford any more

REFERENCE

1. E.G.R. Taylor: *The Mathematical Practitioners of Hanoverian England 1714-1840*, Cambridge University Press, (1966).

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Southampton, SO16 8LR

Postcard potpourri 1
Coldwell Clough, Kinder

In what we hope will become a regular feature, Peter Ransom writes about some of his collection of postcards. In Bulletin 96.3 (October 1996) he wrote a major article about sundials on postcards. His collection has grown since!

Checking postcards for sundials sometimes delivers a surprise! This post-card features a sundial that is not in the present register, so perhaps a member living near Hayfield in Derbyshire might like to see whether it is still there. Cold-well Clough is by the River Sett about a mile south-east of Hayfield at SK052858. The postcard has not been used so there is no postmark by which to date it. It states 'Postage Inland ½d' which may give some idea of when it was printed.

The dial appears to be a horizontal one with what appears to be E8 on one side and O6 on another. It looks as if there is a circular plate on the top of the pedestal with two inclined plates. Do these form a slit through which the light shines?

The dial seems to be set in a gap in the wall which probably allows access to a footpath. Now, is that one of the original BSS members in the background? On the back is printed "James Garside" and at the website

http://freepages.genealogy.rootsweb.com/~dusk/bethel_chapel_history.html

it mentions, in the history of Bethel Chapel, Hayfield, that "John Garside became a teacher in 1839. Luke Garside was his son and James Garside, Sunday School secretary for over 50 years, his grandson." Fascinating where a post-card takes you!

pransom@btinternet.com

I HATE DRAINPIPES!

MIKE COWHAM

No, I'm not talking about the drainpipe trousers that some of us wore back in the 1950s. What I really mean are downpipes for rainwater, plastic or metal, round or square, they are all as bad. Builders have no regard for where they put them as long as they carry water away from the roof. In photographing sundials I have almost become obsessed by them. How can a builder place these ugly things next to or even across a sundial? They don't even try to disguise them in many cases.

I have now looked through my photo archives and can see why I get so heated about them. Some of my best shots seem to include them. I really shouldn't complain too much about British builders because their Continental cousins are probably worse, if that is possible. Some examples are shown here of the total disregard that builders have for our fine dials. I would even like to put forward three dials for prizes for those most disfigured but I am sure that many BSS Members will be able to better these examples.

Fig. 1. Mass dials at Egleton.

The most vulnerable seem to be mass dials. They are covered up by notice boards, plaster and drainpipes - not to mention the lichens on their surface and trees nearby. My first example is of the mass dials at Egleton, not actually covered by a drainpipe but it certainly encroaches on them.

Even at Oxford, dials are not immune from drainpipes. Look at the way that the dial at Christchurch has its over-friendly downpipe. Ugh!

It's not just vertical dials that suffer from drainpipes, they can affect even the simplest horizontal dial. My example is the dial in Conwy churchyard that I photographed for 'Sundials of the British Isles'. I sent my pictures to David

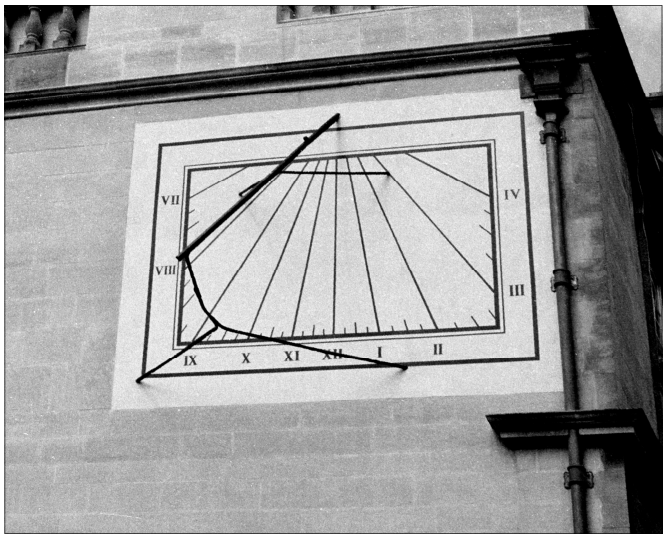

Fig. 2. Christchurch College, Oxford.

Fig. 3. The Conwy dial with its curvaceous gnomon.

Young, who was co-author for the Welsh chapter, and he immediately came back and told me that the dial that I had sent him labelled 'Conwy' could not be right because it had a straight back edge to the gnomon whereas Conwy has a nicely profiled curve. At first glance I could see that he was right, then when I expanded the picture on my PC I saw the offending drainpipe positioned just at the back of the gnomon making it look as if it were straight. What a relief! Luckily with the wonders of modern technology I was able to remove the offending object.

Now let me give you the four dials that would receive my prize for 'Disfigurement by Drainpipes'.

Fig. 4. The Conwy dial in my photo.

Fig. 5. The Unicorn Inn, Uppingham.

Fig. 6. Noon mark at Nothalten,

In fourth place I would like to cite the dial on the former Unicorn Inn at Uppingham. As you will see, this fine dial has already been disfigured by being painted over, but when the rays of the Sun are at a very low angle, then it is possible to see in relief the former painting of the dial. This picture was taken late in the afternoon and the shadow of that drainpipe goes right across the dial making it look even worse. The only solution will be to go back (too) early one morning when the Sun's rays come from the opposite side.

In third place I must go to the Continent where an interesting noon mark has a very close encounter with one of our friends. This dial is at Nothalten in the Alsace region of France. Admittedly it is not going to affect its function at noon but is uncomfortably close, casting a big shadow across it later in the day.

Fig. 7. Werfen, Austria.

It was difficult to decide on first and second places so I will give both of them first prize. On the distillery at Werfen, Austria, the drainpipe is actually over one edge of the dial. In the other case at Bad Aibling in Austria we find a similar disfigurement. These are both unforgivable - and such pretty and colourful dials too.

Drainpipes are not the only offending objects to disfigure our dials. Guttering, usually added since the church was built, often stops the summer Sun from reaching some of the dial. And what about those dials over the church porch where a lamp has been mounted. Shouldn't someone have

Fig. 8. The dial at Bad Aibling, Germany.

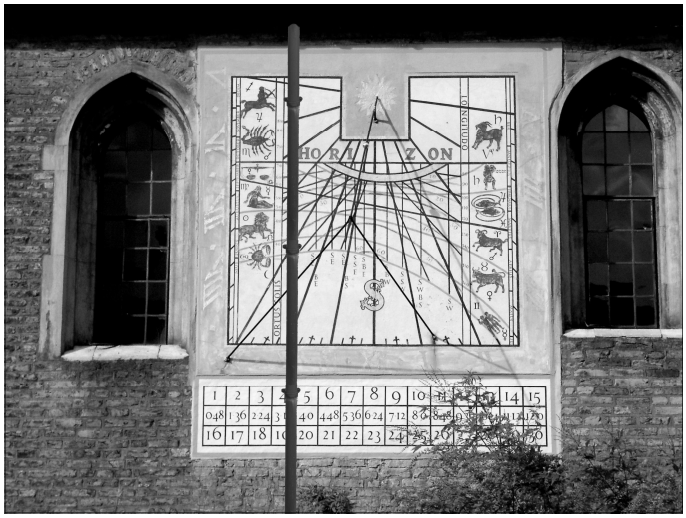

Fig. 9. Queens' College, Cambridge (luckily, only simulated!).

realised that dials don't work at night, at least from a lamp!

Let's hope that with the influence of the BSS and similar societies we will be able to 'guide' builders by telling them of the folly of their ways before it is too late.

As a final thought, the builders at Queens' College, Cambridge are doing some roofing repairs above the dial and will no doubt be replacing downpipes. Let's hope that we catch this action before we disfigure such an interesting and important dial.

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READERS' LETTERS

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What is a little disturbing about their reproduction dials is that they were often signed and dated in imitation of old dials and this often causes errors when these dials are now recorded. The illustration shown is taken from a Pearson-Page-Jewsbury catalogue of around 1932. The dial is falsely dated 1630 and has *'Long Life ye King Charles'* inscribed on it. The rest of the text beneath the skull and sickle is illegible but all of the engraved text could have been changed according to the customer's wishes.

I fear that you will get several reports from BSS members of a sighting of the Wigmore Grange dial but these will probably be of one of the Pearson-Page replicas.

Mike Cowham
Cambs.

[There seems to be only one of these dials in the Register 2005: SN3068 in St Ives museum. I wonder if they know they probably have a modern reproduction?! – Ed.]

DURHAM

I wish to thank all who organized the Annual Meeting in Durham. After being a member for over a decade, it was delightful at last to be able to associate faces with names and to get to know fellow sundial afficianados.

On my way back to London, I visited the famous 11th century Anglo-Saxon sundial on St. Gregory's Minster at Kirkdale, near Kirkbymoorside, North Yorkshire (SN 0320). It is in good shape, but the modern one in the Register (SN 0319) has gone missing for some reason. Members may be interested to know that it is possible to make a crayon rubbing of this dial! I had great fun doing so. The rubbing is thankfully not done on the original, but on an accurate metal facsimile that is in the activity room at the The Moors Centre run by the North York Moors National Park, just east of Danby.

Woody Sullivan
woody@astro.washington.edu

MERIDIAN LINES

So, it appears that I, the BSS and all the contributors who have written for the *Bulletin* on the subject of the meridian lines in continental cathedrals, have got it all wrong. Nothing to do with the dating of Easter, the lines are a relic of the bid by Paris to host the prime meridian. Rather like their bid for the Olympic Games, which they also lost.

I have also learned that the lines are concerned with another important matter, to do with "rose lines", or "Roslyn", something like that, but I forget exactly what. But then the book, and the film of the book are both forgettable.

It will take the BSS another two millennia to teach the public the real facts.

Roger Bowling
Macclesfield, SK10 3LH

[This is the first and I hope only letter on this over-exposed topic. Ed.]

A HOME-MADE VERTICAL DECLINING DIAL

K H HEAD

To mark the occasion of our Golden Wedding Anniversary in June 1999, I decided to design and make a vertical sundial for the wall of our house. I had previously delineated a horizontal 'double dial' complete with zodiac lines, using a cardboard gnomon with a notch in the manner described by Waugh.[1] I used his graphical method as well as his equations. I had also set out an analemmatic dial on my lawn.

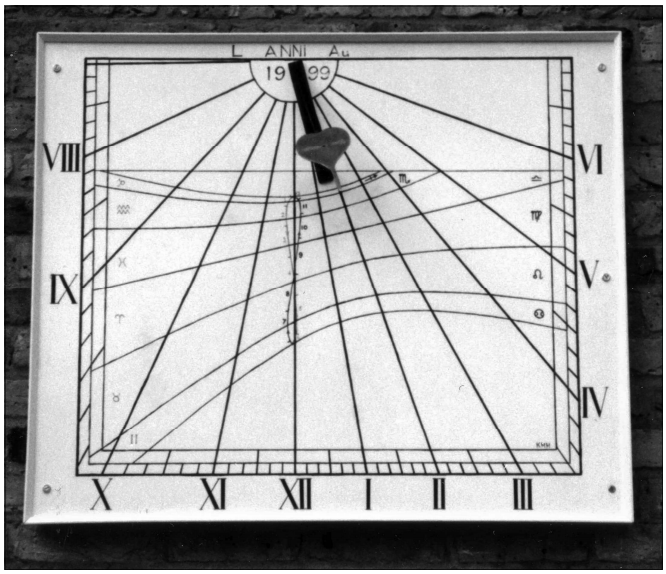

Fig. 1. The dial as initially installed.

From observations of shadows cast by a metre-long vertical stick, I had ascertained that the back wall of our house faced about 18° west of south, and I thought that the design of a declining vertical dial would make an interesting challenge. I particularly liked the principle of using the spot of light from a pinhole image of the sun for tracking the zodiac lines. My idea was to mount on the gnomon a disc with a central hole for projecting the image. I also wanted to make the shadow large enough to read from near the end of the garden, so I decided to extend the gnomon in the manner of the hour hand of a church clock. (Could this therefore be termed a 'triple dial'?) I decided that, in view of the occasion to be celebrated, it would be appropriate to substitute a heart shape for the disc, and to make it of brass to give the 'golden' touch.

The size of the dial board was determined by the dimensions of a piece of marine ply I had, which was about 1000×800 mm, and this was large enough for the dial to be read from a distance. To fit the midsummer solstice line comfortably within the square, a nodus height of 150mm seemed appropriate. As an interesting exercise, I started the setting out using Waugh's graphical method, and this confirmed that the chosen dimensions were suitable. The detailed plotting of the hour lines and zodiac lines was done during the winter evenings from calculations using the equations given by Waugh, which I entered into my computer on a spread-sheet – much easier than using even a programmable calculator. It provided an excellent introduction to the use of MS Excel, as well as being a useful exercise. I was able to derive both polar and Cartesian coordinates, which facilitated accurate plotting of the calculated points.

The trimmed board was edged with a narrow 'picture-frame' border and then coated with wood primer, followed by white undercoat and external white gloss paint. I traced the plotted hour lines and zodiac lines, and incised them into the board with a craft knife. The straight lines were easy, but the curves took a little longer! I did this to avoid losing the lines when the board needs to be re-painted. For good visibility, after trials using felt pens on paper, I found that a line width of 3mm was suitable. The incisions were filled with black Valspar lacquer, using a fine brush. I also added the noon analemma 'figure-of-eight' curve, and the zodiac signs, but for these I used 'permanent' felt pens because time was getting short. Unfortunately these markings almost disappeared after only a few months, so they will have to be properly painted one day. The direction of the sub-style line was calculated and marked on the board.

I decided to use traditional Roman numerals and settled on a height of 50mm with a stroke thickness of 5mm. Painting them would have been too time-consuming, so I bought some car number-plate stick-on letters ('M's, 'H's and 'W's were the best value), cut them to one-third of their width

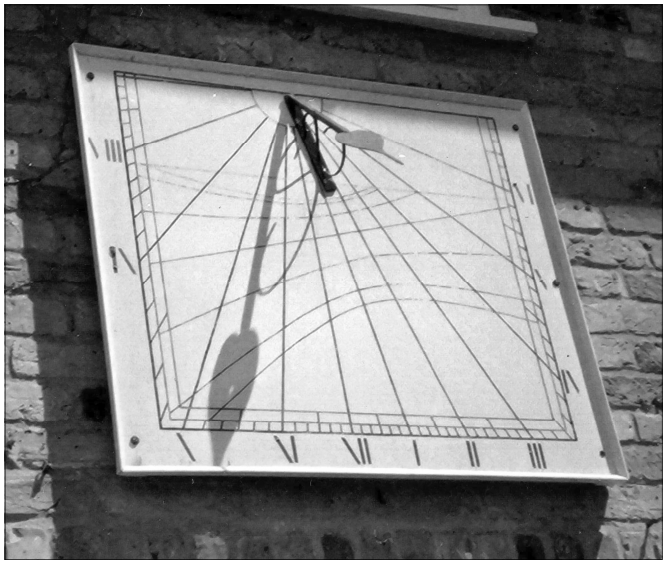

Fig. 2. The dial after two years exposure to the sun.

and stuck them in position. These still remain in good condition, but the thin strokes which I added with a black 'permanent' marker have now vanished.

