The British Sundial Society

BULLETIN

No. 98.3

OCT. 1998

Front cover: Sundial at Burnt Norton, Gloucestershire
Back cover: Burnt Norton, with sundial and clock
(Photos: P. Swann)

'Time present and the time past
Are both perhaps present in time future
And time future contained in time past...'
T. S. Eliot: 'Burnt Norton'

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// BULLETIN

OF THE BRITISH SUNDIAL SOCIETY

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EDITORIAL

Our versatile contributors are offering readers of this issue sundials for several age groups and periods. There is a dial ('Gregory') for youngsters in a school playground, and one ('Helios') for elderly contemplatives musing in a summerhouse beside a pool. There are dials Ancient: (Greek in Athens, Saxon in Ryedale, late medieval around Harleston;) and a dial Ultra-Modern, a gilded metal leaf in South Africa. The highways and byways of dialling history and mathematics are well-represented as ever. The ingenuity and craftsmanship of our membership never fail to impress us. We very much hope that a wider public will be able to appreciate them, by entries into the Society's Awards Scheme. So if you consider that you, or anyone of your acquaintance, has done a good job in design and execution of a dial, you are urged to submit it for the 'Awards Scheme 2000' as advertised in this issue.

A major article herein is the written version of Sarah Symons' Andrew Somerville Lecture. members attending the Conference at Dunchurch last May found Ms. Symons' account of the Egyptian Shadow Clocks absorbingly interesting. The general membership of the Society will now have the opportunity of reading her lucid and scholarly account of these strange and significant objects from a late period of ancient Egyptian civilisation.

Next Spring, about the time of our next issue of the Bulletin, the Sundial Society will reach its tenth anniversary. We will be thanking our foundation members, and especially those instrumental in bringing the Society into being. We commend to our readers in this issue the very interesting biographical obituary of one of the Founding Fathers, Charles Aked, of whom our Chairman has written with elegance and appreciation.

SHADOWY SECRETS: THE LURE OF THE OBSCURE (PART 1)

JOHN MOIR

The subject of 'hidden meanings' in paintings containing sundials has already been well explored. For example Holbein's 'The Ambassadors' and Rossetti's 'Beata Beatrice' have both been the subject of probing and fascinating enquiries into their symbolic contents.(BSS Bull. 95.3 and 97.1) However, not only paintings but sundials in themselves display many interesting examples of hidden meaning, symbolism and imagery. It is not surprising that diallists through the ages have shown an interest in the Occult. After all, it is precisely by hiding or 'occulting' the sun that the gnomon does its job.

Before describing some of the ways in which diallists have sought to puzzle and intrigue the onlooker, it is worth considering the following paradox. The more cunning the puzzle, the more it will be appreciated,--but if it is too clever it will not be appreciated at all! The reader can now judge for himself, in each of the following examples, how successfully this paradox has been dealt with.

Perhaps the most common 'mystery' device used on monuments, buildings and sundials is the **Chronogram.** Widely used in the 18th century, and even earlier, the chronogram conceals a pertinent date within a Latin inscription, as in this example from Gatty (1900 edition).

HONOR **D**O**MI**NO PRO PA**C**E
POP**VL**O S**V**O PARTA

Honour be to the Lord for the peace
procured for His people.

This motto was inscribed on a dial formerly on Nantwich Church and removed in 1800

Question 1. What is the hidden date?
Clue: the motto refers to the restoration of Charles II
(Answers to the Questions may be found at the end of the article, after the author's address.)

Whilst chronograms are common, **palindromes,** being much harder to compose, are rare. This is a pity as the realisation that the words one is reading can also be read backwards is always a delight. The only palindrome in the dialling world of which I am aware is:

NEMO NISI NOMEN
I am nothing but a name

with its play on the word 'gnomon'. This was recorded in a 1625 list of sundial mottoes compiled by the Kentish priest John Parmenter.

We now come to the **Anagram.** Mrs Gatty records a horizontal dial dated 1643, dedicated to Rene de Briolay, abbot in the diocese of Angers. It was inscribed with his Latinised name and anagram:

RENATUS BRIOLEUS - UT ROSA LENIS RUBE

Around the dial a typical 'over-the-top' eulogy is inscribed, which contains the same anagram:
'Ut rosa sic nobis lenis odore rube'...'Do thou, like the rose, blush for us, gentle in perfume'

The representation of words by pictorial means, the **Rebus,** was a common device used in Coats of Arms. A good example is that of a 16th century Prior Bolton, whose rebus showed an arrow (bolt) piercing a barrel (ton). My first example of a dialling rebus, again from Mrs Gatty, is shown in Fig. 1. Ignoring the cipher below for which she could give no explanation, and turning a blind eye to the fact that the hour lines as drawn are wildly inaccurate for the Lat. 44°N,

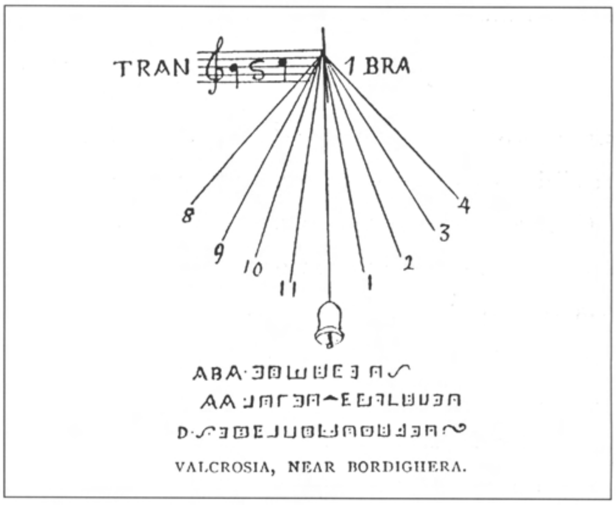

Fig. 1. A musical rebus.

Question 2: What is the motto?
Two further snatches of music are shown in Fig. 2. These extracts have been engraved by our member John Davis on a garden sundial which he made himself to amuse and inform friends and family. They of course will have no difficulty in identifying the melodies, which frequently emanate from his bathroom window.
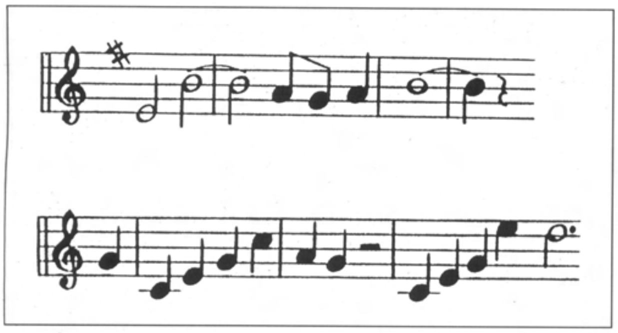
Fig. 2. Two Dial Ditties.

Question 3: Can you name these tunes?

My final rebus, Fig. 3, is on a vertical sundial which I made in handmade ceramic tiles, hiding a simple message which nowadays often goes by the board.

Fig. 3. A rustic Rebus

Question 4: What is the motto?

Word-play like the rebus relies heavily on punning, but of a non-visual kind. Fig. 4, shows an example from a South of England village. As the inscription portends, 'Ye may not know when...' but whenever it is, it will be about 19.5 minutes earlier by local sun time than at Greenwich. So

Question 5: Can you name this village?

A second example of word-play, Fig. 5, is on an east facing wall dial at Kedleston Hall, Derbyshire. Dials similar to this have been quite common from at least the 17th century and I imagine there are several extant to this day.

Fig. 4. ...but know ye where?

Question 6: 'Wee shall'...what?

The final category in this brief tour of enigmatic sundials is that of **False Identity.** Here we are dealing with dials which in essence have been around for years but masquerading as something completely different, awaiting someone to discover their true purpose. Fig. 6 shows a handsome translucent equatorial dial, in all respects tailor-made for the job. Readers of Maurice Kenn's article, Bulletin 97.1 will know that it was purchased by him as a coffee-maker. However it is now better as a time-keeper than as a maker of drinkable coffee.

The religious symbol of Agnus Dei (Lamb of God), Fig.7, has existed for even longer than the coffee-pot. It has been adopted as a pub sign, 'The Lamb and Flag', but it can also be seen as a carving or in stained glass in places of worship, as a symbol of St. John the Baptist. One day it occurred to me that the cross and swirling banner were nothing less than the gnomon and helical hour-scale in disguise. This led me to produce the model in Fig.8. Although the radius of the helix varies, it is of course constant within the hour-marked section. Suggestions would be welcomed from anyone with ideas or facilities for making this dial in weatherproof material.

Fig. 5. A Kedleston conundrum

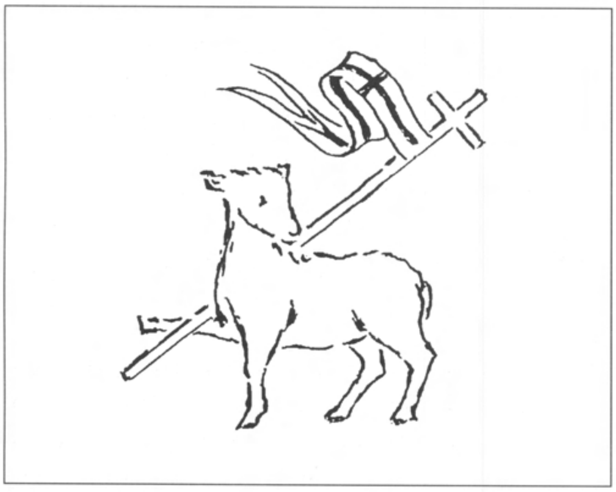

Fig. 7. "Agnus Dei" - Symbol

Acknowledgements: My thanks to John Davis and Maurice Kenn for their illustrations, to David Young for providing ideas and Figs 4 and 5, and of course to Mrs. Gatty.

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Fig. 6. "Coffee-time" sundial

Fig.8. "Agnus Dei" - Sundial

Answers: (1) M + D + C + L + V + V + I = 1661 (2) Transis ut umbra--You pass like a shadow. The notes Te and Doh were at one time Si and Ut, the 1 stands for UM (from UN) Thus :-- TRAN SI S UT UM BRA (3) Blue Skies; The sun has got its hat on. (4) Be on time (Bee on Thyme). (5)St. Wenn, Cornwall. (6)We shall die-all (dial)

THE MASS DIAL GROUP IN EAST ANGLIA
HARLESTON, NORFOLK 26-28 JUNE 1998

MARGARET STANIER

Some 18 members of the enthusiastic Mass Dial group gathered at the Swan Hotel at Harleston in Norfolk for a week-end of intensive Mass Dial hunting, organised with meticulous attention to detail by Dr. John Davis. We were sad at the absence of Edward Martin, the doyen of the Group, but pleased to have the benefit of the local knowledge of Lyn Stilgoe of King's Lynn, who had already covered much of the ground, and who joined us for the recording trip on Saturday.

On Friday evening after we had been fortified by a lavish dinner at the Swan, John Davis and John Ingram produced maps and lists of churches based on sightings collected from Cole, Arthur Mee, and other sources. Groups of villages, 6 or 7 in each group, were shown circled and numbered on the duplicated sketch maps; and the pairs or trios of dial-hunters were invited to choose one of the numbered groups. We were recommended to tackle the more distant groups on Saturday, leaving the nearer areas for the more limited time on Sunday. We were reminded of the instructions for filling-in our record forms: measurement of hour-line angles anticlockwise from zero at left-horizontal, measurement of wall's declination by orienteering compass and so on.

Then on a rainy Saturday morning 8 well-equipped car-loads of dial-hunters set off around the area. We found few problems over locating from the O.S.1:50,000 maps the position of the church in a village, though the county boundary between Norfolk and Suffolk, essential for record purposes, was not very clear. Sometimes it was difficult to locate the dial even when extracts from the sources gave a hint of its whereabouts ('buttress east of porch'...etc). My fellow-searcher and I always scrutinised a wall at least twice (even three times) before giving up a search, and on several occasions we wondered 'How *could* we have missed it the first time round?' Town churches gave us problems: *which* of all the church dots marked in Lowestoft is St. Margaret's? And when the church dot on the map is half way between two villages: 'Is this Elmham St. Nicholas or Elmham All Saints?' The long wet grass and nettles in some overgrown churchyards made us wish for our wellies, and the heavy rain on Saturday morning turned a few record sheets soggy before on-site completion.

By tea-time on Saturday the teams were trickling back to the 'Swan', welcomed with tea and coffee and edible treats, and reporting considerable success. We exchanged news of our problems, failures and triumphs (*eight* mass dials on one church and six on several others); that day's work had produced 86 dials on 56 churches. We then chose our locations for the Sunday search, and worked out a route on the map, and were given some further briefing.

Then, after another of the Swan's lavish dinners, John Scales of the Round Tower Churches Society gave us a talk, illustrated by slides, of East Anglia's round towers. During dial-hunting we had seen and admired a number of such towers at the churches visited and were glad to learn of their origin and history. Mr. Scales disposed of the popular misconception that the towers had had some defensive purpose. They were in fact made that shape because flint is the only good-quality building stone available in quantity in this area, and such small stones do not lend themselves to construction of sturdy corner-quoins. Indeed as we noticed, any flint-built square tower had its corner-pieces carefully constructed of scarce and precious dressed-stone or brick. The incidental observation of the churches' architecture, furnishings and guide-books is one of the spin-off pleasures of mass-dial-hunting.