I drew up a design for the gnomon, which I took to a local craftsman to make. It has a wrought iron scroll welded to a pair of steel angles which are drilled to take fixing screws for attachment to the board. To the style was welded the 'heart' and extension pointer of brass. The angle of inclination, and the exact position of the hole, were carefully detailed and explained. I was very satisfied with the result. I painted the ironwork with two coats of black Hammerite, leaving the brass heart to be polished. The gnomon was fitted for checking, and then removed before erection.

Four fixing holes had already been carefully positioned and drilled into the house wall, and plugged. Time was short so I was unable to make provision for fine adjustments after erection. I devised a method for hoisting up the board 3m into place using only a ladder and a length of rope, with no helper other than my wife who was partly handicapped at that time. The gnomon was screwed in place and all was ready just in time for our Anniversary party.

Unfortunately that day was showery with not much sun, and the only photograph taken then (Fig. 1) shows no shadow. In a photograph taken two years later (Fig. 2) the spot of light is visible – but not the felt-pen markings.

The performance of the dial is adequate, though not perfect. It reads on average about 1½ minutes slow. The light-spot tracks the curves quite well, but a little too low down, so that it reads about 2 days fast from January to June, and 2 days slow from June to December. When I take it down for re-painting I will make provision for 'tweaking' after re-erection.

The dial is (was!) inscribed 'L ANNI Au', which is my Latinised version of '50 Golden Years'. I dedicated it to my dear wife, with the following effort for a motto. (I am sure that someone else could do better – any offers?)

> Be not wasteful of time –
> Each hour that passes by
> Returns not ever again.
> Yet happy hours with those we hold dear
> Live on in our memories for many a year.

I am not divulging my wife's name.

REFERENCE

1. A.E. Waugh: *Sundials – their theory and construction.* Dover Publications, Inc., 1973

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VISIT TO THE MUSEUM OF THE WORSHIPFUL COMPANY OF CLOCKMAKERS

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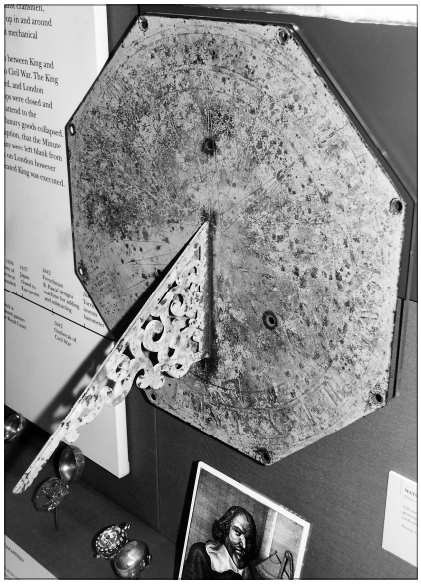

The large horizontal dial by Elias Allen: the originality of the gnomon is unclear.

show the sun's azimuth on the mirrored compass. An even earlier dial is the small square horizontal by Isaack Symmes, around 1600. Another named dial is a universal equinoctial ring dial by Edward Nairne.

By contrast we also saw a modern 50cm bronze equatorial by Joanna Migdal which was on temporary display. The detail in the modelled base and engraving represent professional and hobby interests from the commission.

The museum display was updated, to much acclaim, in 2002. Many of the display cabinets have been cleverly designed so that exhibits are arranged vertically as if on a wall and in some cabinets the glass front is as close as 20 - 30cm to the exhibits. The glass surface treatment and balance of lighting is such that the glass is almost invisible giving an almost tangible access to the clocks on display.

A modern equatorial dial by Joanna Migdal. (Photo: J Migdal)

More tours can be arranged, and indeed welcomed, if there is sufficient interest.

Report by Douglas Bateman.

ENGLISH SUNDIAL MAKERS IN RUSSIA
Part 1. Before the Beginning

ALEKSANDR M BOLDYREV

Introduction

In the heroic age of Peter the Great the most courageous, well educated and energetic people came to Russia from all over the world. Sundial makers from England and Scotland were amongst them.

Two periods are clearly distinguished in the history of the sundial making in Russia. The first concerns the Russian Navy. The Navy grew so rapidly that the instrument making industry could not grow at a corresponding rate. With few exceptions sundials were imported but not manufactured in this period. The second period deals with land-surveying. In this period almost all the European countries had completed geodesic surveys of their territory. Russia, due to its size, could not succeed in this work and invited instrument makers from abroad.[18]

The present article deals mainly with the first period and even with some events before it. It will not reveal all the details but only outline the topic: in this very brief compilation I give some of the historical events that served as the reasons for sundial makers from England to emigrate to Russia. In this period sundial makers had not yet arrived in Russia. That is why I write relatively little about sundial makers in my compilation. I tell as well about a nobleman Jacob Bruce (1669-1735) of Scottish descent who was a tsar's confidant and outstanding man of science and of military art[1] and who, in fact, was a leader of Russian sundial- and instrument-making industries.

Setting the Scene

By the end of the17th century Russia had no seaports in the Black and Baltic Seas. The shores of the Black Sea were under the jurisdiction of Turkey. It was an obstacle to the country's progress. Peter I faced a long war against Turkey and needed allies. During his Grand Tour he visited some European capitals and in September 1697 when he was in The Hague he met William III, who invited him to England. But almost three months passed before Peter came to England due to the fact that he waited for Jacob Bruce, one of his most trustworthy advisers. When at last Bruce arrived, the cause of his delay became clear. He was seriously wounded.

During Peter's European trip the duke-caesar Fyodor Romodanovsky, the head of the secret affairs 'prikaz' (department), was an acting governor of Russia. This man of absolute devotion was noted for extreme cruelty to the tsar's enemies. It is not known for certain whether the duke-ceasar tortured Jacob Bruce or not. But there remains Peter's letter, in which he called his duke-ceasar a brutal animal and promised to 'muzzle' the duke by himself.

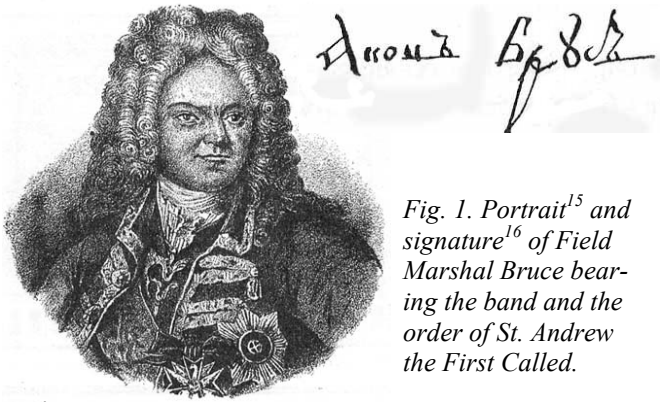

Fig. 1. Portrait[15] and signature[16] of Field Marshal Bruce bearing the band and the order of St. Andrew the First Called.

England was expecting the War of the Spanish Succession and negotiations with William III for the help against the Turks did not succeed. Peter saw Parliament, Oxford, the Arsenal, the Mint, and the Tower of London and Windsor Castle and tried a beautiful twenty-gun yacht, a present from the king.[12] By the end of December 1697 Peter received a message that regiments of the fusiliers had revolted again and had to leave hurriedly for Moscow.

The Grand Tour did not influence Peter directly, but moved his attentions from Turkey to Sweden. He realized that there existed a possibility to break the Swedish supremacy in the Baltic area. He had decided very ambitiously to create a modern army, navy and military industry and not only to win over the Sultan of Turkey but even to beat Charles XII of Sweden. As the first step he ordered Jacob Bruce to stay in England and to study astronomy, mathematics, gun and powder manufacturing, minting techniques and all the subtle nuances of the shipbuilding in England. Of great importance was the order to employ qualified teachers in navigation and mathematics and to buy spyglasses, astrolabes, sundials and some other instruments. Bruce carried out all the orders and, in addition to the instructions, was introduced to Isaac Newton, John Flamsteed and Edmond Halley whom he was in correspondence with for the rest of his life.[14]

Who was Jacob Bruce?

After the execution of Charles I in 1649 some Stuart supporters left their dangerous home for an even more rugged

life abroad. Like Quentin Durward, the Scottish marksman of Walter Scott, a young knight William Bruce, the 14th Lord of Clackmannan and direct descendant of Robert I Bruce, the King of Scotland, came to Russia in 1647. By the end of the 17th century he was the lieutenant colonel in Russian army and gained a reputation as a brave and trustworthy officer. He had two sons, Robert and Jacob.

In 1683 John Patrick Gordon (another Scot in Russia), a trusted confidant of the teenage Peter, had given William Bruce some good advice: to assign his sons to Peter's junior army [roughly equivalent to the Boy Scouts]. From this time Jacob Bruce progressed very rapidly and made a good public and army career. He participated in the Azov (1695-1696) and Crimean (1687, 1689) campaigns against the Turks. During the Great Northern War Bruce was involved in the development of Russian artillery.[1] He was a commander of artillery in the Battle of Poltava (1709), for which he was awarded the Order of St. Andrew the First-Called. In 1727 he became one of the first Russian counts.

The Neptune Society

The young Peter I, Patrick Gordon, Jacob Bruce and some others were the members of the so-called Neptune Society. Almost nothing is known about this society. It is assumed, however, that its members met from time to time and discussed the ways of how to organize the Russian navy. The meetings were usually held in the Sukharev Tower in Moscow. The Grand Tour offered the possibility to make the dreams of the members of the Neptune Society come true.

The School of Navigation

Staying in 1697 in England and fulfilling the Peter's orders, Jacob Bruce managed to engage many Englishman: naval officers, navigators, gunners, ship makers and even an architect. Among them there were three people who should be mentioned especially. They were a Scottish mathematician Prof. Henry Fargwarson (or Farkenson, or Farquharson) from the University of Aberdeen (died in Dec 1739 in St Petersburg) and two English experts in the theory of navigation and astronomy - Stephan Gwyun (1683-1720) and Richard Greice (1681-1711), both from Canterbury Christ Church University College.

In 1699 they came to Moscow where they lived in poverty for more than one year. The Tsar had not forgotten about them, he just had no time to regulate their life, being very busy preparing for the war against Turkey and Sweden. At last, on January 14 1701, he signed a 'ukase' (tsar's decree) "the Navigation School is to be" and ordered the recruitment of students.

The Navigation School was housed in the Sukharev Tower the same edifice where the sessions of the Neptune Society were held. Teachers lived on the first floor. On the ground floor there was a workshop supplied with modern equipment Jacob Bruce had bought in England and where astronomical devices could be made or repaired. The top storey of the tower was assigned to serve as the observatory. Jacob Bruce, when in Moscow on leave from the army, undertook observations there and delivered lectures. The only Russian teacher was Leonty Magnitsky who was the author of the first Russian course of arithmetic. Later on Prof. Fargwarson learned Russian language so as to be able to edit translations from Latin. He taught geodesy in Russian, created the first Russian table of sine and cosine, and wrote school-books in Latin. In 1714 he analyzed the published data on the land-surveying of the Eastern territories. Then the responsibility for land-surveying was transferred to the graduates of the School of Navigation.

Meanwhile, Jacob Bruce was very busy. He headed the gun laboratory, manufactured and introduced new artillery equipment, and translated numerous manuals on military strategy. Yet, he found time to contribute to the Navigation School. He sorted out the manuals and translated them into Russian. In 1708 he translated into Russian a manual of geodesy.

Tsar Peter I himself wrote a chapter for the second edition of this manual. The chapter was referred to as "The way of compasses and ruler with some adding about sundials and the figure transformation". This book together with the tsar's contribution on the sundials was published in 1709 in the Moscow Printing Yard.

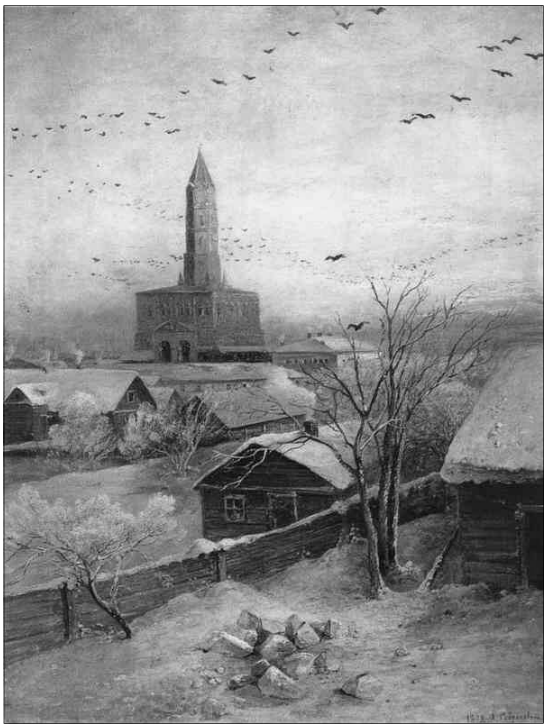

Fig 2. 'The Sukharev Tower' by Alexey Savrasov. 1872. Oil on canvas. The Historical Museum, Moscow. (The tower was demolished in 1930.)

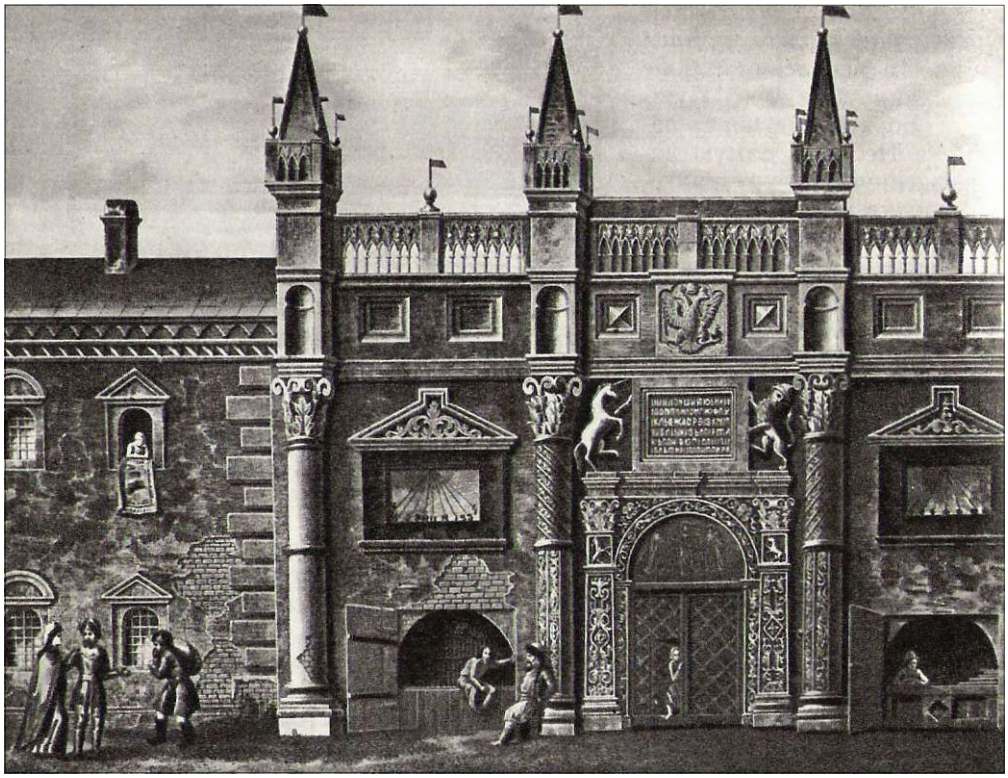

Fig. 3. Moscow Printing Yard with sundials flanking the lion and unicorn on the centre of the façade, late 17th century.[15]

Kurbatov, the clerk of the Tsar's Duma, made complaints against Prof. Fargwarson, who was frequently late to start the lessons and was too lenient to his students. It is a very funny detail, taking into account the brutal habits of that time: for example the service regulations of the Russian navy (modeled on the English ones) provided for eight (!) kinds of death penalty. Kurbatov was in charge of salaries. Prof. Fargwarson's salary was as high as 250 rubles per year, the two other English teachers were paid a salary of 150 rubles each and the only Russian teacher Leonty Magnitsky (a peasant by birth) was paid only 90 rubles per year.[11]

Lyrical digression

The Printing Yard was located close to the Sukharev Tower and less than 1km from the Kremlin. It was built by the 'ukase' of Ivan IV the Terrible in 1553-1663. It consisted of several buildings that were rebuilt and renovated more than once. An old engraving shows that at the time of Jacob Bruce it looked like a palace from a Fairyland. The engraving shows that the entrance into the edifice is decorated with a base relief of a lion and a unicorn with sundials on either side. The similarity with the emblem of the United Kingdom is most probably an accidental coincidence. Ivan IV was a faithful follower of the theory that Moscow is the third Rome and that Orthodoxy, inherited from Byzantium (the second Rome), was the only true religion. He considered the unicorn served as a symbol of the truth of this religion.

It ought to be mentioned here that in the 11th century Russia had inherited from Byzantine the style of stone carving. It can be seen from the engraving than the parts of building (columns, frieze, capitals) are all in the Byzantine style. As

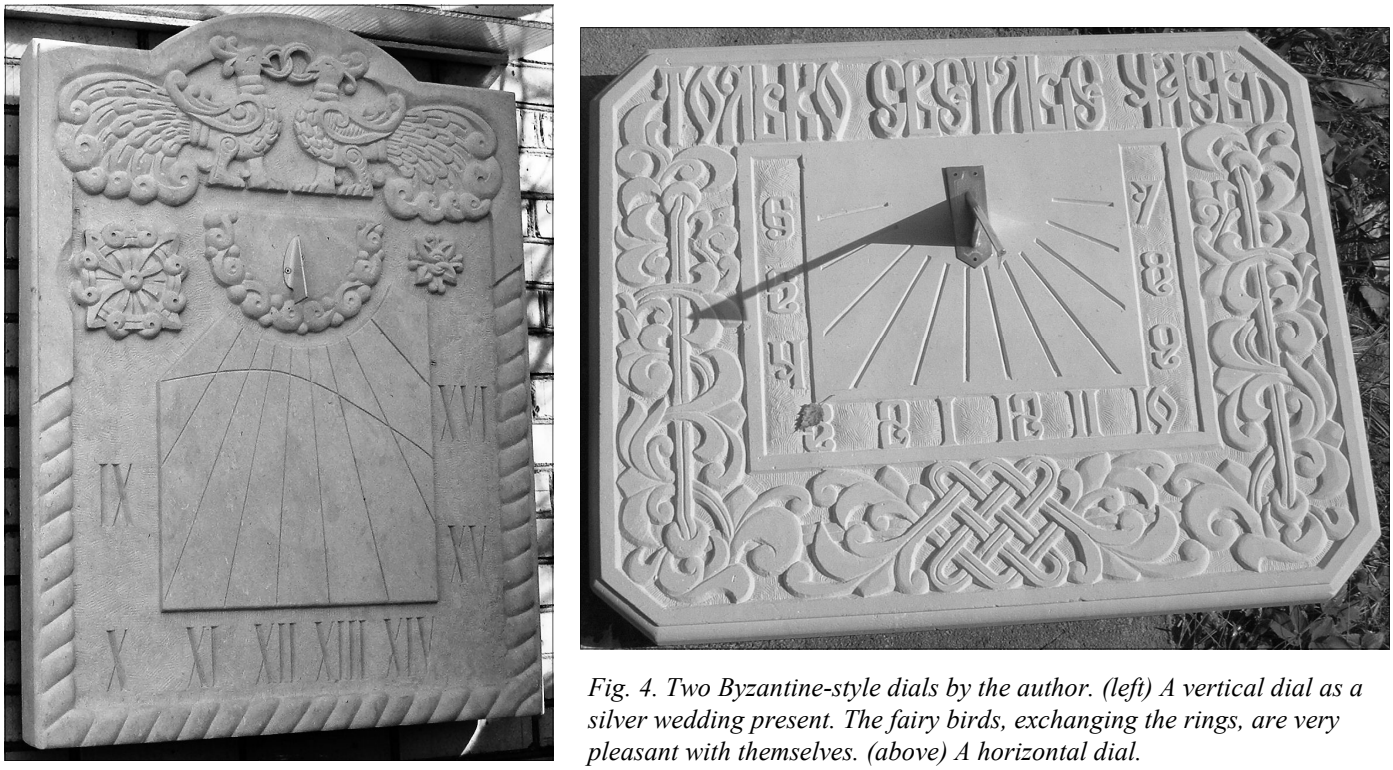

Fig. 4. Two Byzantine-style dials by the author. (left) A vertical dial as a silver wedding present. The fairy birds, exchanging the rings, are very pleasant with themselves. (above) A horizontal dial.

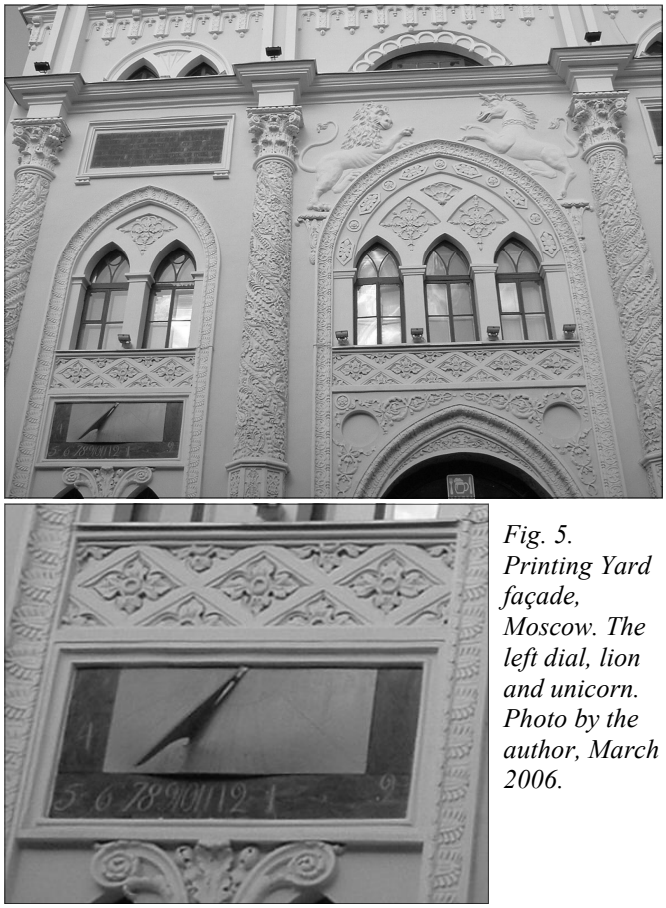

Fig. 5. Printing Yard façade, Moscow. The left dial, lion and unicorn. Photo by the author, March 2006.

can be seen in Fig. 4, some of my own sundials are made in this medieval Byzantine style as well. It is a style which is very rich in carvings.

In the autumn of 1812 Napoleon had occupied Moscow and had burned it to ashes. The buildings of the Printing Yard were destroyed. But in 1814, like a phoenix, it had reappeared due to the talent of the architect I. L. Mironovsky and became even more beautiful. The remaining parts of the destroyed building were carefully inserted into the façade. The sundials flanking the entrance were made more fashionable and the unicorn and its facing the lion were completely renewed. From then, the edifice is not changed much. Now, almost 200 years later, it looks as it is shown in Fig. 5. The Institute of History and Archives is located there.

Admiralty workshops, Navy Academy workshops and other derivates of the Navigation School

In May 1703 Peter I founded a fortress on the shores of a small river Okhta and gave it the name Petersburg. A naval shipyard was ordered to be built right in the centre of Petersburg. In 1712 Peter's navy dominated the Baltic over all the foreign navies. But in Petersburg there was no special navy sub-unit assigned to teach navigators and to make the instruments.

Before 1706 the Navigation School in Moscow was formally the subordinate of Oruzheinaya palata (The State Treasure and Weapon Department). The Sukharev Tower, which was located at least 750km from the nearest sea, was the headquarters of the Russian Admiralty. Later, when the opportunity arose, it was subordinated to the Admiralty board created by Peter I.

In 1715 the Navigation School had left for St. Petersburg. In its new location it was renamed as the Naval Academy. Prof. Fargwarson, his compatriots and Russian students had transferred to St. Petersburg as well. The surviving records[3] show that in 1735 Fargwarson was still the head of the Naval Academy and in 1737 he was given the rank of brigadier (a bit less than general) and professor. It should be mentioned that before Fargwarson nobody in Russia was given the academic status Professor. A workshop was attached to the Naval Academy where instruments including sundials were manufactured.

In 1701 the School of Artillery was founded in Moscow. In 1710 Jacob Bruce offered a job in this School to an outstanding sundial maker from England. His name was John Bradlee.[20] In Russia he was the first English sundial maker (and, perhaps, the best). Some of Bruce's letters have survived[7] in which Bruce ordered to Bradlee to make two sundials fitted with a plumb line device and delineated for the latitude 60°. In 1716 Bradlee had left Moscow for St. Petersburg and, for the rest of his life, worked for the Chancellery of the Head Artillery and Fortification. It is assumed that Bradlee stayed in a close contact with field marshal Bruce, who for a long time was responsible for artillery

Fig. 6. Nikolskaya street leads to the Kremlin. The star on the Kremlin tower is screened by advertising panel crossing the street. The Printing Yard building is on the right. Photo by the author, March 2006, morning.

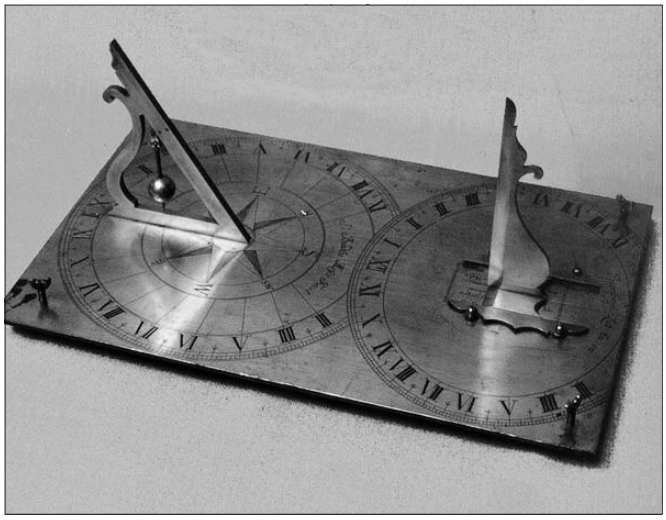

Fig 7. The sundial made by John Bradlee. Lomonosov Museum, St.Petersburg.
Photo courtesy http://www.museum.ru/C470

in Russia. Some of the sundials made by this remarkable master are kept now in the best Russian museums. One of these sundials (Fig. 7) was the favourite one of Peter I and was placed on the table in his private office.

In 1722 the Instrument Workshop was re-organized as the branch of the Admiralty. Among the products there were astrolabes, quadrants, gunner's clinometers, sextants and compass sundials. It is astonishing that this enterprise is still functioning in St. Petersburg. Its name now is Navy Devices Ltd. Though the instruments are now based on microchips, the set of devices manufactured is still the same, with the only exception of sundials. Together with hi-tech compasses and logs, they still manufacture the portable star glob, to be installed in a captain's bridge, and sextants. (I venture to suggest that they make the sextants for the modern sundial makers.)

The direct and indirect derivates of the Navigation School are numerous. It is impossible to make general conclusions about all of them as they are all different. But I would like to mention just a few facts.

For the period of less than 10 years after the foundation of the School of Navigation there were founded 40 schools of mathematic in other Russian cities. They were similar to the School of Navigation almost in every respect. In 1719 two young geodesists, Evreinov and Luzhin, the graduates of Moscow School of Navigation, participated in the Commander Bering expedition to the North Pacific.[2] They draw a map of the North-West shores of America and, as a by-product, discovered the strait between Asia and America – one of the last great discoveries of the world. And, finally, not all of us know that Alexander Fridman (Moscow University), the inventor of the mathematic theory of the Universe Expansion published in 1922, was a geodesist by education. The list may be continued. Yet it is clear that lineal descendants of the School of Navigation are all worthy of the noble house they descend from and of one of its creators Jacob Bruce.

Civilian life

In 1710 Jacob Bruce participated in the siege of Riga. In 1711 in the context of alliance between Russia, Denmark and Saxony he participated in the military operations in the North Germany. After 1712 he had left the military service for the public one.[1]

In 1719-1726 Bruce was at the head of Berg Collegium, a kind of state organization responsible for mining and smelting. In 1720 the mint was affiliated to the Berg Collegium and Bruce organized the assay office in it. Russia was in urgent need of currency reform and Jacob Bruce worked out the detailed plan of how to fulfil this reform. It is easy to see that Bruce's reform bears the features of similarities to the reform which Isaac Newton had fulfilled in England. Thus, it has become clear why Peter I and Bruce, when in England, visited the mint four times.

Jacob Bruce always concentrated his attention on publishing. In collaboration with Vasily Kiprianov, who managed the Moscow Printing Yard, he started to publish an edition of the first Russian secular calendar. The first copper plate was engraved in 1709. The edition lasted six years. The calendar was printed annually in sheets of large size. Altogether there were forty seven pages which included maps, information about the religious holiday, astrological divinations, explanations of lunar eclipses, distances between cities, and agricultural advices. In folk etymology the calendar was referred to as Bruce's calendar. A few surviving copies of this calendar are kept now it the State Hermitage.

Astronomy was his favorite subject. Valentin Boss, a Canadian scientist, says that the first of Bruce's articles on astronomy, which was titled as "A treatise on the movement of the planets" was issued when he visited England in 1698.[5] This manuscript is kept now somewhere in Cambridge. In 1707 together with Vasily Kiprianov who, beyond publishing, was known as an experienced engraver and expert in mathematics, Jacob Bruce published the Copernican star map. He also translated and published "Cosmotheoros" by Christian Huygens. Despite the fact that this book expounding Copernicus's theory and Newton's laws was called "blasphemous libel" for a long time it served as the main manual of astronomy in Russia and ran to two editions (1714 and 1724). Both issues were prefaced with Bruce's introduction.

After Peter the Great

Once in the autumn of 1724 there was a gale. Peter was walking along the shore and saw a small boat in danger of

running aground. Helping the sailors, he waded into the cold water, caught cold and had died a few weeks later.

All Peter's reforms were all stopped. The court intrigues and fight between political parties were not in Jacob Bruce's character. For several years he fulfilled his duties mechanically but soon he resigned from all of his appointments. In June 1726 the first Russian Count, a person of encyclopaedic learning, the bearer of highest Russian orders and descendant of a king of Scotland, field-marshal Bruce went into retirement. From this moment the most mysterious and enigmatic period of his life had started. Almost nothing is known about it.