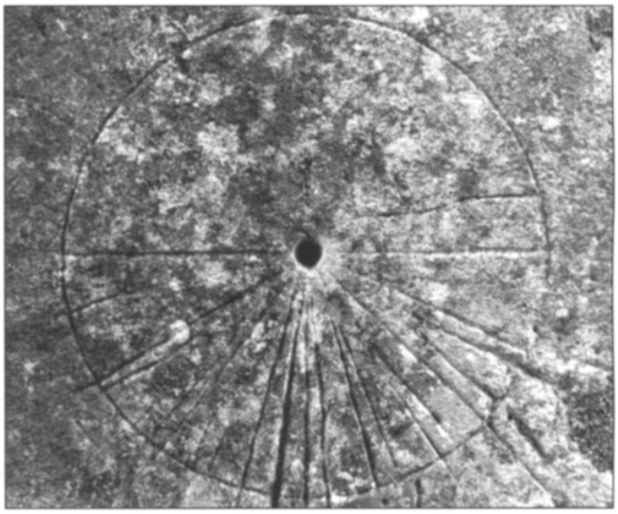

Fig. 1. Mass-dial at St.Mary's Earl Soham, Suffolk (one of 6 at this church)

Sunday was a day (at least for some of the groups) of much better weather. Any complete sundial could have done its job for most of the day. Soon after 9 a.m we set out on our surveys on routes all fairly close to base and returned after further successes between 3 and 4 p,m. The total score for the two days was the finding of 155 dials, and 109 churches visited. The sad news was that of some 15% of the dials appearing on earlier lists, no trace can now be

FIG. 2. All Saints' Church, South Elmham
(two mass dials on porch, orchids in churchyard)

found. An interesting finding was of a couple of 'transitional' dials, with numbered hour-lines, and some dials with holes which could have taken a sloping gnomon. Now we are collecting photographs, completing record sheets and dispatching the products to Edward Martin; and that makes one more area of England (central East Anglia) thoroughly covered.

For my search-partner and me, there were two high spots of the weekend. One was a chance visit on Saturday to the little-used church of St.Michael's Rushmere which was marked on the O.S.map but was not part of our official route: a charming thatch-roofed church with round flint tower, and carrying two mass-dials of much interest. Then, a particular delight on Sunday came a visit to South Elmham All Saints, in the care of the Churches Conservation Trust; it stands in a churchyard managed as a Wildlife Reserve, now colourful with meadow flowers and a mass of Pyramidal Orchids.

Why do I enjoy Mass Dials? Well, I feel sorry for the poor little things which will all vanish in another few centuries, and (I tell myself) we should record them and get the benefit of them before they all disappear. But this is rationalising; what I really enjoy is the pretext or objective for dashing around the countryside looking at ancient village churches, and (who knows?) getting a glimpse of a field of pyramidal orchids.

Margaret Stanier

HELIOS XXII

BARRY MASON

As a sculptor concerned primarily with the creation of works for specific locations I have a long-standing interest in gnomonics both in theory and practice. I was contacted last year by John Moir, one of the stalwart BSS members, in my capacity as a sculptor specialising in works with water. This led to an enjoyable afternoon and incidentally to his recruitment of me as a member of the Society.

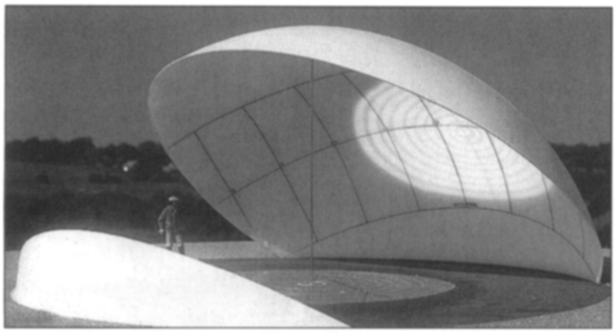

Fig. 1. 12.30 p.m. near equinoxes

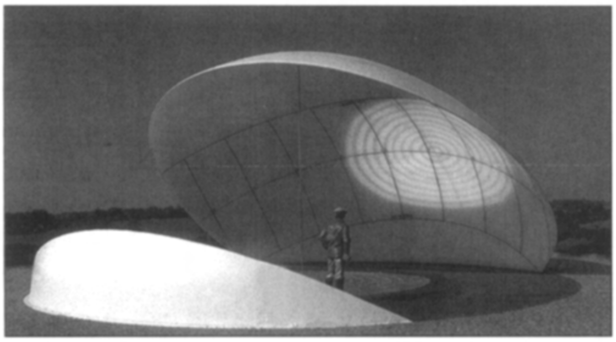

Fig. 2. Mid-afternoon near equinoxes

When John first arranged to meet me I set to work on a few ideas. These gathered momentum, and the result is a project which I have entitled 'Helios XXII'. Here the concept is of an architectural shell structure, a hemispherical dome large enough to create a shady summerhouse or shelter, and complete with a few built-in seats or benches.

In the centre of the floor lies a circular reflective pool, and extending from the centre of this to the zenith of the dome is a stainless steel rod down which water is pumped. This creates a constant flow of circular ripples. The hemisphere is cut with the sunpaths for the site for the winter and summer solstices, and the portion of the dome between these cuts is removed. Except when obscured by cloud the sun can thus always shine onto the pool. Reflections from the water are projected onto the underside of the dome where a few inscribed lines record the passage of the hours and of the seasons. The circular ripples from the water act as a kind of kinetic bullseye.

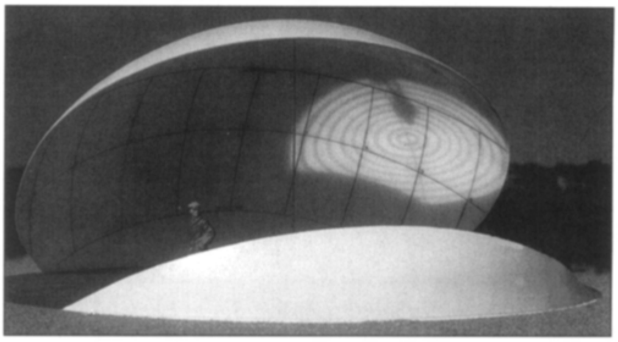

Fig. 3. Approx. 2.45 p.m. April, August

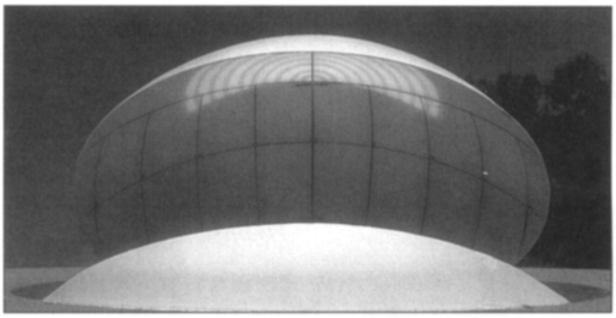

Fig. 4. Noon on Summer Solstice

I worked directly onto a small maquette, and this was easy to mount on an equatorial stand to allow observation and photography. I must say that I have been delighted with the results so far, and this has the potential for a full scale realisation. The reflection forms a very precise target and the underside of the hemisphere always has enough shadow to record this with clarity. As the seasons approach both summer and winter solstices, the reflected circle is gradually eclipsed at the edges of the hemisphere. The remaining half-circle allows plenty enough to take a reading.

At present this is a purely speculative scheme and I am seeking landscape architects and engineers who may be interested in its development. I hope that on a large enough scale this simple form might prove an environment for quiet contemplation, combining the gentle sounds of running water, the visual beauty of sunlight reflected from water, and the function of a sundial and solar calendar.

The photographs show the maquette of 'Helios XXII' at certain hours and dates. Comments from members would be most welcome.

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RESTORATION AND CONSERVATION

GRAHAM ALDRED

For some time the Council has recognised the requirement for a clear statement of our ideas regarding Restoration and Conservation. It has proved to be a difficult task, fraught with the problems of definition of terms and the caution required to protect the Society as a body from liability for actions of individual members. In addition, as recent correspondence has shown, there is a wide spectrum of opinion as to what is 'right'. Restoration and Conservation of sundials must take into account that they are scientific instruments with functionality which may demand different actions from those normally applied to the preservation of ornaments. It is hoped that although members will recognise the need for the document set out below, individuals will continue to feel encouraged to be involved in sundial restoration in various capacities. The British Sundial Society is a major focus for sundial expertise and as such has an important contribution to make to the preservation of the heritage of sundials.

BSS RESTORATION AND CONSERVATION POLICY

1.0 Purpose:

The purpose of this document is to define the BSS policy on restoration and conservation of sundials. It is important to define the limits of BSS responsibility and involvement in these activities, because the third objective in the BSS constitution is as follows:-

"To advise on the preservation and restoration of old sundials and the construction of new ones."

2.0 Definitions:

The following broad definitions will apply in this document. In the Conservation community these terms may have less precise meanings.

2.1 Restoration: Actions which restore a sundial into a correct functioning state by carrying out some remedial work. e.g., repainting or re-carving of hour lines, cleaning, replacement of gnomon, removing obstructions to sunlight, securing, levelling, re-aligning.

2.2 Conservation: Actions which attempt to prevent or slow down the decay in the existing fabric of a whole sundial and its support system. Conservation relates to preservation of the **fabric** of the sundial whilst restoration concerns recovery of its **function.**

2.3 Replacement: Actions which replace a complete sundial by a sympathetic reconstruction of the original.

3.0 The policy.

3.1 BSS encourages and supports the accurate restoration and re-installation of sundials. If specifically approached, BSS may give formal advice by defining the correct dial and gnomon geometry in the appropriate historic style. This will be formally underwritten by the secretary on specific BSS notepaper which carries a standard disclaimer.

3.2 BSS does not underwrite any advice or physical restoration / conservation actions carried out by individual members. The society must avoid legal liability which might be incurred if some aspect of the restoration were to become contentious. BSS has no public liability insurance covering damage to third party property.

3.3 Individual members, acting in a private capacity, may give advice and/or carry out restoration work but they must not state that BSS has approved the work that they intend to carry out. This is particularly important if the approach for advice or restoration work was made to them indirectly through the Society.

3.4 Dial makers and Restorers, including professionals and non-members, may submit their names to the Society for entry in a register. This register carries a disclaimer as follows "BSS cannot accept responsibility for the skills and quality of work of those named in this Register. All persons consulting the Register must satisfy themselves as to the competence of the selected dial maker or restorer."

3.5 BSS does not approve of restoration of any Saxon or Mass Dial. In these cases the most appropriate action may be conservation of the dial face to prevent further decay. This is specialist work which should involve wider support from the conservation industry. BSS does record the precise details of these historic dials and will carry on doing so.

3.6 BSS recognises that in many cases the deterioration of a sundial may make its restoration impractical. In these cases, replacement by a replica or sympathetic reconstruction may be the solution. Efforts should be made to record and conserve the decaying original.

3.7 BSS approves the rectification of damage and misalignment, as these are consequences of the passage of time. However modern corrections or improvements to the original delineation would be inappropriate, as these would alter the historic integrity. If there is evidence of drift in the delineation due to periodic restoration, the original delineation should be recovered if possible, otherwise it should be recalculated.

4.0 Guidelines.

BSS recognises that each restoration will have unique features and problems. The remedies chosen will be based on the judgement of the restorer, the wishes of the owner and the approval of the Local or Heritage Authorities (where applicable). Consequently BSS can suggest only certain broad guidelines which should be applied to the work where possible. At the very least, a record should be created which includes the following:

4.1 Careful and accurate documentation with photographs of the historic detail of the sundial before the work starts, e.g. gnomon geometry, hour line angles, dial furniture, pedestal arrangement.

4.2 Measurements of wall declination, where applicable (Ideally, these should be taken on more than once occasion. The measured value should be compared with that of the existing dial layout; if these values differ, the owner should be informed of the consequent time error if an incorrect value is used in the restoration.)

4.3 Full documentation of all new calculations and design which are applied to the restoration.

4.4 Documentation of the processes and treatments which may have been used to conserve the fabric of the sundial.

4.5 Records showing that the proposed restoration meets the approval of the appropriate planning authorities where the property is either listed or scheduled.

BSS would appreciate a copy of the file for record and archive purposes.

5.0 Policy status.

This policy was approved by the BSS Council in May 1998 and will be reviewed annually.

THE NEWBURY MEETING 20 JUNE 1998

JOHN MOIR & PETER RANSOM

Just to show that the Druids do not have a monopoly on celebrating the sun's high point, BSS members met on the Eve of the Summer Solstice, possibly for the last time at the usual venue, since Priors Court School is moving to Bath this year. However, David Pawley assures us the Newbury meets will continue, even if at a different location.

Peter Ransom kicked off the day with a slide talk on Hampshire sundials. The commentary ranged from pondering why so many scratch dials were placed behind drain pipes to an account of his gate-crashing a wedding at Titchfield Abbey to photograph a sundial. Being mistaken for the official photographer was a piece of luck he was quick to exploit, though we were not told whether he got to kiss the bride as well.

Next Maurice Kenn showed slides of a raised horizontal dial in Brisbane. You stand underneath its translucent dial plate, onto which the gnomon's shadow falls. Two slides of dials based on lateral thinking followed - first his conversion of an astro-compass to a helio-chronometer, then his chocolate box conversion to a double polar dial. Maurice had this on display in the exhibition together with a superb display of other sundials he has made or seen.