It is known that Bruce bought a large estate named Glinky located not far from Moscow. His new home did not satisfy his demands and Bruce rebuilt the estate, attached an observatory to the main building and raised some new ones for chemical experiments. He also reconstructed the garden. It is impossible to know for certain, but some evidence suggests that Bruce himself made the architectural sketch and the landscaping plan. As a condition indispensable to life, Bruce's home was supplied with a workshop equipped with modern machines and devices.[6]

When preparation was finished he took up residence for the rest of his life. Here Bruce spent his time performing chemical experiments and constructing new astronomical devices and sundials. A telescope lens which Bruce made is still kept in Lomonosov Museum in St. Petersburg. He lived in his castle in solitude, visiting Moscow only rarely. In Moscow he went up the Sukharev Tower, stayed there for some time and conducted his astronomical observations. He made sundials and watched the stars through the telescope. Like a dragon of Clifford Simak ("The Goblin Reservation") – a relic of the lost Universe – he did not find himself in this new world. How insignificant this world seemed to him as compared to the extraordinary accomplishments of the great past age.

Jacob Bruce died in April 1735 and was buried in a Lutheran church in Moscow. He did a great deal and stayed in our memory as an enlightener and man of honour. His student Vasily Tatishev, a well known Russian historian, said "Being in tsar's good graces he was a paragon of virtue and has hurt nobody's feelings searching by any means the opportunity to express his sympathies to everybody".[19]

Heritage

In 1735 the St. Petersburg Academy of Science bought the research library and collection of rarities that had been left by Bruce.

Rarities included the instruments, sundials, coins and specimens of oriental applied art. The library consisted of more than 1500 books on mathematics, astronomy, medicine and other disciplines. In 1829 a part of this collection was donated to the Helsinki University (Finland). Several of Bruce's books are now in the library of Moscow University and the Mining Institute. Bruce marked his books with ex-libris and signed some of them. Elena Savelieva, a researcher from St. Petersburg Academy Library, says that Bruce had put his signature on the title-page of a copy of William Leybourn's 1682 'Dialing plain concave and convex'.

In modern Russia Jacob Bruce is considered as a national hero. The literature about Bruce is abundant, continues in demand and varies from short articles[8] to full valued books.[10, 13] Bruce's birthday is marked with organizing of the special exhibitions in leading museums. The last one was written in 2003 by Filimon[14], the director of Bruce's Museum-estate Glinky.

Russian Nostradamus

Experts have many reasons to consider Bruce to be one of the initiators of geodesy, mining, instrument-making industry and military engineering in Russia. As to the rest of the population, they, as usual, are interested only in the mythical component. The contemporaries of Bruce said that he was an outwardly restrained person and tended to be an armchair scientist rather than a Field Marshal. Together with astrological divinations published in the calendar, this feature of his character, as well as the fact that he lived a recluse in a village, was the food for rumours. The old rumours have reached us through a bit less than 300 years with adding of new details. For example Robert Collis, researcher from University of Turku (Finland), asserts now that Field Marshal Bruce was an alchemist and a freemason.[9]

In Russia, Bruce has been a subject of romantic prose for the last 15 years. It is said that he made a parlor maid of flowers to serve to him and that on a hot summer day he had frozen the water in a pond. This year (2006) the Memorial Estate of Jacob Bruce in Glinky village has celebrated his 150th anniversary. The lectures were delivered in the anniversary meeting. One of the lectures was devoted to cryogenic machinery, which Bruce could apply to freeze the pond.

As long ago as in his lifetime Bruce was well famed as a magician, predictor and a person reminiscent of Michel Nostradamus.[4] This comes as no surprise because of a part of the contemporaries considered Peter's best friend to be at least an accomplice of devil and Peter himself to be a blood-thirsty monster. Besides, the locality of the Sukharev Tower had an ill-boding reputation. Before the School of Navigation was organized, the Sukharev Tower was used as a barrack for colonel Sukharev soldiers. The possessing of cardinal virtues was not the determinative peculiarity of

Fig. 8. (above and right). The blank dial-plate of "Bruce's" dial at the corner of Dobroslobodskaya and Spartakovskay streets. Moscow. March, 2006. Photographs by the author.

their behavior. No wonder the rumours proliferated that Bruce animated the dead bodies and that somebody even saw him flying out of the Sukharev Tower astride a bird made of steel and wood.

In 1872 during the celebration of Peter's 200th birthday there was a competition among painters. The first prize was awarded to Savrasov. Nothing could express the spirit of Peter's epoch better than the Sukharev Tower. Looking at the landscape waiting for forthcoming spring and surrounding the tower of Russian Baroque taste one can imagine that somewhere inside the tower two Scottish gentlemen, Jacob Bruce and Henry Fargwarson, discuss something of great importance in ancient Latin. Not only spring but even summer is just around the corner.

Here is a paradox to finish with. There is a house in which the Moscow University of Building is now located. This house was built at the end of 18th century by Count Musin-Pushkin who was married to Jacob Bruce's grand-niece and who was a relative of the poet Alexander Pushkin. Between two left hand windows of the second floor you can see a blank dial-plate shaped as a coffin lid. This dial was designed and constructed by a priest named Seruge, who was a tutor of the Count's children. Jacob Bruce had never been to this house for he had died much earlier. Nevertheless, for the last 200 years this dial is referred to as Bruce's dial. It was said that the dial pointed out the treasures which Bruce buried in the wall and that on the eve of revolutions and wars the dial runs with blood.

In 1930, because of superstitions and partly in order to put a stop to idle talk, the drawing was erased from the dial face, but the dial remained. Superstitions are tenacious of life. A ghost of a tall old man wearing a wig and an old-fashioned brocade camisole still appears before the students of the University of Building.

ACKNOWLEDGEMENTS

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20. John Bradley (Bradlee). Apprenticed to John Worgan in the Grocers' guild in 1697, turned over to Jonathan Roberts (Broderers' guild) in 1697, made free in the Grocers' guild in 1704. Worked in London from 1704 to 1710, then to Moscow and to St Petersburg in 1716. Died 1743. He was probably 14 years old when he started his apprenticeship, giving a date of birth of c.1684. (Ref. Clifton: *Directory of British Scientific Instrument Makers 1550-1851*, Zwemmer.)

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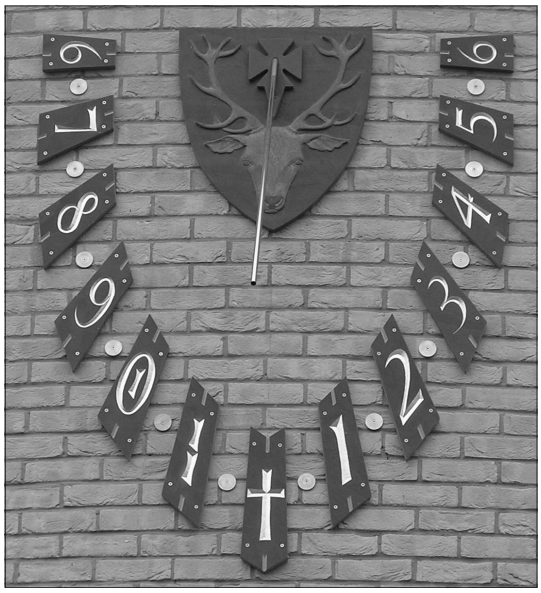
NEW OXFORD DIAL OPENED



Photos: D Brown

A new dial, designed and made by BSS member David Brown for Hertford College, Oxford, was unveiled by Lord David Waddington in the presence of members of The Hertford Society on 25th June. The dial was commissioned by the Hertford Society in honour of Alfred Nathan, a benefactor and former member of the college. Unfortunately the sun did not shine! The dial, approximately 2 metres tall, is 10 metres above the ground and directly over a waterway, was made in slate with stainless steel gnomon and half-hour points. The edges of each of the gilt hour plates correspond to quarter-hours. The dial is a direct south cylindrical dial with polar-pointing gnomon (dubbed a 'bullnose' dial, partly because of its being on a bullnose wall, and partly because it is in Oxford, the home of the Morris Bullnose car). A stainless steel tablet below the dial gives the dedication in honour of Alfred Nathan together with an equation of time correction curve.

A REVIEW OF THE HELIOCHRONOMETERS BY PILKINGTON & GIBBS

Part 2. Procedures for setting up the Helio-Chronometer

GRAHAM ALDRED

INTRODUCTION

When setting up the Helio-Chronometer (HC), the modern owner has the advantage of knowing the exact GMT and therefore can calculate LAT. However, he does not know where to mount the minute sector on the old worn HC and must therefore recalibrate it. By contrast, a hundred years ago the HC owner did not know GMT exactly but the minute sector was in the correct position on his brand new HC. Finding the meridian was more difficult then without an accurate time reference, the rather daunting advice from P&G was to select an instrument azimuth at which the sun's declination was constant for several hours during the day by marking the height of the image on the screen. For post-1918 installations, the GMT was known reasonably accurately so, with the minute sector correctly positioned (ex-factory), the procedure was reasonably straightforward.

The following sections describe a sequence of practical methods used by the author for recalibrating and reinstalling Helio-Chronometers. Some preparatory work is generally needed prior to installation. Some of the terms used in this description were defined in Part 1 of this article (BSS Bulletin 18(ii), June 2006).

Levelling and installing the lower base plate

Sun is not required. Ensure that the pedestal is level and stable and that the rag bolt is securely fitted in the pedestal, otherwise refit it using two-part epoxy resin, protecting the threads with insulation tape during this operation. Using an engineering-quality spirit level, check the cardinal directions on the pedestal. Unless the levels are extremely good, drill and tap three holes (e.g. 2BA) in the webs of the lower base plate disposed at 120º and prepare three brass grub screws of appropriate length as shown in Fig. 9. These will not be seen after installation.

Fig. 9. Lower base plate showing the three new grub screws that enable very accurate levelling of the instrument. These are shown longer than required for illustration purposes; in practice they would be nearly flush with the casting.

Mount the lower base plate loosely on the rag bolt and adjust the three grub screws sitting on copper pads (or old coins) until the base plate is perfectly level. Fit the rag bolt nut and tighten cautiously: check the level and use the adjusting screws to correct it. This is a precise method of levelling with good control, superior to use of shims that tend to skid at final tightening. If this is to be a permanent installation, mark the angular position of the base plate on the pedestal then remove it. Protect the rag bolt threads and the six tapped clamping holes with insulation tape on both sides. Prepare some hard mortar or, preferably, epoxy, put appropriate quantities in the required places on the pedestal and then refit the lower plate in the marked position, pressing down until it bottoms on the levelling screws and pads. Fit the rag bolt nut and tighten cautiously, checking the levels. Ensure that no epoxy or mortar sets on the visible machined surfaces. As the epoxy sets, a small additional turn will transfer the load from the levelling screws onto the greater area of epoxy.

Fig. 10. Illustrating the use of a specific latitude template and high quality spirit level to set the co-latitude on a Mk 2 HC.

Setting the co-latitude

The requirement is that the Instrument Centre Line (ICL) must be elevated to an angle equal to the co-latitude above the horizontal plane, defined by the exact levelling of the

base plate. Although Mk 2 HCs have a latitude scale inscribed on the hemisphere mounting sector, a latitude template is recommended for greater accuracy. This is made using 18mm MDF by constructing a right triangle with hypotenuse of at least 12" using x-y methods for the required co-latitude. Sun not required. Fit the hemisphere and its upper base plate onto the base plate, tightening the six screws evenly (the orientation is not important) and hand-tighten the bowl nut. The template is pegged onto the ICL to complement the co-latitude, as shown in Fig. 10. Using an accurate spirit level, attempt to adjust the bowl to make the top edge of the template horizontal. Progressively tighten the bowl nut. This is an iterative and tedious adjustment that requires several cycles because tightening the bowl clamp nut inevitably changes the latitude. A rubber mallet is essential for fine tuning the bowl position prior to final tightening.

Fig. 11. Illustrating the more elaborate lectern method required to stabilise the hemisphere in both cardinal directions when setting the co-latitude on a Mk 1 HC.

One of the important design improvements in the Mk 2 was the redesigned bowl mounting method that constrained movement during latitude adjustment to only one plane (N-S), whereas the Mk 1 simply has a large oval hole in the bowl that allows it to be elevated in any tilted position in any direction. So, even though the ICL may be adjusted to the correct co-latitude (with great difficulty), the bowl will inevitably lean to the East or West. The only safe solution is to make a two sided MDF 'lectern' (Fig. 11) elevated at the co-latitude and of such a height that the bowl can be mounted underneath using the mounting ring holes. This method requires a larger horizontal level surface for the feet of the lectern. The HC is thus constrained in the N-S and E-W planes while the nut is tightened through a hole in the lectern with the same care and similar difficulty as for the Mk 2. Obviously this method could also be used for the Mk. 2.

Meridian setting preparation

The instrument is now level and set to the correct co-latitude. The equatorial plate assembly should be mounted and the base clamp screws released sufficiently to allow the instrument to rotate about its vertical axis (see Fig. 2 in Part 1). The next step is to establish a normal sundial with no mean time adjustment in operation but to use the sighting system to find the shadow centre very precisely. In order to achieve this, the minute sector must be positioned on absolute zero and then the mean time adjustment must be carefully inhibited.

Setting the Minute Sector at Absolute Zero.

In this operation the hour plate is used as a convenient protractor to position the minute scale centre at 97.5º from the ICL. In order to achieve this, the Principal Reference Diameter (PRD) on the dial plate must be rotated to coincide exactly with the ICL. To identify the PRD, remove the sight, screen and month plate from the dial plate then lay a straight edge from 6pm to 6am, draw a short pencil line from 6pm to the edge of the sight slot.

Fig. 12. Showing the sight-screen line coincident with the Plate Reference Diameter. This is the position in which the mean time adjustment is zero. It is most unlikely to occur at an EoT zero date as discussed.

On most HCs there is a faint scribed line at the top of the bowl on the rim and this defines one end of the ICL. If this line is lost, the centre of the top screw hole in the support ring may be used, although more precise engineering methods would involve a height gauge or scribing block. As Fig. 12 shows, these two lines are at right angles and it is not possible to judge their coincidence exactly without a bridge to connect them. Fortunately, the minute sector has the exact shape and line markings to achieve this and so it

can be used as shown in Fig.13 to set the PRD coincident with the ICL by rotating the dial plate. When this is done the minute sector is fixed to, say, 12:00 exactly. The sector centre line will now be at the 97.5º, the absolute zero position. It is wise to mark absolute zero (initially in pencil) and to measure the relative times of the original 'o' and 'G' lines with respect to absolute zero for historical interest.

Fig. 13. Showing the unconventional use of the minute sector to bridge the gap. The minute sector line markings project the PRD through a right angle to allow coincidence with the Instrument Centre Line to be established.

SSL/PRD Coincidence

On the sight of most HCs there is an extension of the vertical two-hole centre line onto the edge of the sight foot: this is one end of the sight screen centre line (SSL). If this line is missing then it is necessary to devise a means to reproduce it. Again, the most accurate method would involve using a vertical height gauge or a scribing block. Now SSL and PRD must be made to coincide exactly by selecting an appropriate date by rotation of the month plate. The coincidence of the two lines can easily be judged visually (Fig.12) and it will occur near to a date with zero EoT due the finite EoT zero offset. The instrument is now a basic equinoctial sundial with mean time adjustment inhibited.

Positioning on the Meridian.