After admiring the school's analemmatic dial by David Brown, we were given a tour of a small exhibition of David Pawley's work as a tower clock maker/repairer - a real bonus for the several clock enthusiasts present.

A pleasant picnic lunch in the sun (or shade) followed, then we resumed proceedings with two TV videos featuring our Chairman talking about some of the many dials he has designed and collected. He ended with the telling

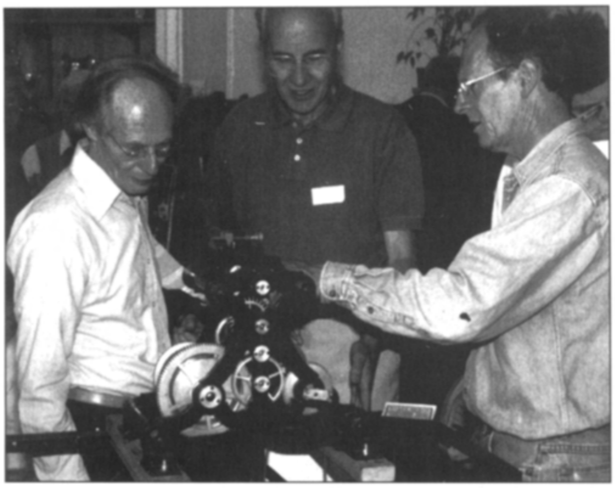

Fig. 1. BSS members look at a tower clock mechanism restored by David Pawley.

observation that, whilst his 180 foot millennium sundial proposal would have cost £4 million, the current Dome project is to cost £758 million.

We next had a presentation, by Jane Walker, of the 'Basic Theory' set of slides, produced by the BSS some years ago as a teaching aid at the elementary level. Her invitation for comments as to their suitability produced a lively discussion. The lack of consensus amongst the group showed how difficult it is to put across dialling concepts to the totally uninitiated. Many agreed that 3-D models were more useful than slides. The demonstration of his own models, by Michael Maltin, which followed, made this point very clearly. He also had the information from *Compact Data for Navigation and Astronomy* on his lap top computer.

In complete contrast, this was followed by a demo, by Ian Wootton, on binding the Bulletin and dial reports (which now run into 19 volumes taking up several feet of shelf space). Ian has spent two years on this important task, and is now working on the NASS *Compendium.*

The final item of a varied programme was a short talk by Tim Desbois demonstrating his pocket 'sun compass'. Being involved in helicopter film making, he explained how dawn and dusk shots could be spoilt by wrongly assuming that the sun would always be directly East or West. He therefore drew out sunrise and sunset azimuth lines for monthly intervals on a plastic plate, with a compass fixed on it to give the correct orientation. His product is now selling like hot cakes, not so much to film makers as to house buyers, who need to consider room usage relative to the sun's varying position throughout the year.

The exhibitions were as varied as the talks. Peter Ransom nearly filled one wall with A1 display boards of

Fig. 2. Tim Desbois demonstrates his pocket 'sun compass'. In the background is part of Peter Ransom's display.

photographic work, beneath which were his sundial postcard collection and free cut-out multiple cross dial. (This is still available, and members who wish to have one should send three 26p stamps (to cover post, packing and photocopying) to him at 29, Rufus Close, Rownhams Southampton SO16 8LR)

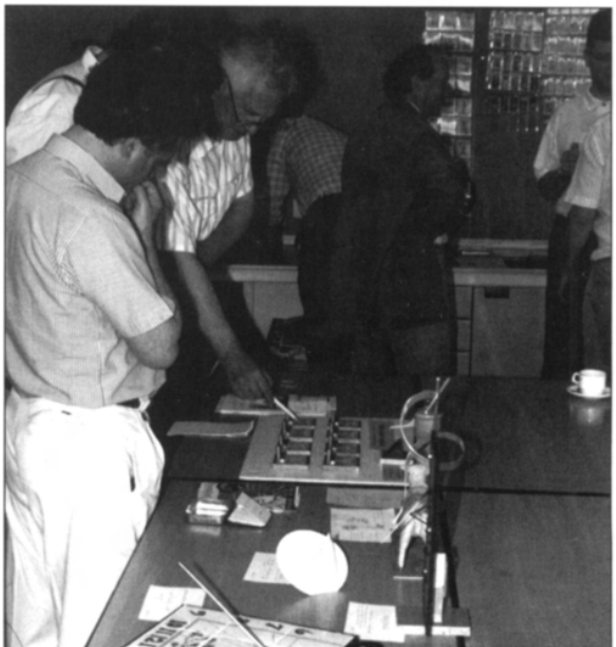

Fig. 3. John Moir demonstrates models of sundials featuring Italic and Babylonic hours, by J.M. Bores (see review of Compendium , page 40)

Colin Davis had a display of postcards and cigarette cards together with his *Old Colin's Sundial Almanac* computer programme in QBASIC. This gives the angles for the hour and half hour lines for a variety of dials, given the latitude. It also computes the equation of time. Members who wish to obtain a copy should write to him at 23, Vernon Walk, Northampton NN1 5ST.

Technology was also on display by Patrick Powers, our Registrar, who showed many members the records on his lap top computer. John Moir demonstrated some models of sundials featuring the Italic and Babylonic hours by J.M.Bores of Madrid. He also had an excellent selection of sundials including his origami one that featured in a recent Bulletin. Also impressive was Colin McVean's wooden lady who held a polar dial and can wear a variety of head-dresses to give gnomonic or meteorological information.

David Pawley brought along the large polar dial he designed for the Solent Business Park, and complemented this with smaller models of different types of dials. We owe him our sincere thanks for organising the conference and refreshments as well as laying out two fantastic displays. Not knowing who is going to turn up and give talks or exhibit material must make it quite a headache, but David took this all in his stride. He remained cool and confident throughout, despite the photographic evidence which should not be misinterpreted. He assures us that his finger points to celestial north, for which we are all grateful. Many thanks David!

Fig. 4. Onwards and upwards (to Polaris) with David Pawley.

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ANALYSIS OF THE SUNDIALS ON THE TOWER OF THE WINDS, ATHENS:

POSSIBLE PARAMETERS USED IN CONSTRUCTION

MANFRED HÜTTIG

The Tower of the Winds in Athens, built by Andronikos Kyrrhestes, is one of the best preserved monuments from ancient times. In the past the sundials on the tower have been analysed by Delambre,[1] Drecker,[2] Antonacopolous & Fragakis[3], and Bromley & Wright,[4] based on the measurements made in 1762 by Stuart & Revett.[5] Only Palaskas[6] performed his own measurements. The data in all these cases, as is now apparent from new measurements, are not as accurate as they seem; despite this, all authors draw favourable conclusions about the accuracy of the construction. Gibbs[7] seems to be the first to have recognised the few remains on the cyclinder annex as part of another sundial. This fragment is also mentioned by Noble & de Solla Price[8].

Vitruvius, (writer of 'De Architectura' a 10-book work , in late 1st century B.C.) mentions the Tower of the Winds and its designer (Book 1) only in the context of finding the cardinal directions for town planning, not in connection with horology. Again later (Book 9) when he deals with sundials in particular, no mention is made of this outstanding time-standard. This aroused a discussion about whether the sundials were added later. Palaskas objected to this, and if it is not already clear from the overall architectural concept, the design of the cyclindical dial would be proof enough.

The current analysis of the sundials is part of a Greek-German Project to investigate thoroughly the whole building.(See Kienast[9]) The data acquisition was performed with the Leica System TC 1610, (a high-precision geodetic data-acquisition system) resulting in absolute coordinates with an uncertainty of less than 3mm. The position and orientation of the coordinate system is also known with high precision.

Taking into account contemporary achievements in mathematics, astronomy and geography, the analysis

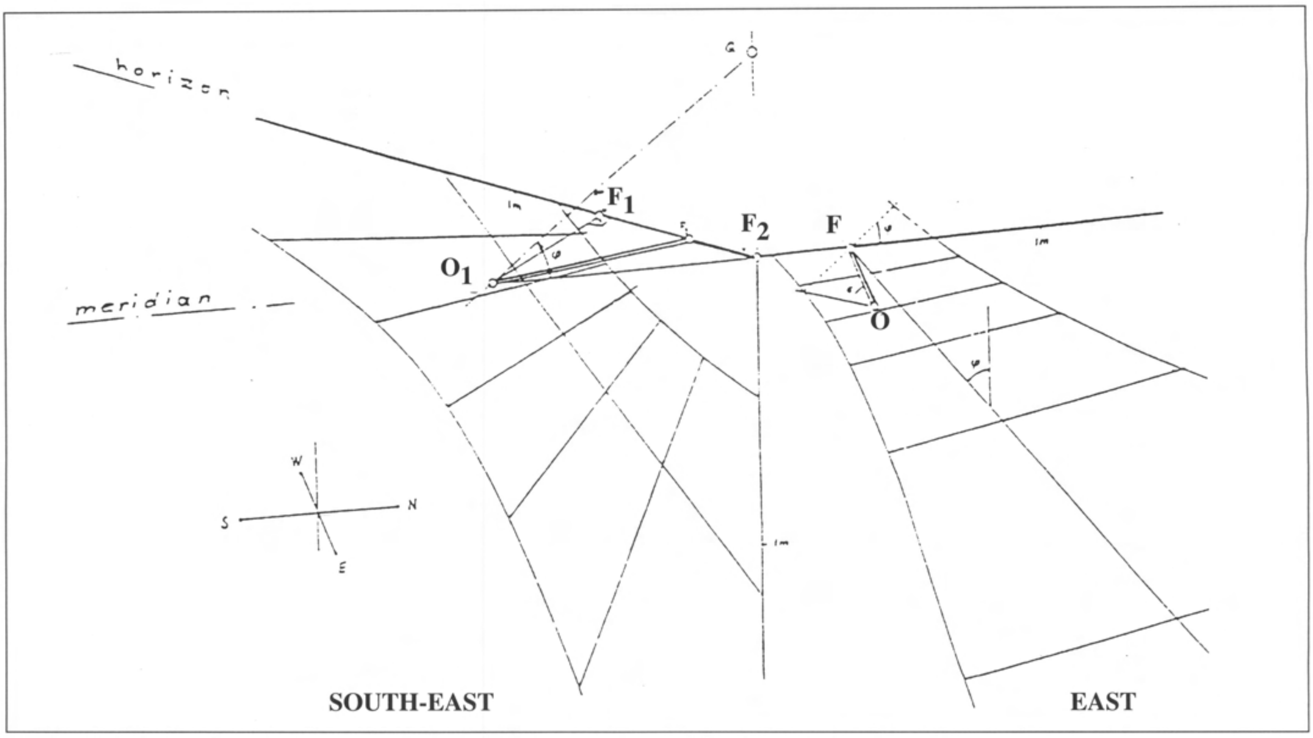

Fig.1 Partial View of the Sundials on the South-east and East faces, showing different cardinal parameters

reveals the cardinal design parameters used in the construction of the sundials. These are:

(a) geographic latitude and orientation of the wall

(b) angle of the ecliptic

(c) length of the gnomon, in ancient units.

It should be pointed out that the engineers of that time faced a similar problem of measurement to that which must still be solved today in national laboratories: namely that when setting up a primary standard of time (atomic clock nowadays) there is no simple standard of comparison available.The duration of one day, when the shadow of the sundial arrives at the very same position, (which is observable with an uncertainty of only a few seconds) could have been used for calibrating the water-clock.

Since the objective of this analysis is to find parameters used in the construction of given sundials, not to construct a sundial according to given parameters, one is faced with an 'inverse problem,' with the intrinsic difficulty of possible deficiencies in the available data. The 'inverse problem' must be solved by knowledge-guided trial-and-error. A set of parameters is selected in order to calculate a model which will be compared with the reality presented. The consequences of the deficiencies will be that two or more models are equivalent, according to certain error-criteria. Fortunately the range of parameters is limited by the nature of the problem and by practical considerations of the design. A final selection will take advantage of special points on the day-line at equinox and the hour line at noon, together with *a priori* knowledge of the parameters.

There are four main reasons for the defects of the data: deficiency of the basic concept; deficiencies during construction of the dials; changes by external impact such as earthquakes; uncertainties of data acquisition. The high-precision measurements showed that in any case the walls to the South, South-east and East are still very well in place after the long period, and therefore add no problems to the analysis. Doubts about the basic concept were listed merely for completeness; thus, the analysis for the three sundials mentioned above will have to deal only with the imperfections of the realization.

The first parameters - position of the wall and its orientation with respect to the cardinal points-- have been verified. The position of the Tower was found with respect to two trigonometric points as: 37° 58' 21.6" N and 23° 43' 28.8" E. The orientation of the Tower has been determined by observation of the sun and by utilising information from the global positioning system (GPS). A coodinate system was defined for the Tower based on the best fit of a regular octagon to the inner walls at floor level. The cardinal axis of this octagon nearest to the North-South direction has an azimuth of 5'30". Palaskas, who determined the orientation of several outer faces, obtained a mean value of 17', which shows the imperfections of his measurements; not, as he claims, those of Andronikos, who probably used the method now known as 'Indian Circles', as described by Vitruvius, obviously to great perfection.

The angle of the ecliptic was known in ancient times with limited accuracy: $\in$ = 23° 51' (Eratosthenes.) For practical reasons of geometric construction the value $\in$ =

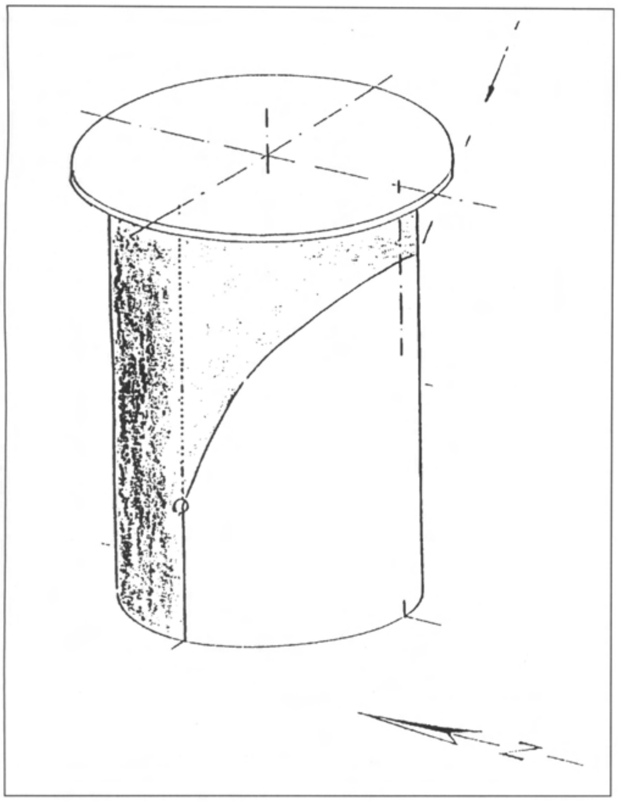

Fig. 2a Drawing to show possible functional principle of the sundial on the cylindrical annex

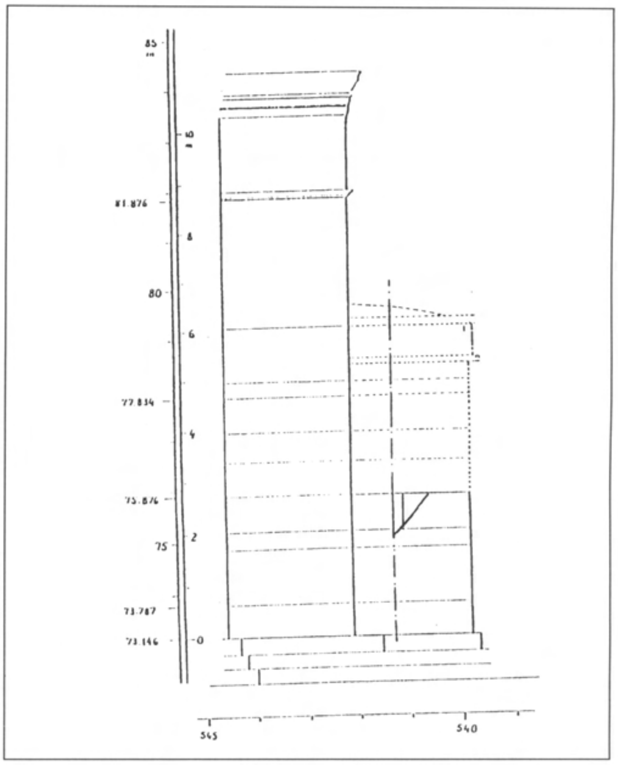

Fig. 2b Drawing to show position of annex against south wall of Tower. Dotted lines show stone-work no longer in existence

24°(Vitruvius) might have been used. The value actually changes slowly with time so as to be 23° 42' 20" in 100 B.C. (23° 26' 21" in 2000 A.D.) These differences have only a small effect on the shape of the sundials and one can certainly not hope to date the building this way, as Palaskas suggested.

The geographic latitude, ∅, had been determined as the ratio of the shadow length at equinox noon to the gnomon height, expressed with small integer numbers. The following values were reported in the case of Athens (with modern writing):

Latitude ∅ = arctan 3/4 = 36° 52' 12" (Vitruvius, Book 9)

Latitude ∅ = arctan 16/21 = 37° 18 '14" (Plinius, Book 6)

With the East and West Sundials, the angle made by the day line at equinox with the vertical directly represents the latitude. It is found here close to:

∅ = arctan 16/20 = 38° 39'36"

Finally the length of the gnomon is the free parameter to be chosen by the designer for determining the overall size of the sundial. One could reasonably expect 'nice' values in terms of the ancient unit of length. As a hypothesis supported by several dimensions of the Tower itself, it may be assumed that the construction is based on the roman foot: 1 pes monetalis = 16 digits = 12 unciae = 296.17 mm. This implies that the Tower was built after this length standard had been established in Athens by the Romans. If this result can be confirmed this investigation would also help to answer the question as to when the Tower was built, (Freeden,[10]). In contrast to modern sundials having a stylus mounted parallel to the axis of the earth, only the shadow of the gnomon *tip* is essential for ancient sundials; this gives freedom for the mounting of the gnomon onto the wall. In fact the gnomons were mounted here above the horizontal. The length is to be measured normal to the wall, (OF in Fig.1) in the case of S-, N-, E-, and W- dials, whereas for the others there is an angle of 30° (F_1 O_1 F_2) to the normal.

It is difficult to decide the question of whether the sundials were constructed according to theory with certain specific parameters, as most authors suppose; or simply by marking the shadow, using another 'horologion', maybe the water-clock inside, as a standard, (Palaskas): though the use of a water-clock for calibration has an inherent inaccuracy because of the large temperature effect on the viscosity of water. It is remarkable in particular that various different values of the latitude seem to have been used. From this it appears plausible that the combination ∅ = arctan 4/5, ∈ = 24° is to be interpreted as geometrical construction, whereas the actual values (37°58'22", 23° 42'20") give a hint of the empirical method. Table 1 summarises the values of the parameters for the sundials on the eight sides of the Tower, according to the current working hypothesis.

Table 1: Summary of cardinal elements of the sundials

Dial	Gnomon length unciae	mm	Latitude,∅ o	'	"	Ecliptic,∈ o	'	"
S	11	271.5	37	58	15	23	42	20
SE	30*	740.4*	37	58	15	23	42	20
E	20	493.6	38	39	35	24	00	00
NE	9*	222.1*	37	58	15	23	42	20
N	11	271.5	37	58	15	23	42	20
NW	9*	222.1*	37	38	15	23	42	20
W	20	493.6	38	39	35	24	00	00
SW	30*	740.4*	37	58	15	23	42	20

*Angle against normal to wall, 30°

As to the cylinder dial, Bromley & Wright have already pointed out that the remaining lines on the cylinder cannot be explained with gnomons, and call for another solution. The following proposal has convincing aspects. Fig 2a shows how the combination of the shadow cast by the cornice like the 'brim' of a 'hat', together with the 'eigen'

Fig. 3 South wall of Tower of the Winds, showing ruin of cylindical annex near the base (Photo: C.K. Aked)

shadow of the cylinder body, forms a corner-point the position of which is unique for the day and the seasons. Traces on the south face lead to the reconstruction of a cornice 8 unciae in depth. With the values $\varnothing = \arctan 4/5$, $\in = 24°$, this is consistent with the position of the lower end of the noon line on the cylinder at summer solstice. Unfortunately the theory demands that the day line crosses at a right angle with the hour line at noon. The apparent 'day line' might also be interpreted as the shape of the shadow at noon, reducing the sundial to a noon indicator. In this case the theory would call for a much smaller angle towards the vertical. Since there is no other functional requirement for the cornice in the architecture of the annex, the basic idea - the corner point of two shadows - is plausible.

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TIME'S TUNE ON A LIQUIDAMBAR LEAF

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[Robin Holliday's article 'UmKhonto we Langa, Spear of the Sun' describing a horizontal sundial with linearly-spaced hour points, was published in BSS Bull.97.1 pp21-23. The article below describes the making of a sundial of similar design but with a more elaborate equation-of-time correction.]

I accepted a commission to make a new dial following a South African magazine article, which generated a lot of interest here: my first ever commission, so I wanted it to be unique, not a Spear of the Sun this time, though based on the same 'linear scale' concept. We have a tree in our garden called a Liquidambar, *(Liquidambar styrciflua)* and it struck me that the leaf form could accommodate the linear time scale and make a most unusual dial. The result in gilding metal is very pretty. I have induced some oxide films onto the golden-coloured metal which give it an autumn-leaf appearance; and I have also given it depth by deforming the metal into troughs like a leaf. It is mounted on a polished granite block (Fig.1)

I have produced a new treatment of the Equation of Time, and also a new 'time o'clock' graticule, permitting direct read-out of time o'clock. As Step 1, I have transformed the usual graph to a musical analogy which I call 'Time's Tune', equating its values to musical notes on the treble clef of a music sheet. This clef has only 5 full lines, but with the three auxiliary lines can display two full octaves; i.e. from "middle C" to the "high C" two octaves higher. To the two octaves, add the two outlying notes, B below Middle C, and D above High C: then as many as 17 notes on 8 lines and 9 spaces can be defined with unequivocal accuracy and remarkable economy of inscription, each being instantaneously recognisable. My idea is that if we take one full note as being two minutes, the whole 30-minute spread of the Equation of Time can be plotted as musical notes on the treble clef. (See Fig.2).

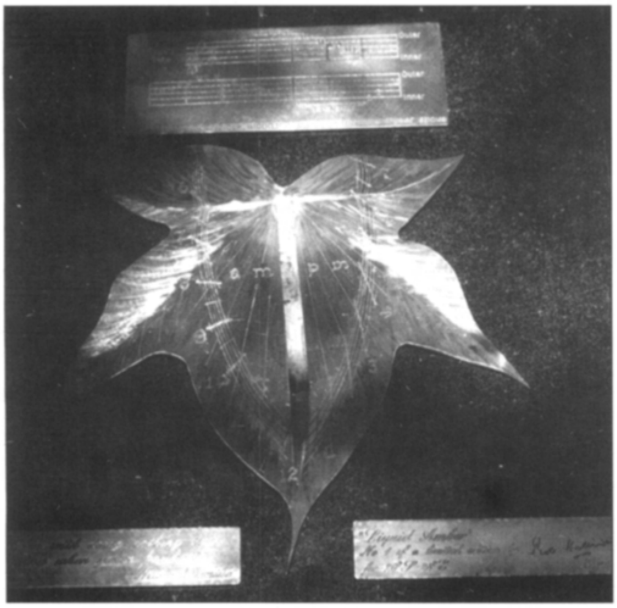

Fig.1a. Photograph of dial plate on metallic Liquidambar leaf, with 'Time's Tune' EOT-correction plate above

Step 2: Divide each of the twelve months into 4 periods or 'beats' each, (four beats to the bar). Each bar is a month and each minim or beat is nearly but not exactly a week, call it a 'time o'year'. Thus January's 4 beats gives 4 notes annotated "J a n u" respectively. December has "D e X m" (X for Xmas). It is the *average* value of the Equation of Time over each beat or time o'year, that is plotted as a 'musical note', each only being labelled by the respective period, e.g. X at Christmas.

Step 3: Having done this I plot the 5-line clef on my dial, each line being a constant velocity "umKhonto we Langa" line. The hour markers are the conventional ones, and complete the basic 'time o'dial graticule' Next, note that our Standard Time Zone is 30 degrees East Longitude, and two hours ahead of the Greenwich Mean Time, but at Johannesburg, 28° E, the sun reaches us 8 minutes late, so this must be added to the Equation of Time, which then ranges from "add maximum 8 + 14 = 22 minutes in February to minimum 8 - 16 = - 8 minutes in October": in toto, 30 minutes requiring 15 lines to fix 15 values at 2 minutes each, plus 1 line for the time when correction is zero If you refer to the drawing, (Fig. 2) you will now see that I have plotted these extreme values as offsets from each hour-line along the outer and inner auxiliary clef lines.