In good sunshine, calculate LAT and, with the minute sector at absolute zero, revolve the hour plate to indicate LAT. Then rotate the whole instrument on its vertical axis (Part 1 Fig. 2) to centre the image on the screen, taking care not to disturb the month plate that is holding SSL on PRD. Mark this position in fine pencil on the bowl support ring, then repeat several times at different LATs until it is consistent. Finally tighten the six base clamp screws using a special screwdriver or spanner. The Instrument Centre Line is now on the Meridian and the instrument is now a functioning LAT sundial.

The new EoT Zero offset

Good sun is required. Set the date to the chosen EoT zero date as discussed in Part 1 (25 Dec or perhaps 1 Sept). SSL and PRD will no longer coincide because SSL is now a chord on the dial plate. Loosen the minute sector screws. Calculate LAT, centre the image on the screen by rotating the dial plate. Reposition the minute sector to indicate the calculated LAT. Tighten the minute sector screws. The centre line of the sector now defines the new 'o' mark for the current state of wear. Repeat this procedure until it is consistent, and then mark with a fine line on the support ring.

Thus, if LAT is ever required or needs to be checked, the position for the minute sector will be known for the chosen EoT zero date. Wear causes the 'o' mark to drift clockwise from its original position. Using the minute sector, this time drift can easily be measured for historical interest.

The Longitude adjustment

No sun is required. Rotate the hour plate to, say, 30 minutes past any hour. Calculate the longitude adjustment. If the adjustment is West, move the minute sector anticlockwise to add this number of minutes to LAT, then tighten the screws. The minute sector centre line now defines the new 'G' line for the location. Daylight saving adjustment in UK requires a one hour shift also anticlockwise relative to 'G'.

Testing the Instrument

In theory, the Helio-Chronometer is now correctly set up and adjusted to the local longitude. Set today's date and compare the indicated time with mean time. If it is around ±1minutes, the set up may be considered provisionally successful. If the difference is around ±2 minutes, it may be legitimate to adjust the minute sector very slightly. This can be justified because the cam may be unevenly worn; however, doing this could compromise readings in another part of the year. If the difference is >3 minutes the whole sequence should be repeated. It is strongly recommended that the whole procedure is repeated whatever the reading: it takes much longer to describe than to do! Then it is important to monitor the accuracy over days and weeks. If it drifts, the whole set up procedure should be repeated, especially making sure that the meridian finding is done in good sun. Any detectable drift in image height on the screen during the day (10am to 4pm) is a clear indication that the instrument centre line (ICL) does not lie on the meridian.

Final remarks

These general procedures, written for the Northern Hemisphere (NH) instruments, apply very closely to all other mounting arrangements like the Type V Universal model. The rare Southern Hemisphere (SH) instruments necessarily have certain mechanical and scale differences so these

procedures would need to be adapted with some directions reversed: see Appendix 2.

If restorers intend to re-install an HC for an owner, it is wise to practise and repeat the whole installation sequence at home. This will establish the zero position of the minute sector and the new 'o' and 'G' line positions. Knowing where these lines should be is a useful confidence check when the installation actually takes place, typically on a day of intermittent sunshine. In addition, the co-latitude can be pre-set and locked. Although the recalibrated HC could be returned to its owner with some setting up instructions, not all owners would have the confidence and ability to proceed, especially with levelling, tightening and finding the meridian. It is desirable that reinstallation is carried out by the restorer where possible because even a small mistake during installation will be magnified and will compromise the achievable accuracy of the Helio-Chronometer.

Appendix 1
Summary of adjustments on Northern Hemisphere Models

Some of the adjustments required by HCs may seem counter-intuitive so the summary tables in Figs. 14 & 15 are provided as a helpful reference for HC owners, researchers and, especially, restorers.

Adjustment Required	Reason (example)	Method of Adjustment	
		Direction	Result
EoT	Nov 3	Sight Arm Clockwise	Subtracts from LAT
EoT	Feb 11	Sight Arm Anti-Clockwise	Adds to LAT
Longitude	East of Std Meridian	Minute Sector Clockwise	Subtracts from LAT
Longitude	West of Std Meridian	Minute Sector Anti-Clockwise	Adds to LAT
Daylight saving	Summer	Minute Sector Anti-Clockwise	Adds to LAT

Fig. 14. Reference table of adjustments for calibrating and installing the HelioChronometer.

EoT Zero Offset Condition		Method of Compensation	
Offset	Consequence	Direction	Result
Sight Arm Clockwise	Subtracts X mins from LAT	Minute Sector Anti- Clockwise	Adds X mins to LAT
Sight Arm Anti-Clock	Adds Y mins. to LAT	Minute Sector Clockwise	Subtracts Y mins from LAT

Fig. 15. Reference table for negating EoT zero offset in HCs caused by initial non-zero state and subsequent wear of the cam system.

The HC has been designed to modify LAT according to the following algebraic sum:

GMT = LAT + {EoT + EoT zero offset} – EoT zero offset + Long Adj + BST

Appendix 2
Southern Hemisphere Models

The Southern hemisphere (SH) models were developed from the NH models. On SH models, the dial plate and minute sector numeration are reversed because the dial plate must be rotated anticlockwise to track the sun. The EoT adjustments must also be mechanically reversed so that, for example, the sight is moved 16 minutes anti-clockwise on 3 November. One option would have been simply to invert the cam profile, the equivalent of plotting EoT with negative sundial fast values, so that November adjustments are below the mean time reference circle (see Fig. 6 in Pt 1). This implementation would not require any fundamental mechanical changes to the NH components, but a stronger spring might be required.

The other option would have been to retain the NH cam but to reposition the month plate and cam on the right hand side of the dial plate. This allows a mirror image of the control arm to push the sight anticlockwise in November, thus reversing the NH EoT adjustment direction. This method requires several fundamental casting and manufacturing changes including moving the minute sector to the LHS of the dial plate, so it is curious that P&G chose it rather than the inverse cam option. Perhaps this indicates how difficult it had been to produce the master cam initially and they could not face reversing it for such a limited market. Although all other known SH models have a repositioned month plate, recently there has been one report of an inverse cam model in New Zealand.

For setting up these SH models, the words clockwise and anti clockwise should be exchanged in Figs. 14 & 15.

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CHURCH ALIGNMENT:
TOWARDS PATRONAL SAINT SUNRISE?

IAN HINTON

The article[1] by John Wall on church orientation in Bulletin 18(i) raises many interesting points on church alignment generally, more specifically that of patronal saint sunrise alignment and the issue of differently aligned naves and chancels. My own research on this subject has involved several years of surveying churches in various counties across the country. Although it is primarily focussed on the siting of churches, the large dataset has enabled many of the earlier theories of alignment to be tested.

Of the 1670 churches so far surveyed, 1051 (63%) are aligned within 10º of true east, whilst only 29 (2%) are aligned more than 30º from east. Having said that, the mean alignment does vary by longitude (but not by latitude). This is a result of the fact that the data are skewed about the mean. In the west of the country more than three-quarters of churches are aligned to the north of east, but less than half of churches in the east of the country are aligned to the north of east. There are no topographical factors within the survey that can explain this, and the issue is still under investigation - any contributions towards a solution would be welcome.

Misaligned chancels

The twelfth-century imagery of the Crucifixion, contemporary with many of these churches, showed Jesus' head to be held vertically, rather than canted to the left, leaving the 'religious imagery' argument as a Victorian antiquarian idea. In an earlier article[2] I showed that 1 in 6 of all churches has a difference between nave and chancel alignment of 2º or more. Despite the overall ratio of misalignment left and right being almost exactly 50:50, the chancels of churches that were differently aligned from their naves were usually (75%) aligned closer to east. They were not aligned closer to sunrise on their patronal saint's feast day, nor closer to magnetic east, but to true east. Whether this implies a different 'focus' for church builders as time passed, or improved technology or ability to realise their original aim, is not clear.

Patronal saint sunrise

It is thought that the concept of alignment of churches towards sunrise on the day of the patronal saint may have originated as a Masonic tradition. It is quoted in 1859 in the History of Freemasonry[3], but uses William Wordsworth's earlier reference in a poem in 1823[4] as corroboration. In his poem, he refers to a vigil on the site on the night before the dedication of the church, and the fixing of the sunrise point the next morning. Earlier references to the idea date back to the 17th century[5] and the words quoted are very similar to those used in Wordsworth's poem, indicating that the popular 19th century references were repeats of a much earlier idea. St Mary's at Rydal (Cumbria), the subject of Wordsworth's poem, is aligned with sunrise on July 2nd (Feast of The Visitation) taking into account the 12º elevation of the horizon.

There are three specific issues which need to be considered when analysing the results of any survey relating to sunrise and patronal saints. The first concerns the height of the eastern horizon relative to the church. An elevated horizon would delay sunrise and make the sun appear later, and therefore further to the south, with a delay of between 1.5º and 2° along the horizon per one degree of horizon elevation.[6] This would apply to many churches located in valley bottoms or on slopes that rise in an easterly direction. The opposite situation, where the church is higher than its eastern horizon would have the reverse effect, advancing sunrise relative to a level horizon and making it appear more northerly. This has not been observed as part of the horizon measurements in this survey, and would be an unusual situation, as a church facing down a hillside is more likely to be facing a similar hill the other side of the valley (effectively making its horizon level, or even elevated) than to be located on a hill facing out over a flat plain with a significantly depressed distant horizon. However, in order to allow for either of these situations, in the general analyses presented in this paper a range of 15° either side of the level horizon sunrise position has been used, which will take all but the most extreme differences into account. A separate analysis of the alignment of the churches in four counties, where horizon elevation has been measured, is presented afterwards.

The second issue concerns calendar drift, which progressively affected the relationship between the calendar date and the solar date in Britain until AD 1752, when the error was corrected by deducting 11 days from the calendar. The error grew steadily after the introduction of the Julian calendar in 45 BC. During the period when most churches were being built, the error varied from 6 days in the middle of the tenth century to 9 days in the middle of the fourteenth century.[7] The difference between a specific date in the twelfth century, a period of much church building, and the same date today, is approximately 7 days – sunrise oc-

curring effectively 7 days earlier then. This translates to a difference in sunrise position of approximately 5° further north on the horizon around the autumn equinox, when the sunrise position is moving south; 5° further south at the spring equinox, when sunrise is moving north; but virtually no difference at the summer and winter solstices, when there is little day to day change in sunrise position. If the time of the year when the initial alignment of individual churches was determined was spread throughout the year, then the differences noted above would tend to cancel each other out. Even if some bias does remain, the following general analysis deals with a range of ±15° around the sunrise position on each saint's day, as noted above, to allow for any variation brought about by the calendar change (and horizon differences). This avoids the need to recalculate sunrise positions based on dates which would not only depend on knowing in which year the church alignment was first set-out, but considerably more problematically, in which specific season of that year.

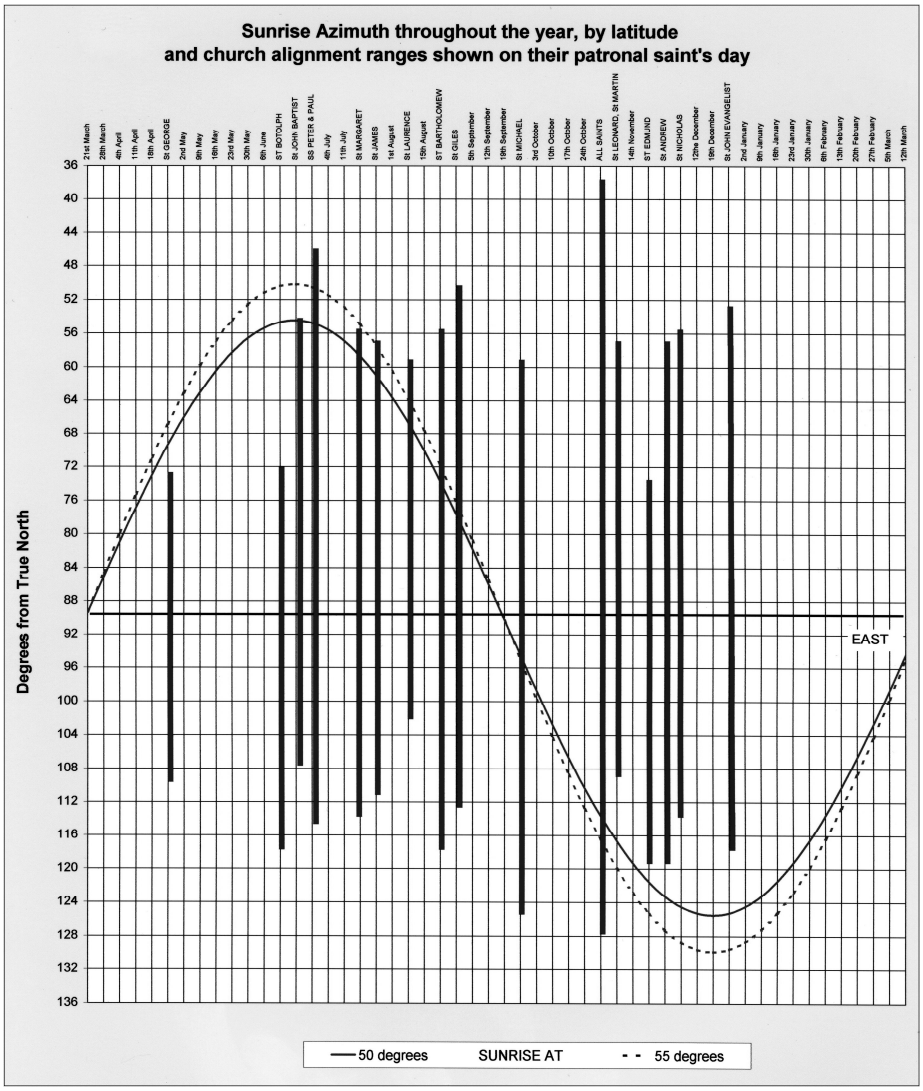

Fig. 1. Sunrise azimuth and church alignment.

The third issue involves church re-dedications, either in very early times at a change of manorial lordship[8], or as part of the later religious upheaval in the sixteenth- and seventeenth-centuries, when many dedications were altered to one of the biblical saints or to The Holy Trinity, in order to have a less idolatrous feel[9]. Re-dedication would hide the fact that a church may have been correctly aligned with sunrise appropriate to its original dedication. Richard Clark's work[10] has shown that 40 per cent of the churches in Derbyshire changed dedication between the sixteenth century and the present day, and there appears to be no reason to assume that Derbyshire was unusual in this. Since the majority of the areas examined in this survey have yet to be covered by the work on church dedications pioneered by Graham Jones as part of the TASC database[11], this leaves as the only complete source the pre-reformation dedications set out in Arnold-Forster's index of parishes.[12] This would provide information on changes occurring from the later middle-ages, according to the sources that she used, but would not incorporate the unknown number of early re-dedications. In order to avoid these problems, the churches in the survey will firstly be analysed by their current dedication and broad conclusions drawn, then a summary analysis of dedications by their season will be presented and the results compared.

The 1670 churches examined in this survey are dedicated to over 150 different saints. Most of the analysis that follows concentrates on the most common dedications and those with a single feastday. Churches dedicated to St Mary have been excluded in the majority of instances because, without knowing which of the six feast days was originally celebrated at specific churches, the introduction of additional possible sunrise points for so many churches complicates the issue.

General analysis of saints day sunrise assuming level horizons

Figure 1 shows the position of sunrise at a level horizon throughout the year, as the two curves, for the extremes of latitude in England - Cornwall (50°) and Cumbria (55°). They are shown in degrees from true north (the vertical axis), with east at 90° showing sunrises at the spring and autumn equinoxes where the curves cross the 'east' line. Superimposed are columns indicating the range of alignments for all the churches in this survey dedicated to a 'major' saint and are shown for each individual dedication on the date of the saint's feastday (the horizontal axis).

	total	Range of align-ments	**MEAN Align-ment**	St.Dev +/-	% North of East
All Saints	235	38-128	**86.5**	1.1	64
Holy Trinity	26	59-106	**84.9**	3.3	65
SS Peter&Paul	49	47-115	**87.4**	2.3	55
St Andrew	120	58-120	**88.1**	0.9	56
St Bartholomew	22	56-118	**87.8**	4.1	59
St Botolph	15	73-118	**85.5**	4.9	80
St George	20	73-110	**87.0**	2.3	65
St James	29	58-112	**87.1**	3.7	52
St John Baptist	41	55-108	**85.2**	2.4	63
St Laurence	34	60-103	**84.7**	2.9	71
St Leonard	19	57-109	**84.4**	4.4	74
St Margaret	74	57-111	**88.4**	1.7	49
St Martin	23	65-107	**83.8**	2.7	74
St Mary	352	56-116	**86.7**	0.4	63
St Michael	98	60-126	**87.9**	0.9	61
St Nicholas	59	57-114	**86.1**	1.8	63
St Peter	132	55-116	**86.5**	0.8	64
Other (or no) Saints	322	50-121	**84.3**	0.9	66
TOTAL	1670	38-128	**86.2**	0.3	63

Fig. 2. Table showing the alignment of churches by dedication.

It is immediately apparent that few churches are aligned towards sunrise on their patronal saints' day, shown by the fact that many of the columns in the diagram, describing the range of observed alignments for each dedication, fail to meet the curve which represents the sunrise position that day, at all. Almost all churches dedicated to saints with festival days around midsummer (such as St. John the Baptist and SS Peter & Paul), or during the later autumn and winter (such as St. Andrew, St. Martin, St. Leonard and St. Nicholas) fail to meet the curve and therefore have no churches facing their sunrise. For the majority of those where the column is intersected (St James, St Laurence, All Saints), it is only at the extreme end of the alignment range, thereby automatically excluding the possibility that the vast majority of churches, clustered around the middle (mean value) of the alignment range, face their sunrise.

Most of the other saint's dedications have columns of roughly similar length and position, showing that almost all dedications have fairly similar alignment ranges, centred approximately on east, despite the fact that festival day sunrises vary between St John the Baptist & SS Peter & Paul, around 50°, and St Andrew & St Nicholas, at around 124°. Even the results for St Michael, with two festival dates close together, and near the middle of the range of possible alignments - 92° and 97°, are inconclusive, as the alignments of the 85 churches dedicated to St Michael in this survey vary between 60° and 126°.

The figures shown in Fig. 2 confirm how similar the mean alignment and range of alignments across churches with different dedications. Only churches dedicated to two saints, St Margaret and St Martin, vary by more than 2º from the overall mean.

The consistency in alignment eastwards, irrespective of dedication, rather than towards different sunrises, is emphasised by the figures shown in Fig. 3. Four out every five churches (80%) in the survey are aligned within ±15° of east, varying between 67% for churches dedicated to St. Botolph and 86% for those dedicated to All Saints, whereas only one in six (18%) is aligned within ±15° of its sunrise position, and just over half (52%) of all the churches in the survey are aligned more than 30° away from their saint's day sunrise.

Only churches dedicated to one saint, (St Michael - whose feastdays are close to the equinox) has more than 50% of their churches aligned within ±15° of its sunrise position, and even then, a greater number of churches dedicated to St Michael (78%) are aligned within ±15º of east, suggesting that even with a feastday sunrise close to east, east itself was a greater focus for the church builder. Every dedication analysed has a greater proportion of its churches facing east than facing its sunrise. The fact that churches dedicated to four saints (St Botolph, St Leonard, St Nicholas and Saints Peter & Paul – 142 churches in all) have either no churches, or just a single church, aligned within ±15° of their sunrise, but 114 (80%) facing within ±15° of east, confirms the consistency with which churches of all dedications face generally eastwards rather than generally towards their patronal saint's sunrise point.

Saint's 'season'

The results are summarised in Fig. 4 by grouping churches together whose patronal saints' feast-days occur in the same season of the year. This is done on the basis that if the individual church alignment was affected by a respect for the

Saints Season	No	Range	Mean	Std. dev	% N of East
Winter	352	54-120	86.2	±1.2	63
Summer	434	47-118	86.3	±1.1	60
Equinoctial	839	38-128	86.3	±0.8	64
No Saint's Day	41	54-111	85.0	±3.3	76
	1670		**86.2**	**±0.3**	**62.9**

Fig. 4. Overall medieval results by season of the patron saint of the church.

		degrees from Saints day sunrise					degrees from Due East				
		±15°		16-30°	31+°		±15°		16-30	31+°	
	total	No.	%		No.	%	No.	%		No.	%
All Saints	238	26	**11**	110	102	**43**	204	**86**	31	3	**1**
Holy Trinity	26	2	**8**	6	18	**69**	20	**77**	5	1	**4**
SS Peter & Paul	49	1	**2**	13	35	**71**	40	**82**	8	1	**2**
St Andrew	119	3	**3**	24	92	**77**	96	**81**	22	1	**1**
St Bart'mew	22	10	**45**	9	3	**14**	18	**82**	3	1	**5**
St Botolph	15	0	**-**	5	10	**67**	10	**67**	5	-	**-**
St George	20	9	**45**	8	3	**15**	15	**75**	5	-	**-**
St James	29	3	**10**	9	17	**59**	23	**79**	5	1	**3**
St John Bapt.	42	4	**10**	8	30	**71**	31	**74**	10	1	**2**
St Laurence	34	9	**26**	19	6	**18**	29	**85**	5	-	**-**
St Leonard	19	1	**5**	10	8	**42**	14	**74**	4	1	**5**
St Margaret	74	4	**5**	22	48	**65**	59	**80**	14	1	**1**
St Martin	23	2	**9**	4	17	**74**	17	**74**	6	-	**-**
St Michael	98	71	**72**	22	5	**5**	76	**78**	21	1	**1**
St Nicholas	59	1	**2**	5	53	**92**	50	**85**	7	2	**3**
St Peter	130	4	**3**	38	88	**68**	106	**82**	23	1	**1**
Other (with saints day)	278	77	**28**	78	120	**44**	215	**78**	49	11	**4**
TOTAL	**1272**	227	**18**	390	655	**52**	**1023**	**80**	223	26	**2**
Other w/out saints day	44						35	**80**	8	1	**2**
St Mary	352						295	**83**	57	2	**1**

Fig. 3 (above). Church alignment compared with Saints day sunrise and Due East, by dedication. (All dedicated churches in survey with a known Saints feastday.)

		degrees from Saints day sunrise					degrees from Due East				
		±15°		16-30°	≥31°		±15°		16-30	≥31°	
	total	No.	%		No.	%	No.	%		No.	%
All Saints	136	22	**16**	58	56	**41**	117	**86**	16	3	**2**
SS Peter&Paul	28	1	**4**	9	18	**64**	21	**75**	6	1	**4**
St Andrew	71	5	**7**	21	45	**63**	59	**83**	12	-	**-**
St Botolph	11	-	**-**	1	10	**91**	7	**64**	4	-	**-**
St John Baptist	20	5	**25**	2	13	**67**	16	**80**	4	-	**-**
St Margaret	42	3	**7**	12	27	**64**	35	**83**	7	-	**-**
St Michael	49	37	**76**	10	2	**4**	38	**78**	11	-	**-**
St Nicholas	32	2	**6**	7	23	**72**	29	**91**	3	-	**-**
St Peter	68	5	**7**	25	38	**56**	56	**82**	12	-	**-**
Other (with saints day)	194	52	**27**	55	87	**45**	162	**84**	28	4	**2**
TOTAL	651	132	**20**	200	319	**49**	540	**83**	103	8	**1**
Other w/out saints day	2								2	-	
St Mary	196						174	89	21	1	1

Fig. 5 (right). Church alignment compared with actual Saints day sunrise and Due East, by dedication. (Churches in Cumbria, Bedfordshire, Oxfordshire and Norfolk.)

feastday sunrise point, then the alignment of those churches dedicated to a saint with a feastday in the depth of winter, or the height of summer, would tend to cluster together well away from due east. For the purposes of this analysis, the year was divided into four equal segments, centred on the solstices and equinoxes. 'winter' is taken as the 92 days from 6th November to 5th February, 'summer', is the 91 days from 8th May to 6th August, the remaining 182 days were classed as equinoctial. As the table below shows, only 0.1° separates the mean alignments of churches dedicated to saints in each of these seasons. The results for the 'no saint's day' category are different, having a slightly lower mean, and a considerably higher proportion of churches aligned to the north of east, because 60% of these churches are located in Cornwall, where many churches are dedicated to obscure local saints without recorded feast-days[13], and where alignments are numerically lower (more northerly).

Elevated horizons

It was noted earlier that horizons elevated above the horizontal would delay sunrise, therefore making the actual point of sunrise appear further to the south. To take this into account, the horizons of 849 churches in four counties, Cumbria, Bedfordshire, Oxfordshire and Norfolk, were measured and calculations of the actual sunrise position.

These results for churches where the horizon was measured and the actual sunrise position was calculated, demonstrate the same alignment patterns as shown in Fig. 3 for the whole sample – one in five churches (20%) aligned within 15° of their saint's day sunrise, whereas half (49%) are aligned more than 30° away from the actual sunrise point. However, more than four of every five churches (83%) are aligned within 15° of east, with only eight churches aligned more than 30° away from east. These figures are confirmed by Fig. 6, which illustrates the pattern in Norfolk, showing the majority of saint's day sunrises to be at the

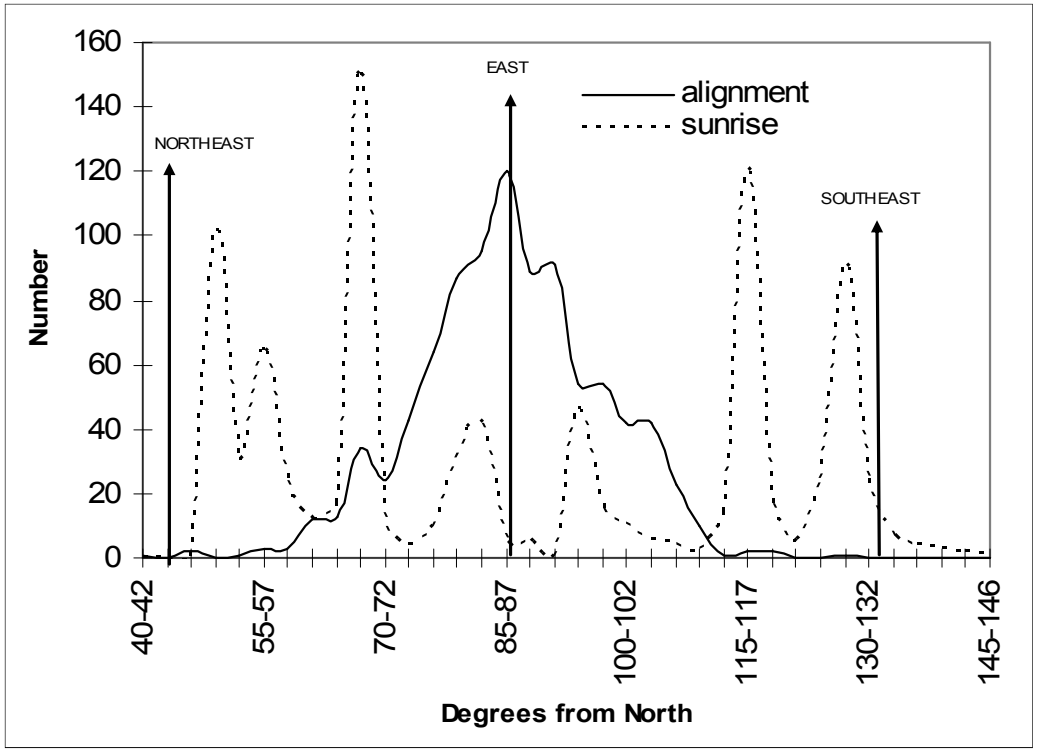

Fig. 6. Comparison of actual Patron saint sunrise and church alignment in Norfolk.

extreme ends of the church alignment range or outside it completely.

Conclusions

The results here seem to argue conclusively against the idea that churches were aligned with sunrise on their patronal saint's day feastday, at least within this group of rural churches. For statistical purposes, some of the groups are small, but, if churches did indeed face 'their' sunrise, then all the churches of each dedication would tend to align closer to a single direction, so that the size of the sample would not matter. However, churches of each particular dedication patently do not align in different directions and added to this is the fact that churches in the "other saints" group, which consists of 278 churches dedicated to over 100 different saints, displays a similar range of alignments, with a similar mean direction to that of each of the individual saints, and has a similar proportion of churches facing close to east (78%).

Read together with the summary 'saint's season' results, it is definite that this concept is not true now. Whether a large number of these churches have been rededicated so that they are not still aligned towards their original patron saint's sunrise is not known. However, if that were he case, then those churches would have to have been dedicated to saints whose feastday is close to the equinox (sunrise due east [90º]), such as St Michael, since the majority of churches are aligned within 10º of east. It would also mean that churches dedicated to some of the most popular saints, whose feastdays are close to the solstices – for example St Andrew, St Nicholas, St John the Evangelist, St John the Baptist and St Peter, could never have been aligned towards their sunrise. It seems most unlikely, on this evidence, that the concept of churches facing their patronal saint's sunrise has ever been true.

ACKNOWLEDGEMENTS

Thanks are particularly due to my wife, Maggy Chatterley, for her surveying assistance and her map-reading skills in remote parts of the country, but most of all for her patience with my obsession. Thanks also to John Davis for his assistance with formulae and calculations and to Larry Newitt of the Canadian Geological Service for long electronic discussions on historic magnetic declination.

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Penshurst dial stolen, a twin found

An unusually handsome vertical dial on a tall column was taken from the gardens of Penshurst Place, Kent, and, quite by chance, an almost identical dial has been found in the gardens of grand country house. There does not appear to be any connection between the locations, other than that both are in the south of England.

Penshurst Place is set in the rural Weald of Kent surrounded by picturesque countryside and ancient parkland. The mediaeval house and gardens have changed little over the centuries, having been the seat of the Sidney family since 1552. Today, Philip Sidney, Viscount De L'Isle, continues the family guardianship with his family and welcomes the public. The location is unusual from the sundial point of view by having five dials including the vertical one. One of the dials is an analemmatic in a play area by David Brown.

The Penshurst dial: note that most of the hour lines are visible and the metal stay to the wall. Photo: David Brown.

The Penshurst dial was set in part of the 11 acre formal gardens known as the Demi Lune. It was situated very close to the tall garden wall; so close that there was a metal stay between the top part of the dial and the wall.

In 2004 David Brown reported to the BSS Registrar that this vertical dial, formerly considered unique, had been lifted over the wall of the garden of Penshurst Place, Kent. The whole dial with its column and half-round plinth was taken. So far, the police have not recovered it.

On this dial the lichens have almost obliterated the hour markings.