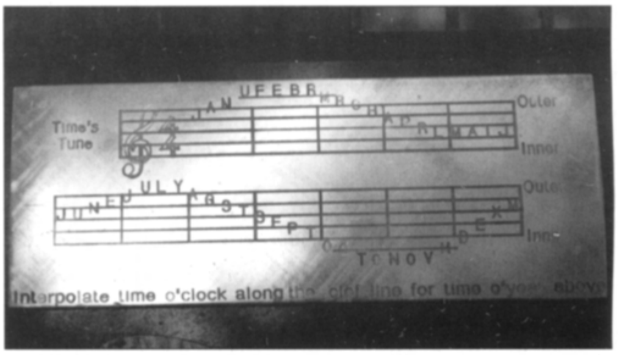

Fig.1b. Photo of 'Time's Tune' plate

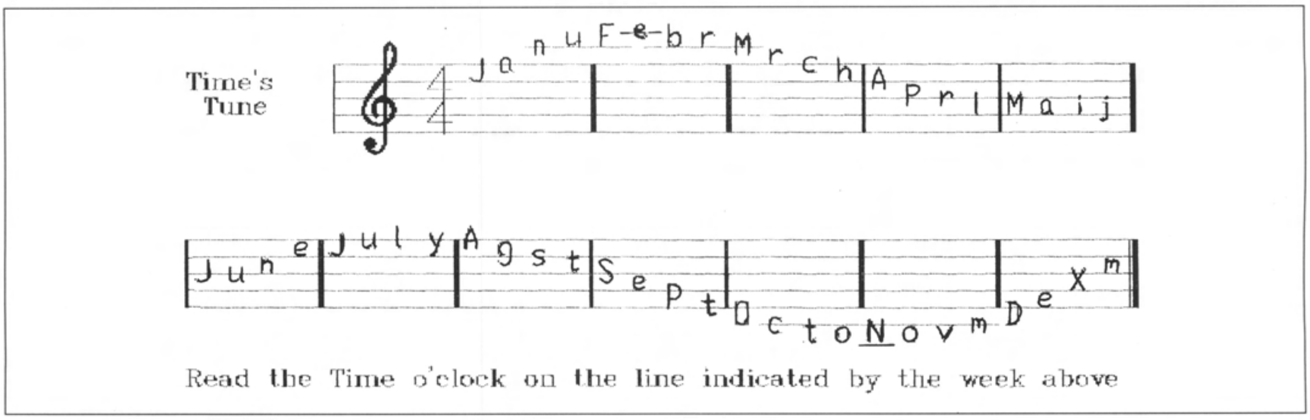

Fig.2. Drawing of 'Time's Tune' plate

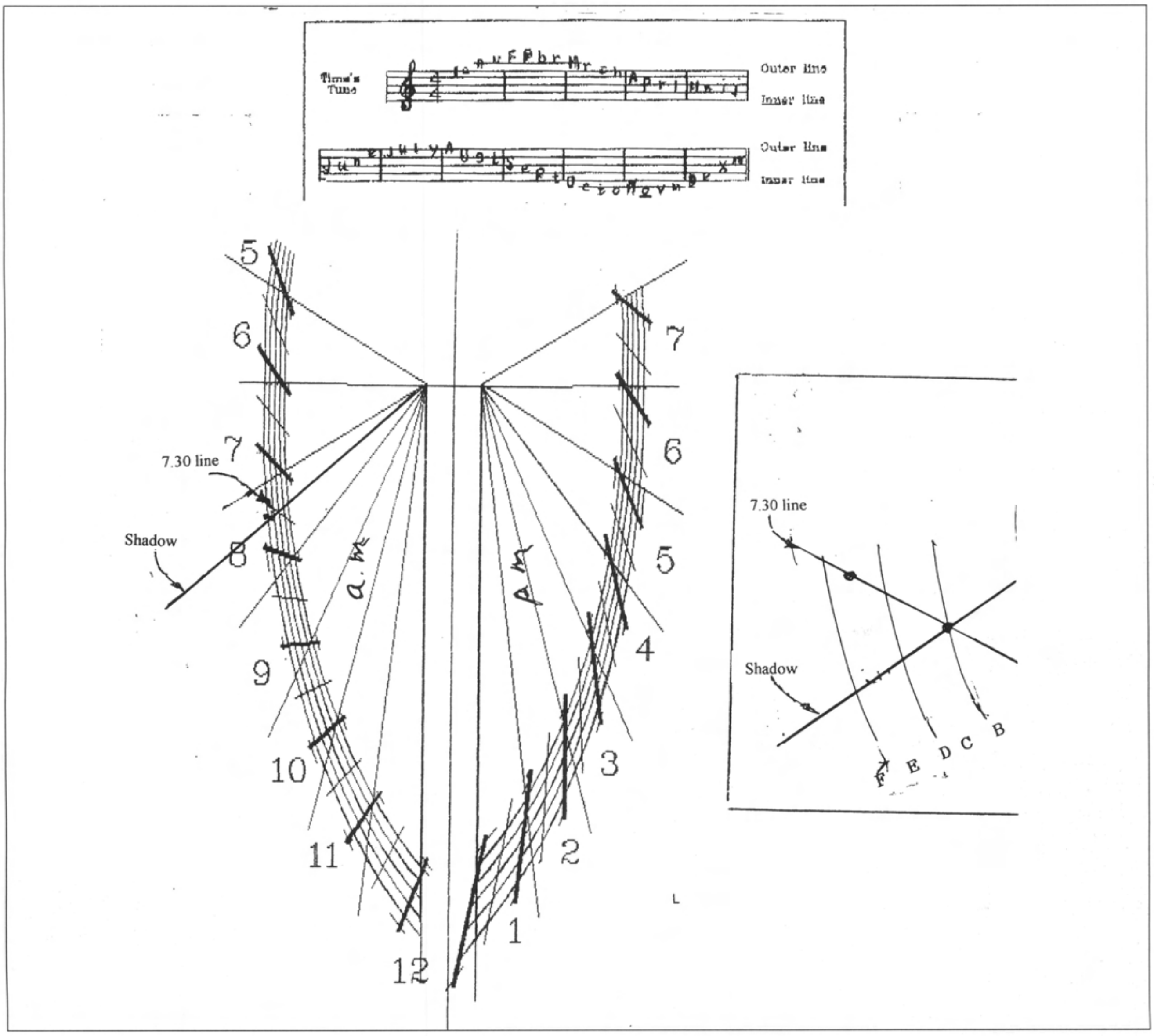

Fig.3. Diagram to describe the reading of 'Time's Tune' EOT-correction

(a) The time o'year is late March, the period marked by the letter 'h' on the stave at the top. 'h' stands on the top space of the stave, which gives the note 'E' in the treble clef.

(b) The gnomon's shadow (moving anticlockwise in the southern hemisphere) is quite close to the 7.30 a.m. line. But it has already passed the point where the 7.30 line crosses the note 'E' space. (See inset on right)

(c) The shadow is crossing the 7.30 line on the stave-line which gives the note 'B'. So make additions: E→D→C→B: 3 additions, each of 2 minutes, = 6 minutes. So the time is 7.36 a.m.

Intermediate values are also plotted and run diagonally across the clef lines, so completing the 'time o'clock graticule'. (These diagonals curve because of the curve inherent in the 'umKhonto' clef lines, and create a rather intriguing spiral pattern.) At a different location, the Time's Tune diagram would remain unaltered; any correction for a different longitude would be handled on the dial face by making appropriate offsets from the time o'dial hourlines. The gnomon is made of a brass rod of D-shaped cross-section to resemble a split twig; the sharp edges cast the a.m .and p.m. shadows.

That completes the design. To read time o'clock, first ascertain from the Tune of Time diagram which clef line is appropriate for that time o'year, then note where the shadow falls *relative to the adjacent diagonals* rather than relative to the 'time o'dial' hour markers. One can now interpolate the shadow between them to find time o'clock, the interpolation being linear. See drawing on Fig 3.

In my latest design I have inserted half-hour lines between the hour-lines numbered around the dial-face. This ensures that the shadow will always lie across either an hour-line or a half-hour line, and thus no interpolation is necessary.

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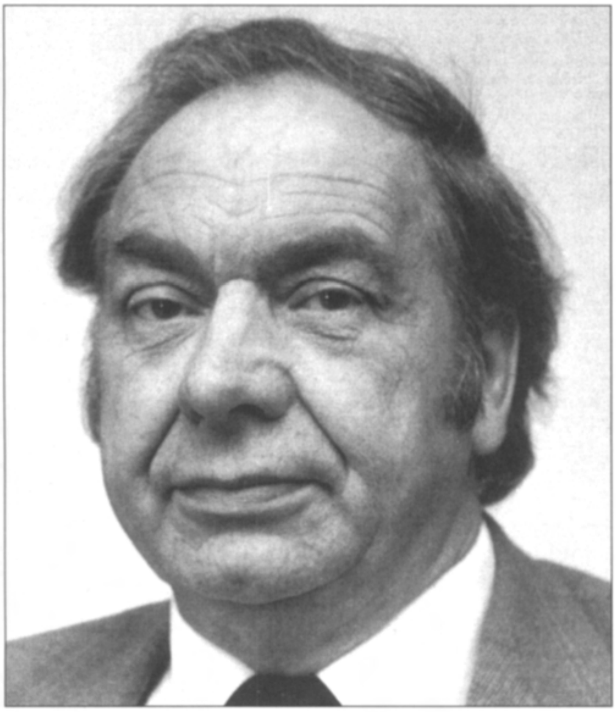
OBITUARY:
CHARLES KENNETH AKED (1921-1998)



Following a prolonged battle against cancer, extending over a period of more than five years, Charles Kenneth Aked died in his seventy-seventh year in Hillingdon Hospital on Wednesday, 22 April 1998. Although for several months beforehand, Charles had ceased much of his normal activity and was reluctant to have visitors, he was overcome very suddenly at the end. His funeral took place on 1 May 1998, the first day of the Society's annual conference, at Dunchurch, when the members present stood in a minute's silence, before the evening meal, in remembrance of Charles (and also of Philip Adams who died on 1 November 1997). His funeral was attended by Douglas Bateman, who represented the Society and who took a photograph of the Society's blue and yellow 'logo' wreath, published in the last Bulletin.

Charles Aked was the principal 'founding father' of the British Sundial Society, being the 'spark' which 'ignited' the organisation that was formed at a meeting in Chingford, at David Young's house, on 5 May 1989, when Andrew Somerville became the first Chairman. On this occasion, David Young became the Secretary and Charles became the first Editor of the Society's Bulletin, the publication that has done so much to bring about the Society's emergence as a flourishing and respected institution.

The eldest of four brothers, Charles Kenneth Aked was born on 9 December 1921 at Batley in Yorkshire. As a young boy, he suffered a bad attack of measles which robbed him of good hearing, a problem that plagued him for the rest of his life. He was educated at Pudsey Grammar School - a scholarship winner - where he excelled at chemistry. On leaving school, he joined his father's jewellery firm in Rhyl; but, in his spare time, he studied for his Higher National Certificates in Electrical and Mechanical Engineering. His efforts were rewarded: he became top student in his class-year. He had intended taking up a career in chemistry and had received some training as an industrial chemist, when the 1939-1945 Second World War intervened. He was called up for military service in 1942, serving with the Royal Electrical and Mechanical Engineers (REME), from 1942 to 1946, in radar communications. He was responsible for the repair and maintenance of all types of radio, radar and signal equipment. On being discharged from his service in the army, at the age of twenty-five, he briefly rejoined the family jewellery business, but left after a year in 1947, to join a research team in the Royal Naval Scientific Service at the Admiralty Signals and Radar Establishment, at Risley in Lancashire. Here he was involved in development work in the Quartz Crystal Section from 1947 to 1955. In April 1947, he married Irene Martin and together they brought up three sons, John, Christopher and James. During the early years of their married life, whilst at Risley, Charles and Irene managed a television and radio repair business. Charles built several television sets, the first of which was completed just in time to see the Queen's Coronation! At about this point Charles appears to have taken up writing, since he wrote a number of articles on building radios and television sets, which were published in *Wireless World.*

In 1955, he moved with his family to West Drayton, where he joined the Admiralty Engineering Laboratory, becoming Works Manager and Head of Services, retiring in 1984 as Principal Scientific Officer. Here he was involved in research in naval communications specialising in high power transmitters and advanced radar techniques. He helped in the development of the high speed automatic voltage regulator (QUAVOR). He also had responsibility for the preparations for 'Open Days' at West Drayton and for displays at Portsmouth, Chatham and the Middlesex show. During this period of his career, he managed to write some thirty scientific papers that were published in the *Royal Naval Scientific Journal.*

Apart from his career, Charles had many other interests, the most notable of which was probably his life-long passion for horology, which led him to join the Antiquarian Horological Society in 1962. He held various honorary posts in this organisation that involved him in writing, editing and publishing, which gained him a global reputation in the horological world. He still found time to gain a reputation as an accomplished horticulturist, being awarded numerous Royal Horticultural Society medals and prizes for his flowers and his vegetables. In later years, from about 1990 it would seem, he took up writing poetry. Some of his poems have appeared in the *Bulletin,* but he had several poems published elsewhere, being awarded various prizes, including one from the International Library of Poetry in 1997.

Charles's interest and expertise in sundials, and dialling literature, is well-known. Members of the Society will have read his frequent articles, reviews and editorials, that clearly showed his wealth of knowledge of the subject. What is not so well-known is the fact that, in addition to all his interests, his writing, and his editorial duties, he managed to find time to compile a monumental listing of some 3,200 dialling references, which he produced as a limited private publication, entitled *A New Opusculum of Dialling References,* (1997). Ten pages of this work, *Appendix I,* are devoted to a list of 218 dialling entries by Charles Aked himself.

Considering all that he wrote and had published in other fields, his output in dialling was quite remarkable and a notable achievement itself. Yet, in the eyes of the Society, his greatest achievement must be the production of the *Bulletin,* without which the Society would not be here today. I am glad that we thanked him when we did (*Bulletin* No 97.3, July 1997, pp33-34.), at the time when he retired from the editorship, when he was also elected a Vice President of the Society, for at least he was able to read the views expressed. Whether he altogether believed them is another matter; but I think that he did. I hope so, for I am sure that he needed to *know* that the Society appreciated and respected him.