Recently, more or less by chance, I visited a country house and, given the location, I was not surprised to find a perfectly respectable horizontal dial and this amazing vertical dial. Our Registrar's suspicions were alerted but I was convinced that the dial had been at the location for some time - the base was 'aged', had a moss-filled repair and the base alignment matched the garden layout. There were no sighs of recent transportation or setting up. A follow up visit confirmed the originality and photographs and garden design plans showed that the dial was put in place in 1901.

The two dials are so similar that they must surely have been made by the same hand. The dial part, with its unusual half 'chariot wheel' form (720mm diameter) has Roman numerals, a noon gap and a substantial brass or bronze gnomon. The gnomon base is positioned back from the plane of the dial so that it would appear to be in error across the 6am - 6pm line, but the design is correct and allows for the set back. Both dials show clean stone in a broad band in line with the gnomon and where water drips from the tip of the gnomon onto the plinth. This is due to the herbicidal effects of the copper ions carried from the gnomon by the quite natural acidic rain. The elegant hexagonal column rises to a curved leaf decoration followed by a transition to a square cross section series of mouldings.

Above:The Penshurst dial, photographed in 1997 by David Brown.

Left: The newly-located dial on a square plinth in a formal garden.

The Penshurst dial was on a circular plinth with the second dial on a large square one with mottoes on each face. The most legible on the front says "I work(?) only sunny hours". On the sides only the odd Latin word is detectable under the lichen and moss and on the reverse a repair has eliminated all but a couple of letters.

The owners of the second dial are happy to cooperate with Viscount De L'Isle if they wish to make an exact copy, and the Society can hope for a happy outcome.

Report from Doug Bateman

SUNDIAL DELINEATION USING VECTOR METHODS
Part 5 - Polar Dials

TONY WOOD

*[Readers are reminded that the meanings of symbols used in this paper do not follow the normal BSS convention. See the first part of the series (Bull. **17**(iii) pp.121-127) for their definitions here. Ed.]*

For a polar dial the dial plate is rotated 90° about Ox_G to intermediate position P1 and so Ox_G and Ox_{P1} are the same and Oy_{P1} lies along Oz_G. Oz_{P1} then lies along the negative Oy_G axis). Thereby the gnomon is in the plane of the dial plate; the dial plate is then moved 'back' d_P in a further axis transformation as in the cases of direct east and direct west dials.

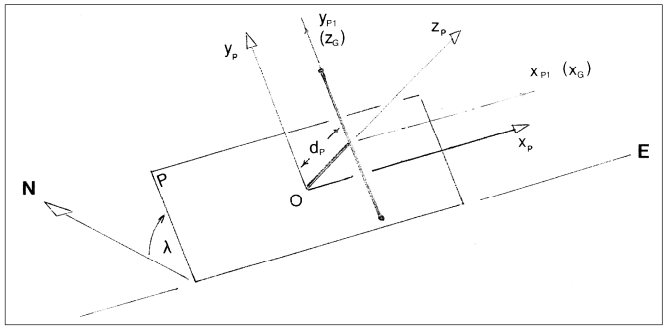


Fig. 19. Polar dial. Axis system.

The vector components (Fig. 19) of the shadow plane, now in polar dial plate axes $(Oxyz)_P$ are:

$x_P = p\cos\alpha \qquad y_P = q \qquad z_P = -p\sin\alpha - d_P$

(Again d_P is negative.)

Equating to $(x, y, z)_P = (s, t, 0)_P$, we have:

$x_P = -d_P/\tan\alpha$

i.e. a series of straight lines parallel to the Oy_P axis.

The declination lines are found from the ray line components:

$x_P = p\cos\varepsilon\cos\alpha \quad y_P = n - p\sin\varepsilon \quad z_P = -p\cos\varepsilon\sin\alpha - d_P$

The nodus is now at $(0, 0, 0)_G$ in gnomon axes and so n = 0.

Equating to the dial plate components $(x, y, z)_P = (s, t, 0)_P$ and eliminating p and then α, we have:

$y_P = -\tan\varepsilon \times (x_P^2 + d_P^2)^{½}$ i.e. a series of hyperbolas,

the equinox line ($\varepsilon = 0$) being along Ox_P, i.e. $y_P = 0$.

The sub-style line is trivially along Oy_P corresponding to noon.

The gnomon is parallel to the dial plate and $-d_P$ above it.

The sub-nodus point is: $(x_n, y_n)_P = (0, 0)_P$

The nodus height above the dial plate is: $(z_n)_P = -d_P$

Illumination Times

The horizon limit L_H is as given in Pt. 1 for horizontal dials.

The sun position limit L_S is given when the z_P component of the ray line becomes equal to $-d_P$ and so, from $\sin\alpha = 0$ the sun position limits are:

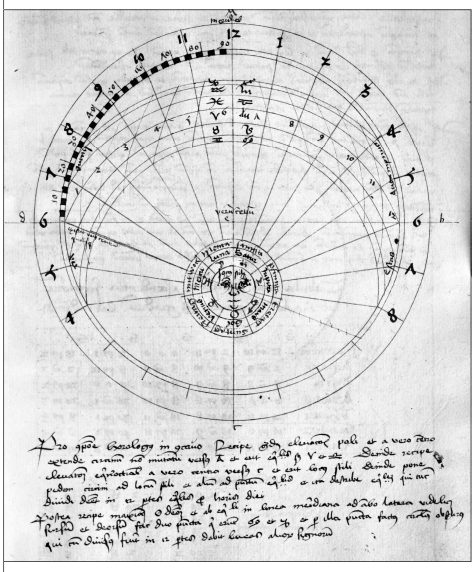
T_{24} = 06:00 to 18:00

To be continued

EARLY DIALLING MANUSCRIPT FOUND

Italian diallist Nicola Severino has recently made the worldwide dialling community aware of a previously unknown early manuscript, now located in the library of Lund University, Sweden.

The anonymous manuscript, written over the period 1477-1505 in a difficult-to-read Latin, is mainly on astronomy and mathematics but also has an excellent section on sundials. This makes it slightly earlier than the works of Oronce Finé in France or Nicholaus Kratzer in England. It was probably written in a mid-European location such as Vienna or Augsburg (example dials have a latitude of around 48°) and later moved to Lund. The dialling pages, beautiful with their red and black inks, show many dial types and the tables for constructing them. One example is the pillar (shepherd's) dial; others include dials with planetary and Babylonian hours. There are also quadrants, astrolabe-like instruments and representations of the heavenly sphere, some with functioning volvelles. Of particular interest is the 'horizontal astrolabe sundial' which, at first glance appears similar to William Oughtred's double horizontal dial invented almost a century later. More detailed study shows that it is not a stereographic projection but the drawing for a horizontal scaphe dial. Still, it is an intriguing find!



Courtesy Lund University

You can see more of the document on Nicola's website at: *http:// www.nicolaseverino.it* or visit the Lund University site at *http://laurentius.lub.lu.se/* and look for Medeltidshandskrift 47.

Bee on Time! - Harriet James

Old and Worn but Still Working - Ian Butson

PHOTOGRAPHIC COMPETITION 2005

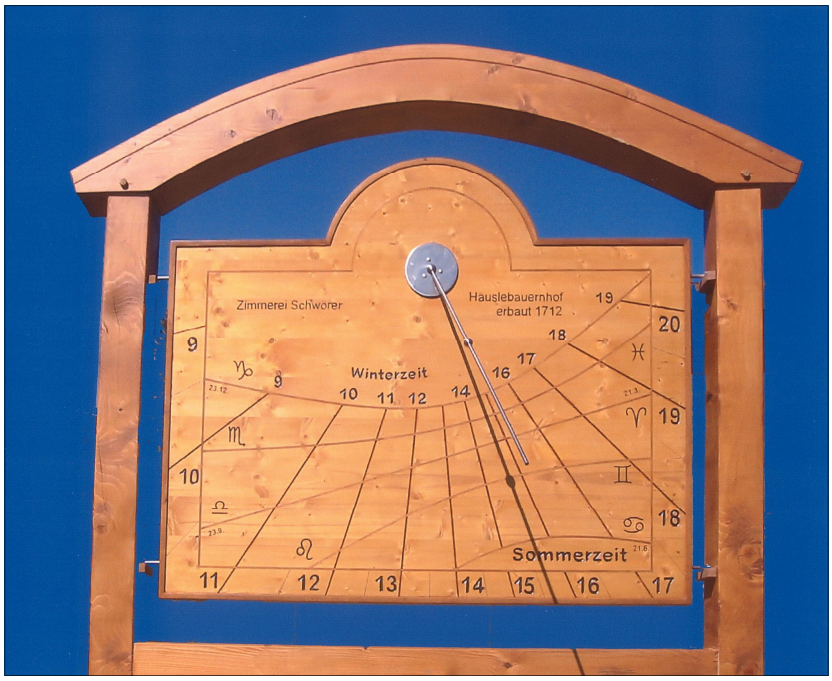
More of the excellent entries to the competition: see the previous issue for the winners.

High Time - Jackie Jones

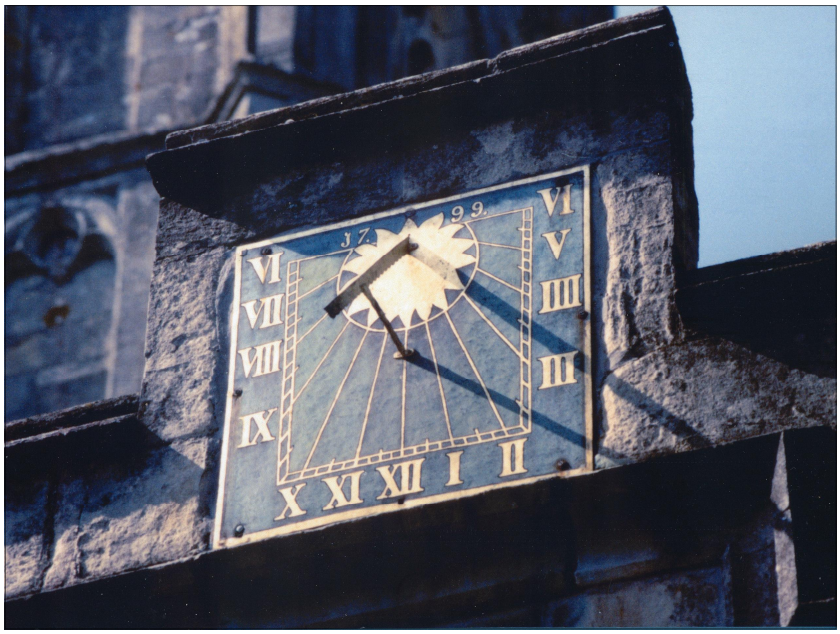
The Tranquility of a Manor House Garden (Sulgrave Manor, Northants)
Mike Cowham

Trompe L'Oeil or the Fine Art of Deception
(Berchtesgaden, Baveria)
Mike Cowham

History Lost to Disney - Ian Hayton



Wooden Dial in the Black Forest - Peter Kunath



None - Tony Wood

Cuban Garden - Jackie Jones

UPDATE ON THE HORNIMAN CEILING DIAL

JOHN MOIR

Anyone who has spent the night in a timber building after a hot summer's day will probably have had their sleep disturbed by strange bangings and creakings, as the timbers readjusted themselves. When Ray Ashley and I installed the Horniman ceiling dial in a wooden building over ten years ago (*BSS Bull* 13(i)) we took the chance that such movement, along with timber shrinkage might, in time, adversely affect the accuracy of the dial. It would only require a tiny movement of the mirror to cause quite large inaccuracies.

Over the years we have monitored the dial, though with only three declination lines and no division lines between the hours this has often been a subjective assessment. Nevertheless, as the years progressed we noticed that the light spot's position was becoming a little erratic and last year decided to reset the mirror. On the day of the autumn equinox, Ray ascended a ladder and, having arranged for the sun to shine at solar noon, he reset the mirror to bring the spot onto the crossing of the noon and equinox lines. It had been only an inch out, but we thought it was a worthwhile endeavour.

We later decided that it would have been interesting to monitor the dial at the winter solstice, but this was not an option, as for a few weeks around that time the sun would be too low, even at midday, to produce a light spot. (Most dials have periods of the day or year when they don't operate and this dial is no exception.) Fig. 1 shows the reflected ray falling on to a ceiling bathed in direct light from the low winter's sun, rendering the light spot invisible.

As Christmas approached, festive balloons became much in evidence, and since every balloon has a shadow we had the answer to our problem. A balloon could be used to block out the sun's direct rays allowing the light spot to show against its shadow. Our good friend Paul Rainey braved the bus trip with balloon and got the photo we wanted, Fig. 2. It was taken at around 11.30 solar time a few days after the solstice and the spot's position was good, if just a fraction too far from the solstice line. Paul even managed to get the mirror (arrowed) into the picture

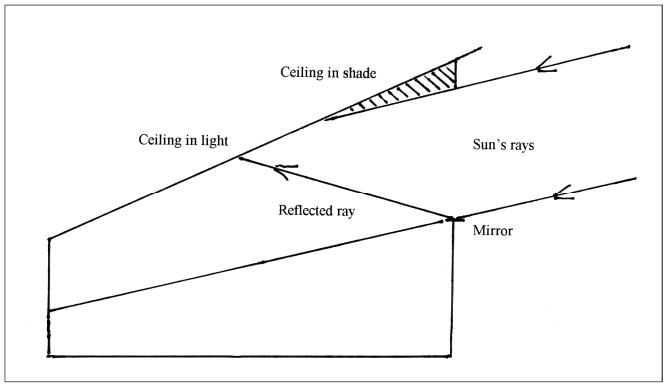


Fig. 1. Light rays on the sloping ceiling.

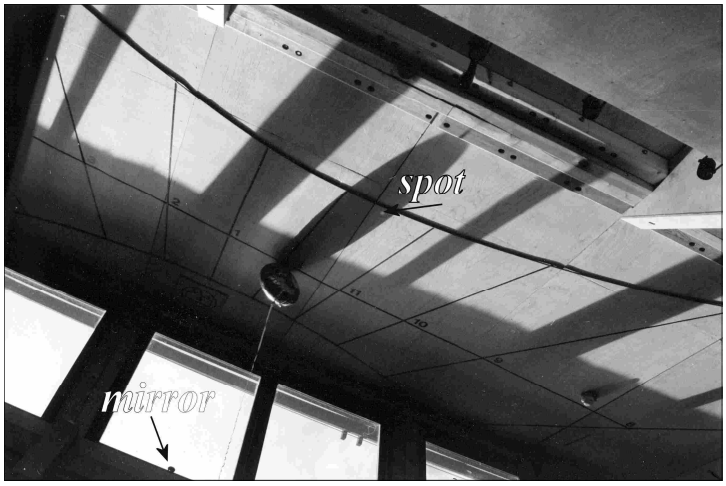


Fig. 2. View of the ceiling with the balloon strategically placed to cast a shadow for the reflected spot.

The Horniman library is now housed in the same building as the dial, making the dial generally accessible to the public. Ten other dials, located in the award winning gardens are described in a museum leaflet and also on a local website, *www.foresthill.org.uk*. Finally, the museum has a wonderful collection of ethnic artifacts obtained from around the world by Victorian tea merchant Frederick Horniman, a major collection of musical instruments and a superb new aquarium to be opened this summer. The museum is a ten minute walk (or bus) from Forest Hill station in South London, just 15 minutes by frequent trains from London Bridge station.

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The double polar dial at the Horniman, designed by John Moir and made by Richard Klose in Hopton Wood stone. The motto, "And hours run mad e'en as men might" is an anagram for The Horniman Museum and Gardens.

SIMPLE DELINEATION OF VERTICAL DECLINING DIALS

TONY BELK

Introduction and Background

Sawyer[1] points out that Foster[2], the originator of dialling scales, proposed that to draw a dial with any declination and inclination one could find an equivalent position on the globe where the dial would be a south facing vertical dial. It can be delineated and constructed and, with the correct longitude correction, used as a vertical declining dial at the original latitude. I have used this concept to produce two calculators in the form of slide rules that allow the determination of the equivalent latitude φ' and equivalent longitude λ' for the simpler case of any declining vertical sundial. The method proposed here requires no complicated graphical constructions or trigonometrical calculations, simply the alignment of two sliding scales. The equivalent longitude λ' is expressed as a time, the so-called hour angle of the plane of the gnomon. The dial can then be delineated using dialling scales.

Illustration

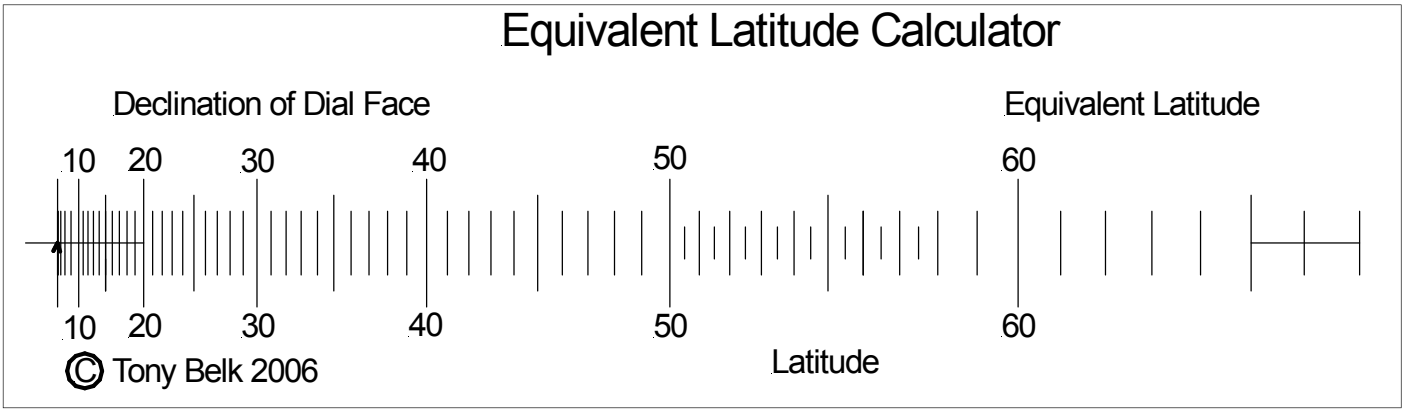
My home location is Shrivenham, latitude 51.6° N, longitude 1.67° W, and the front wall of my house declines 21° east of south. The equivalent latitude φ' and longitude λ' for my dial face are 54.5° N and 26.1° east of Shrivenham. These lead to the location of the small town Daugai in Latvia. A vertical south-facing dial for Daugai, Latvia, *marked in Local Apparent Time for Shrivenham, using the equivalent longitude,* and mounted at Shrivenham so that the 12-noon LAT line is vertical, is the correct vertical declining dial for the front wall of my house.

Cousins[3] gives a lengthy and complicated graphical method of drawing a declining vertical dial and also the following trigonometrical method for finding the equivalent latitude and longitude, using his angles β and H.

$$\cos\varphi' = \sin\beta = \cos d \,.\cos\varphi \qquad \tan\lambda' = \tan H = \tan d / \sin\varphi$$

Simple Method to find Equivalent Lat and Longitude

The equivalent latitude calculator shown in Fig. 1 should be printed on card and cut along the horizontal centre line separating the upper and lower scales. Fix a backing card to the back of the top scale, which protrudes 2cm below the scale. This allows the lower scale to be slid along the upper scale when in use. The equivalent longitude calculator shown in Fig. 2 can also be printed on card, cut along the horizontal central line and used with a backing card to allow the bottom scale to slide along the top scale.



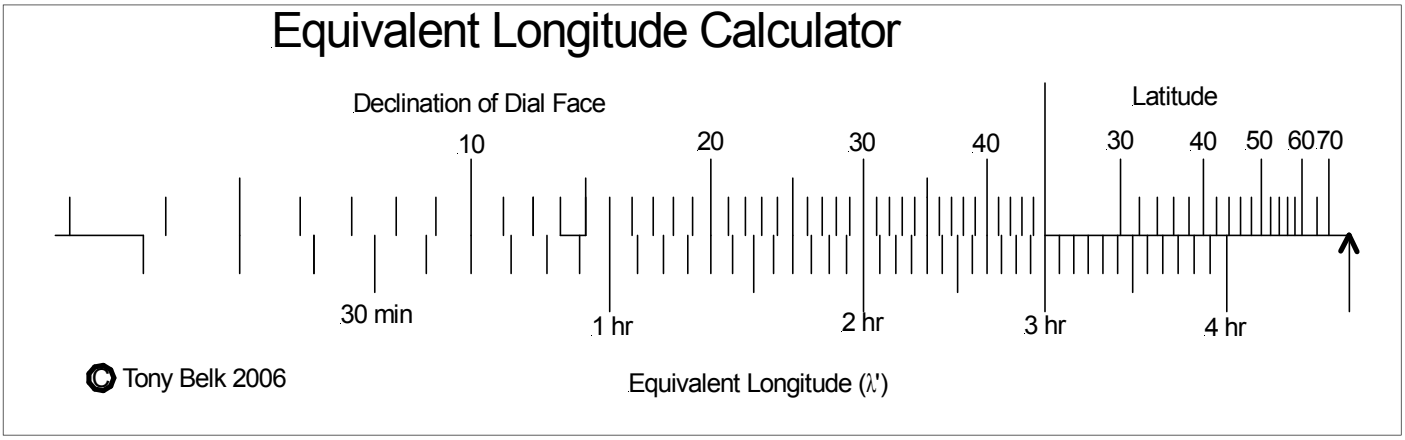


Fig. 1 (top). Equivalent latitude calculator. Fig. 2 (bottom). Equivalent longitude calculator.

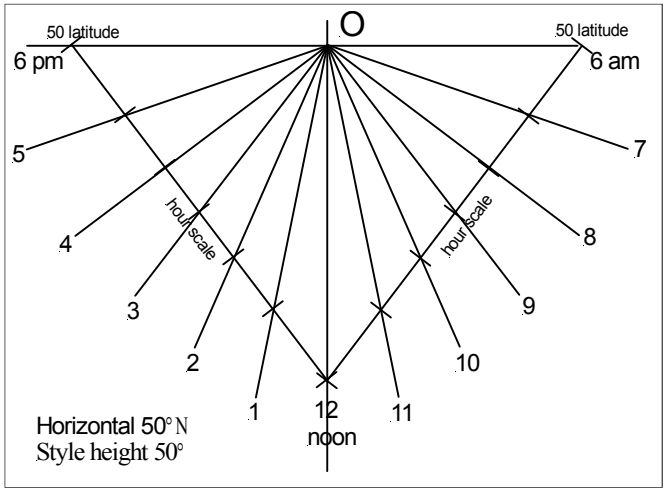


Fig. 3. Horizontal dial 50° N, drawn with dialling scales.

To find the equivalent latitude, set the arrow at the bottom left against the declination ***d*** of the dial face on the top left. Read off the equivalent latitude φ' on the top right scale above the actual latitude φ on the lower right scale. The equivalent latitude calculator is marked in 2° steps up to 10° and then in single degrees, except for UK latitudes where half-degrees are used.

To find the equivalent longitude as an hour angle of the plane of the gnomon λ', set the arrow at the bottom right against the actual latitude φ on the top right. Read off the hour angle λ' at the bottom left against the declination angle ***d*** at the top left. If the declination is west of south the sub-style line is marked as 12 + λ' hours; if it is east of south the sub-style line is 12 - λ' hours. On the equivalent longitude calculator, latitude φ is marked from 30° to 60° in two degree intervals as they are quite close together. Declination ***d*** is marked in single degrees and time λ' in five minute intervals, as are dialling scales.

Use of dialling scales

Dialling scales are the simplest and most accurate method of manually delineating a horizontal or vertical sundial. They consist of a pair of scales, one marked **latitude** in degrees and the other **hours**, from 12 to 6 or 6 to 12 and with five minute markers. [4, 5]

To delineate a horizontal dial at 50° N latitude, take a piece of A4 paper and mark a line parallel to the long edge about 3cm from that edge. (This construction is illustrated in Fig. 3.) Now draw a perpendicular to this line across the centre of the page. From the intersection of the two lines **O**, mark on the longer line on either side of **O** the 50° distance with the latitude scale. These will be the 6:00 am and 6:00 pm points. The shorter line at right angles is the 12:00 noon line. Place the hour scale so that one end is on the 6:00 am mark and the other end lies on the 12:00 noon line, making a triangle. Mark the hours 7:00, 8:00, 9:00, 10:00, 11:00 so that they are clockwise around **O** from the hour scale with pencil points. Now join these points to **O** giving the required hour lines. Repeat this process on the other side of **O** placing the 6:00 pm mark at one end of the hour scale and the other end on the 12:00 noon line. Mark 1:00, 2:00, 3:00, 4:00, 5:00 and join them to **O**. This is the horizontal dial plate with a style height of 50° and the root of the style at **O.**

To draw a vertical south-facing dial the process is similar. Use the co-latitude, 90- φ i.e.40°, to mark the latitude scale and exactly the same method as for the horizontal dial except that the hours are now increasing anti-clockwise around **O** instead of clockwise. The style height is now 90- φ or 40°.

Drawing a Vertical Declining Dial

To draw a vertical declining dial with dialling scales, use the equivalent latitude φ' and mark the points 90- φ' from **O**. The central line which would be 12:00 noon for a south facing dial is now marked 12+ λ' if the wall declines west of south and 12- λ' if the wall declines east of south. Having labelled the central line the hour lines can be plotted using the hour scale but again adding λ' to the reading if declining west or subtracting λ' if declining east. As an example, my house in Shrivenham has the central line 12:00 minus 1 hr 46 min, i.e. 10 hr 14 min. The latitude markers are set at 90 - 54.5 or 35.5° from **O**. Hour 11:00 is marked 46 min beyond the centre line i.e. at 12 hr 46 min according to the hour scale. 12:00 noon is marked at 1 hr 46 min on the hour scale and 1:00 pm, 2:00 pm, 3:00 pm, and 4:00 pm at further increments of one hour and the long line latitude marker is reached at 4 hr 14 min. On the other side of the central line, the latitude spot on the long line is 6 hr minus 1 hr 46 min or 4 hr 14 min. The 5:00, 6:00, 7:00, 8:00, 9:00, and 10:00 hour markers come at 6 hr 46 min, 7 hr 46 min, 8 hr 46 min, 9 hr 46 min, 10 hr 46 min, and 11 hr 46 min on the hour scale. When the dial is delineated and erected at

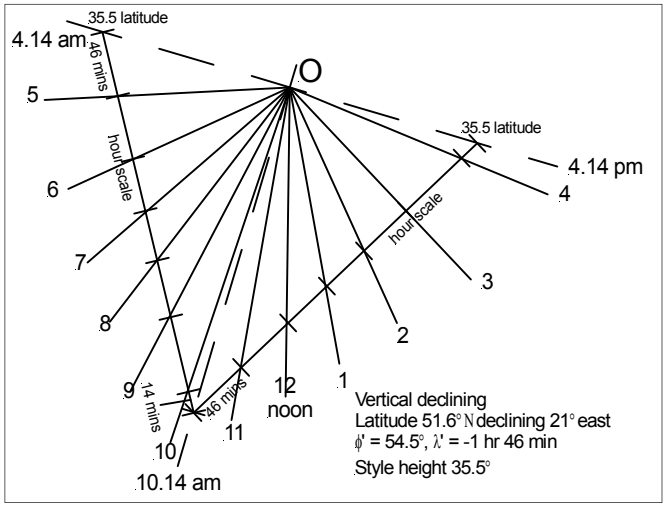


Fig. 4. Vertical dial declining 21° east, latitude 51.6° N. Designed using the calculators in figs 1 and 2 and dialling scales.

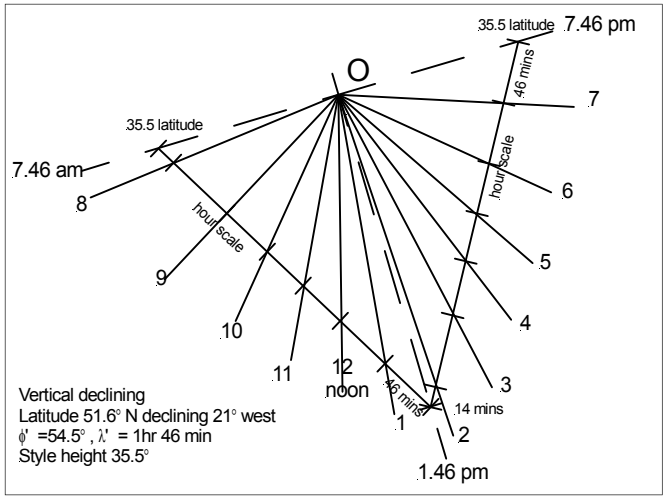


Fig. 5. Vertical dial declining 21° west, latitude 51.6° N. Designed using the calculators in figs 1 and 2 and dialling scales.

latitude φ = 51.6°, the 12 noon line must, of course, be vertical and the dial will be as shown in Fig. 4. The style height is 90-φ', that is 35.5° and the style is mounted along the sub-style line shown dashed in Fig. 4 and labelled 10:14 am.

If the dial face had been declining west by 21° the central line would have been marked 1 hr 46 min and the dial face shown in Fig. 5 would result from completing the rest of the construction. Again, the style is mounted along the dashed sub-style line labelled 1:46 pm.

For all the above operations Local Apparent Time is used. If Standard Time is required the normal longitude correction can be applied, but the 12:00 noon LAT line must still be vertical when the dial is mounted.

Range of Application

The range of the equivalent latitude calculator shown here is for declinations up to 43° for UK latitudes. The range can be extended to 80° declination but this produces a calculator that is significantly less accurate at declinations below 20°. The range of the equivalent longitude calculator is for declinations up to 45° for UK latitudes. Again, the range can be extended to 84° but the accuracy of setting the latitude is less.

WREST PARK

English Heritage has recently acquired the freehold of the historic gardens of Wrest Park in Bedfordshire. As a result, they are now open Thursdays to Mondays in June to October.

BSS members will remember that, amongst the excellent gardens and statuary, they will find a most convincing replica of one of Henry Wynne's large, late-17th century, double horizontal dials on an elegant pedestal. It is well worth a visit.

See www.english-heritage.org.uk/wrestpark for more details.

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SYMBOLS

φ latitude of dial
λ longitude of dial
d declining angle of dial face
β Cousins' equivalent co-latitude
H Cousins' equivalent longitude
φ' equivalent latitude
λ' equivalent longitude

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Editor's Note

Dialling scales can be obtained commercially from Tony Moss at Lindisfarne Sundials.

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