Charles was a modest man. He did not suffer fools gladly and was forthright in saying so. If he thought he had made a mistake, he had the grace to apologise. Otherwise he was blunt and to the point, the true characteristic of a Yorkshireman. He was also a kind, considerate and generous man, with a warm heart and a dry sense of humour, although this was not necessarily evident to those who did not know him. Yet, he was not easy to know, because he tended to remain aloof from the assembled throng. He did not push himself forward. Rather, he would put his heart and soul into his work and his writing: this was his means of expressing himself. His personality could best be appreciated at the Society's annual conference at the 'auction': he would start bidding on some object and, if necessary, buy it, not because he wanted the article, but so that the Society would benefit. When he had the opportunity, he purchased a sundial simply so that it could be restored to its original site. When he reluctantly handed over the editorship of 'his' Bulletin to his successor, he did not believe that anyone could do the job as he had done it. Nevertheless, he quickly came to realise that his creation was in very capable hands and he made no bones about saying so in print! This was Charles Kenneth Aked. He is sadly missed by his widow, Irene, by his three sons and two grandchildren. They will remember him playing chess with his computer or sitting reading a book in his armchair. Members of the Society will remember him in other ways, no doubt with affection, but perhaps as a somewhat cantankerous individual. The Society will surely remember him as a great man and a good man, who was fundamental to the growth and well-being of our organisation. He is a very sad loss to us all; but his dialling bibliography alone will ensure that the name *Charles Aked* is always to the fore in sundial literature. His *New Opusculum of Dialling References* will be an enduring monument.

Christopher St J H Daniel
Chairman

MASS DIALS IN IRELAND

ANDREW J. OGDEN

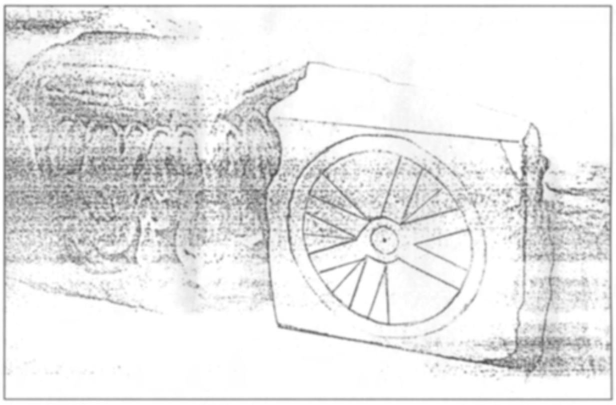
In her lecture to the British Sundial Society in Dublin during the Irish tour of September 1994, Trish Ryan listed and described most of the Irish Sundials of the Early Christian period which are known to exist. It has always been a source of mystery to me that they are so rare. Ireland has a great number of Monasteries, Convents, Friaries, Abbeys and other ecclesiastical foundations, most of which were established by Continental orders. In many cases, such as the Cistercians, even the designs and architecture of the buildings are based on standard continental designs. In France and in England it is easy to find sundials on church buildings, as the Mass Dial Group of the BSS has shown.

The dials were placed on churches so that Masses could be said at the appropriate times, as illustrated in the fascinating article by Mario Arnaldi in BSS Bull.98.1. In his paper on Ancient Sundials of Ireland (BSS Bull. 97.4) Arnaldi points out that because many of the early churches may have been built in wood to begin with, many of the sundials of the early Christian period were carved on a separate stele erected near the church. In this form they could be regarded as portable and this portability may well have been the fate of many of them.

In the days before St. Patrick came to Ireland (corresponding to the Anglo-Saxon period in England) Christianity was represented in many remote areas by early saints, one of who was St. Ciaren on Cape Clear Island off the West Cork coast. His brother Kame built a church on West Skeam Island, one of the many in Roaring Water Bay; the name Skeam comes from St. Kame. On the island is the ruin of a stone-built church which was recently the subject of an archaeological survey. This dated the ruin as 9th or 10th century and it presumably replaced an earlier wooden building; graves nearby were carbon-14-dated to a range of dates from 490 to 770 A.D.

Until 1943 the island was inhabited by the O'Regan family, and recently the Mizen Archaeological & Historical Society published an interview with Joseph O'Regan, in his 97th year, concerning life on the island. He said that his father used to refer to the field behind the church as the "SunDial" field, even though he never saw a sundial there in his time. The description of it was that of a vertical flat-faced stone with a hole in it from which radiated lines carved in the stone. Its eventual use was for the threshold stone of the front door of the house which has now been converted into a holiday house.

I visited the island last summer, only to find that the door has now been built up with masonry. Maybe the sundial is still there, but I doubt that we shall ever see it. It seems likely that many such sundials suffered a similar fate in other remote parts of Ireland, where a good dressed stone would be considered far too useful to be left standing in a field.



'Sundial' Stone, Boyle Abbey, Ireland

Near the town of Boyle in County Roscommon lie the remains of a 13th century Cistercian Abbey. In common with most ecclesiastical foundations it was closed in the 16th century , and from Elizabethan times until the end of the 18th century it was used as a military barracks. The remains are now in the charge of the Office of Public Works.

During some essential conservation work a square stone bearing interesting carving was discovered in one of the walls. In order to preserve the carving from further erosion the stone was brought into the Gate House which has been restored for use as a visitor centre. A description on the wall states that it is a sundial. There is a centre hole which could have held a horizontal gnomon but the markings on it are most curious, as most of them are above the horizon line and therefore could never have had a shadow on them. I am enclosing an enhanced photograph of the stone and I should be interested to hear form any readers of the Bulletin who could explain why these markings may have been made.

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EDITOR'S NOTES

1. Do you know Italian?
The Editor would be glad to hear from anybody who is able to read Italian, and who would be willing to read a Journal 'Gnomonica' 3 times a year, and to write a short review of its contents, for publication in the BSS Bulletin. We have been told by our member Nicola Severino of the existence of this new journal, and a journal-exchange with the BSS. Bulletin has been arranged.

2. 'Italian' and 'Italic' hours
A correspondent has raised an intriguing question of terminology on which it would be interesting to have readers' views. In his *Gnomonique moderne,* Denis Savoie distinguishes between *Italic* hours, counted from sunset, and *Italian* hours counted from half an hour after sunset. While in modern works one does occasionally find *Italic* and *Italian* used synonymously, and while older works sometimes state that Italian hours count from 30 minutes after sunset (but without making any terminological distinction) I am not aware of any discussion of the matter, nor if there is any historical warrant for making the distinction, though it could be useful if many dials are sufficiently finely calibrated. Perhaps relevant to where one starts the count is whether one considers sunset to begin when the Sun's lower limb first touches the horizon, when the Sun's diameter is on the horizon, or when the upper limb finally falls below the horizon. But it would be good to find a discussion of the question in the early literature.

3. Altitude Dials
Those who heard Allan Mills' lucid lecture on 'Altitude Dials' at the BSS Meeting at Dunchurch in May may like to know that the lecture has been published in Annals of Science 53 75-84 (1996)

4. Diallists Down Under
George Smith of Sydney N.S.W. is hoping to organise a group tour of BSS members living in Australia and New Zealand to U.K. for the 10th Anniversary Annual General Meeting and Conference in May 1999. Members are invited to contact George Smith at: P.O.Box 61, Seven Hills, NSW 1730 Australia, or phone 61 9 02 6214049

5. Addendum to Newbury Meeting Report, page 10
In a happy ceremony during the day of the Newbury Meeting, the Headmaster, Paul High, of Prior's Court School, was presented with a sundial kindly donated by John and Barry Singleton, as a thank you for the BSS meetings held there.

David Pawley has now been able to assure members of the BSS that Newbury Meetings will continue at the same venue, and the date for 1999, Saturday 22nd May, has already been booked.

READERS' LETTERS

ORIGIN OF BERNHARDT DIALS

In Margaret Stanier's article on Bernhardt Dials, there was the implication that Bernhardt had not only made but designed his dials. I think this is not correct since the basic design of this type of dial was published by a Dane named H. Brix in the 1981 Journal of the British Astronomical Association under the title 'Another Standard Time Sundial'. The article gives a clear derivation of the gnomon geometry.

Kevin Karney
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FINDING THE MERIDIAN

In the June1998 issue of the Bulletin a solution is given (p.51) to the problem: 'To find the Meridian by the Observation of three unequal shadows'. I think it worth mentioning that a solution to this problem, but by a different method, was given in the February 1994 issue, on page 8. This method used a geometrical construction, but how calculation could be used instead was described in the October 1995 issue, p.46

Prof. J.G. Freeman
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NEWBURY BSS MEETINGS

Priors Court School, 20 June 98: I apologise for those members who were unable to attend this meeting because I had missed the spring Bulletin deadline, and the summer publication was late. The 26 members whom I managed to contact had a most enjoyable day, as reported elsewhere in this issue of the Bulletin.

Stop Press: The new owners have agreed that the Newbury BSS meetings may continue at Priors Court School. The date for 1999 is Saturday 22nd May 1999, the weekend before the late May Bank Holiday.

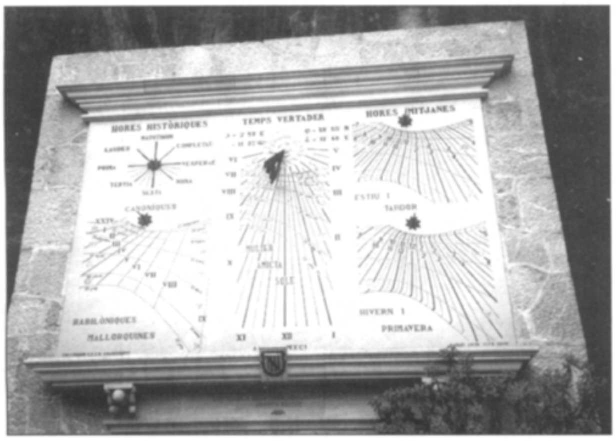
Tenth Anniversary of the BSS: Since 1999 will be the tenth anniversary of the BSS an extra special day is planned at Priors Court, Newbury. If you have never attended any of the BSS meetings, I should like to extend a very warm invitation to come along. Put the date in your diary NOW ! Any ideas or comments you might have regarding the 1999 Newbury meeting are welcome.

For members who live at a distance, arrangements will be made for caravans, camping, B&B locally or staying at the nearby Motel. If this might interest you, please contact David Pawley within a month of receiving this Bulletin. No firm commitments are required now but it would help the planning to get some idea of numbers.

David Pawley,
8 Rosemary Terrace, Enborne Place,
Newbury, Berks, RG14 6BB.

SUNDIAL IN LLUC, MALLORCA

This sundial photograph was taken by my brother Tony Lack when he and his wife visited the monastery at Lluc, Mallorca. It is obviously a vertical dial declining East. Around the central gnomon are four angles. Clockwise from the top left λ = 2° 53'E is the longitude of the site, Ø = 38° 50' N is the latitude, δ = 13° - 48' E is the east declination of the dial face; but I do not know what the fourth angle 11° 32' (G) represents. To the right of the central dial are the names of the four seasons, Summer, Autumn, Winter and Spring but I am unable to identify the two sets of curves shown.



I am hoping that someone among your erudite readership will be able to enlighten my ignorance. I believe that many of your readers will admire this picture of a fine dial.

Claude Lack
32, The Vale , Northampton, NN1 4ST

'EUREKA' CREDIT CARD COMPASS

Maurice Kenn's letter (BSS Bull 98.2 34) about his credit card compass prompted me to get a photocopy onto BSS yellow card and try it out.

The arrangement of Cardinal points seems conventional enough (unless one is playing Mah Jong) and using it as a COMPASS to find north it works well enough: the input required being time-of-day and the shadow from a vertical pin placed on the appropriate time-spot. The shadow should go through the month-dot at the dial 'centre'. Or have I missed something? The use of a peg or pin is known historically from portable dials.

On another point: the last Bulletin's correspondence on restoration resulted in my taking advice from Peter Ransom's article and reading my 'Young Man's Best Companion' (now rather dated, I feel) .I found 'How to colour your Dial', which might be instructive as an indicator that painting and gilding were part of the whole dial-making procedure. It all seems very hard work, and implies that stone dials needed refurbishment more often than ones made of 'best oak'.

A.J. Wood
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Gloucester GL3 1LA

I was interested to see Maurice Kenn's letter in Bulletin 98.2 regarding 'Eureka' Sun Compass, as I too have one of these. The instructions on the card are necessarily brief - too brief, in fact. In use, the style of the gnomon (a matchbox on end is ideal) is placed on the *time of day,* and the dial is turned so that the shadow falls across the month of observation The compass rose will then be correctly orientated, within the limitations of the device, (probably + 10%).

For the device to function in the southern hemisphere, three alterations must be made 1.The two date scales in the centres of the card must be transposed and reversed, i.e. 'December' must appear in the place of 'June' on the summertime scale, and vice versa. 2. The hour numbers must be written in the reverse order to that depicted. 3. The compass rose must be turned through 180°.

The device does function and is correctly designed for its unconventional method of use. Had I designed it I would have done so in the conventional manner, so that it functioned as both compass and dial with the gnomon on its normal position on the date scale. Simply printing the compass rose at 180° to its present orientation would achieve this.

Colin Thorne
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'Eureka' Eureka! I read Maurice Kenn's letter on the Eureka sun compass (Bull 98.2) with great interest. After looking afresh at this device I too was somewhat puzzled by it's unusual layout, but now I think I can offer an explanation.

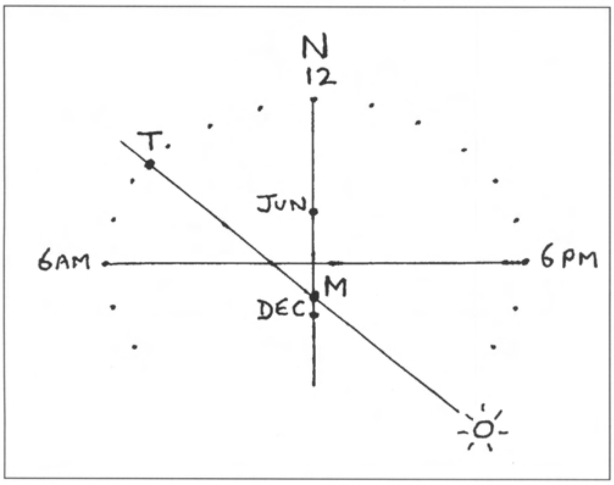

Fig. 1

Fig. 1 shows the configuration of a normal analemmatic dial, showing the sun's azimuth line at any given month M and time T. If we rotate the dial through 180°, we find (Fig. 2) that by rotational symmetry the same azimuth line still points towards the sun. The only difference is that to use it as a sundial, or in this case a sun compass, we must insert a

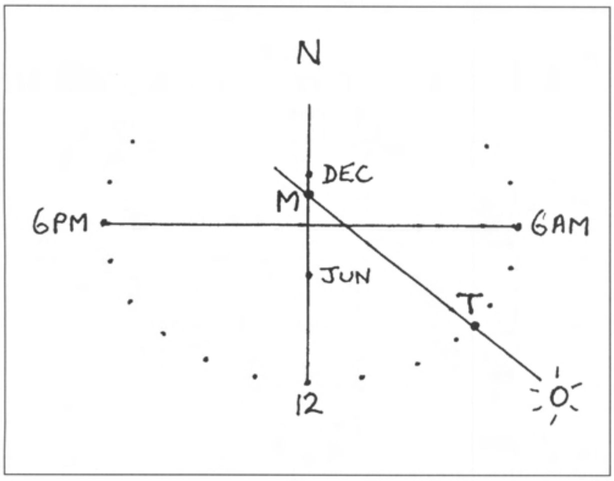

Fig. 2

pin, not on the month spot, but in the (known) hour spot, T. We must then turn the card until the pin's shadow passes thourgh the current month spot M.

One question which puzzled Maurice, and indeed myself, is why did the designer adopt this unconventional arrangement when the normal analemmatic, as in Fig. 1, would suffice? I suggest that the reason is to avoid having the user casting his own shadow over the card when using it. Eureka's upside-down scales confirm this theory.

For those who have not consigned their Eureka cards to propping up a table-leg, I should say that I have checked out the mathematics and found that, for its size, it is reasonably accurate. The month spots, incidentally, are for mid-month declinations.

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AXIAL RODS ON A SPHERICAL DIAL (FULDA GARDENS)

At the 1997 BSS conference in Penrith one of our German friends, a stonemason, exhibited a spherical dial having much in common with that shown on Fig.3 on page 12 of BSS Bulletin 98.2. It differed in that it had a map of the world carved on it in relief, whereas that in the Fulda Gardens seems only to have hour-lines (meridians) and numbers. Presumably each matches its noon with the longitude of its site. I suppose that the dial shown at Penrith must have had hour lines and numerals but my mind's eye seems to have lost them. I am sure that that dial's site was to be somewhere in Germany.

The spherical dial shown at Penrith had a rotatable semicircular shadow-caster ('gnomon' does not seem to be the right word). One end of this device was pivoted at the North Pole and the other at the South Pole. With the dial set up so that the Earth's axis pointed to the Pole Star, the shadow of the shadow-caster would, when the sun, the shadow-caster and the sphere's (Earth's) axis were in one plane, indicate the angular distance (and hence time-difference) between the noon-line for the site and the azimuth of the sun. Clearly, all places along the line of the shadow would be on the same meridian and have the same local time. If the dial had been made for use in Hamburg, Gottingen, Wurzburg or Wurttemberg and set up in one of those places, consulting it at 12.54 p.m. local time would also show that it was noon in Perth and Timbuktu

It seems that the polar rods in the Fulda Gardens dial were originally pivots for a rotatable shadow-caster which has been lost. The shadow-caster itself might have been made from a metal plate rather than a rod so as to be wide in the radial direction, thus ensuring easy alignment with the sun(narrowest shadow). The rods may have been made long to accommodate long bearings for the shadow-caster, to keep it fairly true in spite of inevitable wear in the bearings. The shadow-caster and its bearings would probably have been designed to be ornamental as well as functional.

D.K. Ebdon
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My suggestion is that these iron pins served as pivots for the two ends of a metal gnomon plate in the form of a flat semi-circular band with an inside radius slightly larger than the radius of the stone sphere. To read the dial, the user would rotate this gnomon until the shadow was at its minimum width, allowing an accurate reading on the spherical dial.

Such a dial once stood at Monticello, Thomas Jefferson's home in Virginia. It was installed on a wooden sphere ornamenting a fence post. A similar 'Jeffersonian' Dial has been installed in the garden of the American Academy in Rome.

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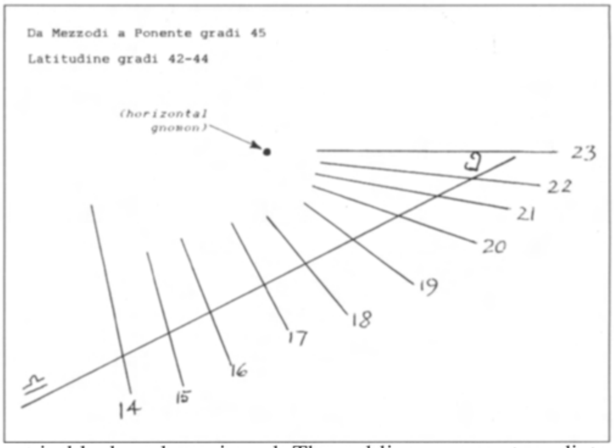
PROBLEMATIC DIALS

I was very interested to read about the 'problematic' dial in Varenna, Italy, described by Graham Lobley (BSS Bull. 98.2) On a recent holiday tour in Tuscany and Umbria I came across a wall dial in Spoleto with equally curious markings. The dial is mounted on the front of the Municipio (Town Hall), and has two sets of markings, one



set in black and one in red. The red lines appear to radiate from a point above the horizontal gnomon, and show conventional hours ('astronomical hours') marked with Roman numerals. The black markings numbered 14 to 23 in Arabic numerals, are stated to indicate 'Italian hours' which I could not understand. In the absence of my camera I made a rough sketch of the black lines which is reproduced herewith, together with a copy of the words inscribed above and below the dial

The latitude of 42° 44' for Spoleto agrees with the map. However I do not understand the reference to 45° west (ponente) because the wall seemed to be aligned only a

few degrees away from the E - W direction. Neither can I see the significance the line with the Libra sign at one end and the Capricorn(?) sign at the other.

Like Mr.Lobley I am a newcomer to gnomonics and I am puzzled by the 'Italian' hours. Are they related to 'Babylonian' hours? I would appreciate an explanation of their purpose. I wonder whether they have a significance similar to the markings on the 'problematic' Varenna dial

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INTERNATIONAL SUNDIAL SYMPOSIUM

GENK, BELGIUM, 20TH JUNE 1998

The Belgian sundial society *Zonnewijzerkring Vlaanderen* announced in Autumn 1996 that it was organizing an international competition for sundial design. Both well-established and entirely new concepts were eligible, with the expectation that a number would be selected for construction and erection along a 'Sundial Trail'. This was to be laid out in the Molenvijverpark public gardens in Genk, not far from the Europlanetarium.

The project was coordinated by Jan de Graeve (Fig. 1), and came to fruition with this conference, held in the spacious auditorium attached to the planetarium. Over 80 designs had been submitted, and a committee composed of both gnomonists and representatives of the city selected 14 for further study. Construction is now proceeding with 12 of these, with one design being held in reserve and another (an ingenious equant dial by BSS member John Moir) proposed

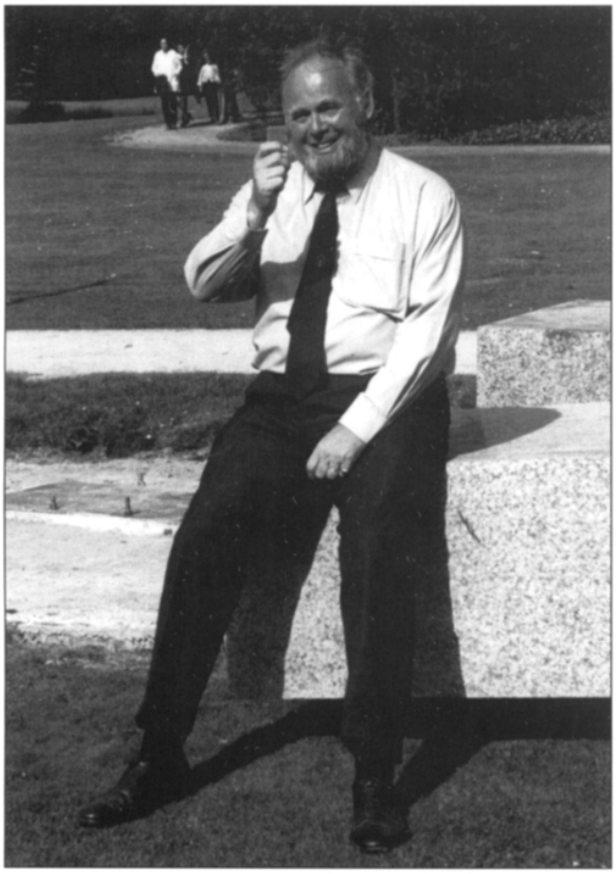

Fig. 1 The coordinator of the Genk Sundial Park, affable Jan de Graeve.

to form a working model incorporated in the cover of a forthcoming booklet describing all the dials in the Zonnewijzerpark.

The symposium opened with the Sun shining between clouds - its first appearance after a long spell of rainy days. Julien Lyssens, the President of the Society, welcomed participants and reminded them of Belgium's distinguished history in the making of fine dials and related scientific instruments. Allan Mills then gave the Opening Address, briefly explaining for the general audience (city dignitaries as well as visiting enthusiasts from many countries) the history and mode of operation of both 'antique' seasonal-hour dials and the 'modern' equinoctial hour families. He then showed slides of memorable examples from around the world, concluding with some unusual - and occasionally unique - instruments.

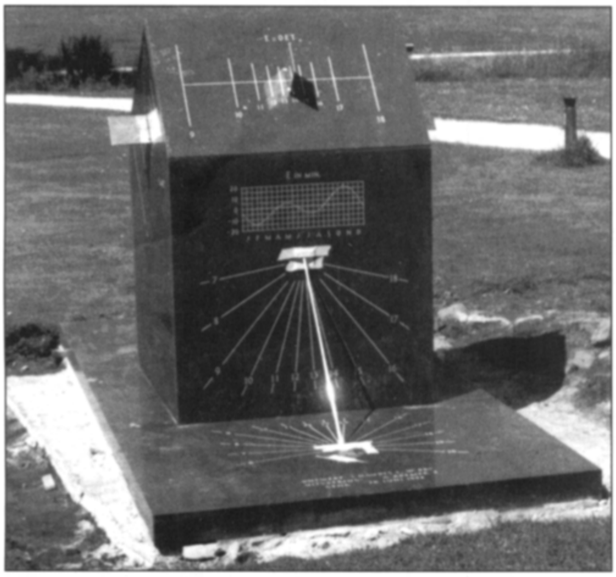

Fig. 2 Polyhedral sundial by Willy Ory and Ignace Naudts.

This lecture prepared the way for the formal announcement of the list of winning designs, which was repeated in a booklet distributed at the meeting. These were:

Type	**Designer**
Armillary sphere	Jan de Graeve
Polyhedral	Willy Ory
Horizontal, with correction for equation of time	Julien Lyssens
Horizontal, 10 m diameter, in ceramic	Mrs. J. Opgenhaffen
Meridian line	Jan de Graeve
Polar	Jean-Michel Ansel
Stepped analemmatic	René Vinck
Horizontal catenary	Rafael Soler Gayá
Conical	Javier Moreno Bores
Digital	Hans Scharstein
Horizontal quadrant of prismatic gnomons	Patrick Oyen
Sonius spar	Jan Kragten and Jan de Vries

Some of these designers were present, and were invited to give short presentations on their work. Your reviewer cannot pretend to have thoroughly understood the Flemish or German technicalities, but fortunately a pleasant lunch was followed by a walk to see some of the newly-erected instruments. This made comprehension very much easier, although a combination of heavy rain and boggy ground had severely limited the number of practical constructions.

First to be seen was the polyhedral dial by Willy Ory and the late Ignace Naudts (Fig. 2). Seven dials were elegantly incised upon a polished block of 'bluestone' - a hard fossiliferous limestone much used in Belgium. The dial furniture will be familiar to members. Next along the path was the 'Book of Time', a polar dial by Jean-Michel Ansel (Fig. 3). It indicates both time of day and time of year particularly clearly, a notch turned in its cylindrical gnomon acting as a nodus. It provides an excellent example of this rather under-used type of dial.

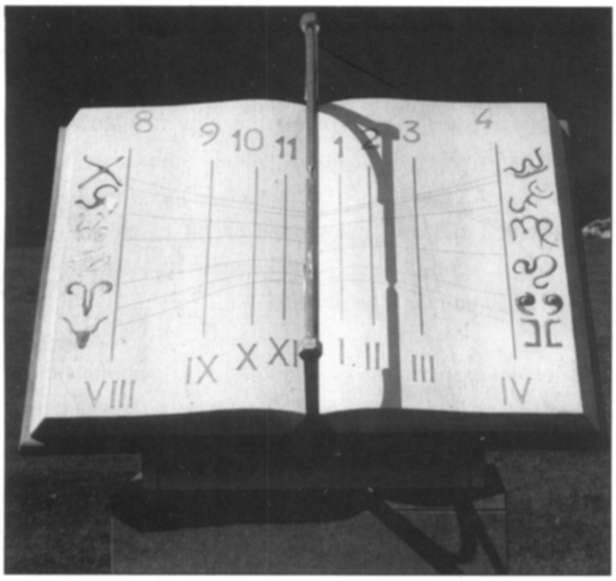

Fig. 3 The 'Book of Time', a well-presented polar dial by Jean-Michel Ansel.

Further on we came to two new types of sundial. Rafael Soler's catenary dial (Fig. 4) is very much a mathematician's instrument. At right angles to a standard gnomon it incorporates a chain hanging freely between two supports, and thereby taking up the curve known as a catenary. The horizontal dial plate is so laid out that the intersection of the shadows of the stile and the catenary gives the date in zodiacal months. A moondial is also included. Unfortunately, vandals are active in Genk too, for during the very first night it was set up one of the supports was wrenched out of the vertical. Another Spanish gnomonist, Javier Moreno Bores, is also pictured in Figure 4. He is the inventor of a brand new form of horizontal dial employing a recumbent cone as the shadow-casting element, but it had not been possible to make this in time for the conference.

Fig. 4 A new catenary dial with its designer, Rafael Soler Gayá, on the left. With him are Jan de Graeve and Javier Moreno Bores.

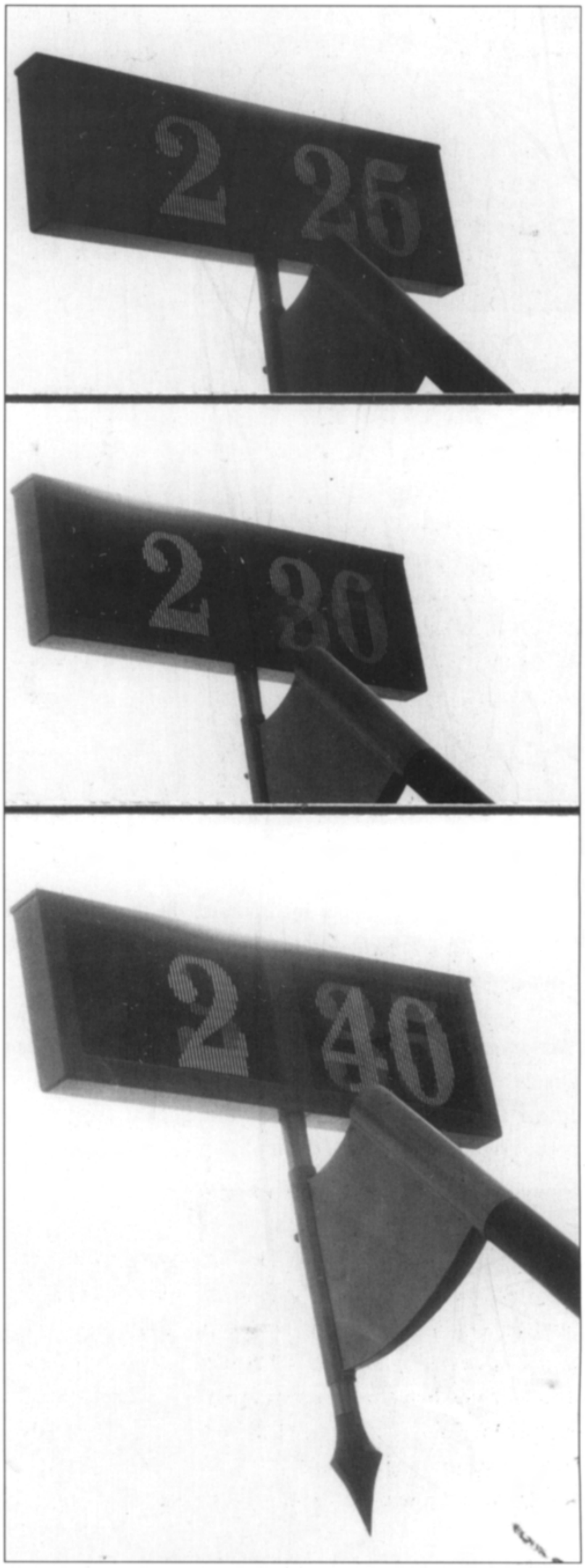

Fig. 5 The incredible digital sundial by Hans Scharstein.

Then, elevated on a mast, we glimpsed the breakthrough that has really excited the dialling world - Hans Scharstein's digital sundial. As the Sun arcs across the sky its parallel rays fall at a continuously varying angle upon a fixed sandwich of clear and opaque slits. These are cunningly disposed relative to one another so that a change in the angle of incidence of only 1.25° - equivalent to 5 minutes of time - causes a corresponding digit to become visible as its predecessor fades away (Fig. 5). Extremely precise alignment of the stripes is obviously essential, so this is not a dial for home construction! Currently, the only other example is displayed at the Science Museum in Munich, but no doubt others will soon be appearing around the world.

Finally, as further mute evidence of the disruptions to the schedule, were two massive granite blocks destined to become Jan de Graeve's meridian and noon mark (Fig. 6). The idea is that they will be positioned vertically with just a narrow gap between their angled edges. At local noon a shaft of sunlight should fall along the Genk meridian, whilst a small block filling the gap at a height of 3.5 m will generate a contrasting shadow to enable the solstices and equinox points to be marked. This is, of course, a reversal of the usual scheme.

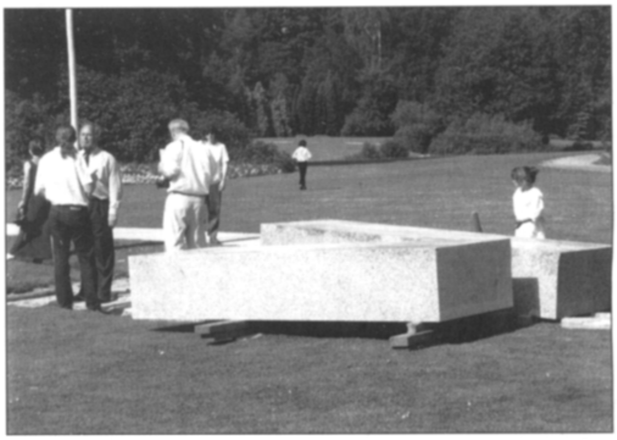

Fig. 6 When these granite blocks have been erected as closely spaced vertical pillars, noon sunbeams penetrating the narrow gap will define the Genk meridian.

The Genk sundial park demonstrates the inexhaustible range of design possible in the sundial, and is a must for every gnomonist. Its is hoped that by Autumn 1998 all the instruments will be in place and booklets printed to explain them.

Allan Mills

GREGORY: THE GIPSY DIAL

A.F. BAIGENT

Very few of the members of the B.S.S. would claim to be in their youth, and all sundials that I have seen have been designed with adults in mind. I therefore decided to make a dial specifically for young children which could be used in schools as the starting-point of some lessons. With the millennium approaching, I feel sure that the Greenwich meridian, time and longitude are going to become much studied educational topics in the near future.

My first objective was to make a dial attractive to youngsters, catch their eye and maybe their interest. It would be personalised, with a name and character of its own. Gypsies tend to be mysterious and fascinating subjects in children's books, so a gypsy-faced dial seemed appropriate. As a child myself I knew a gypsy family named Gregory, and thought this to be a very suitable name, given its connection with the calendar.

I decided on a vertical direct south dial due to its symmetry and the fact that it can be fixed to a wall just above head height, thus reducing the possibility of injury from the gnomon (which was rounded to represent the nose, and for safety). The dial had to withstand both weather and children, so I chose metal as the material from which to make it. Different coloured metals would increase the dial's attractiveness and make the features clearer, as I wanted to include as much information as possible from very simple to more complex, to give starting points for various teaching projects. Again, to reduce confusion the style of lettering would be varied: engraved, stamped, cut out from the blank, and shapes glued into position.

Having decided on my design, I now needed the metal. So, as always, I made out my shopping list: one good-sized aluminium frying pan and any ornaments or gadgets containing flat pieces of copper or brass, and dispatched my wife to the next local jumble sale. This is not as cruel as it might seem, as she actually enjoys the challenge and is really rather good at fulfilling the orders. This day, she exceeded all expectations and returned home with a large oval Tefal pan and some broken clock parts containing brass; no copper but I already had some from a previous expedition.

Construction (Fig.1)
The face was cut from the base of the oval aluminium pan (measuring 270 mm by 185 mm), whilst the ears, formed from the sides, were bent level with the dial plate. All information, including hour lines, was then engraved or stamped on the face

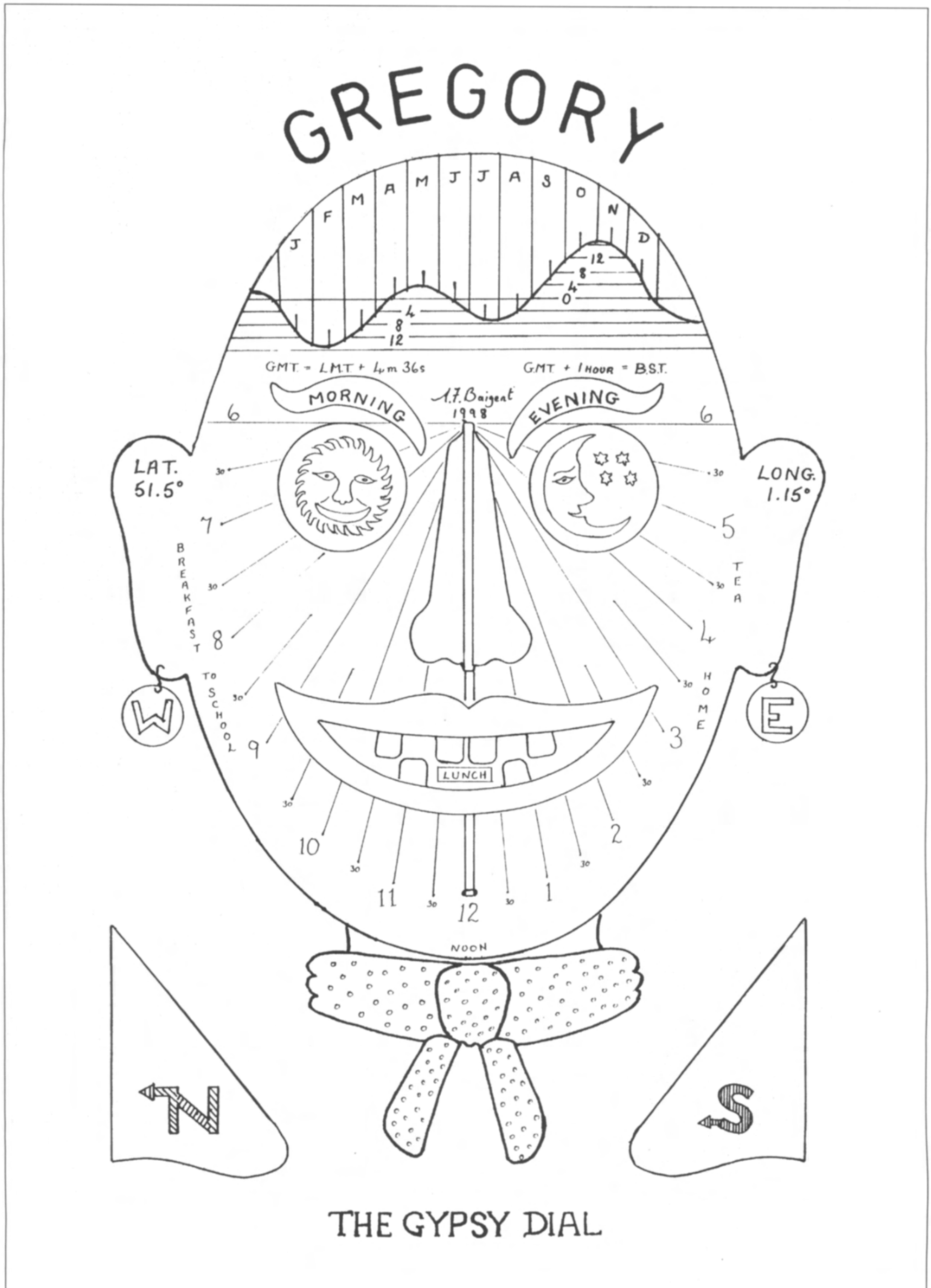

Fig.1 Design Plan

With a certain amount of licence, the gypsy was given copper red hair and eyebrows. The hair line was shaped to represent the equation of time; the engraved month lines become hairs, and the fast/slow minute lines are the furrows on his brow.

Two brass curtain tie-back hooks, purchased from the local hardware shop, formed the eyes. The hook part was removed leaving a disc with a smiling sun for the right eye and one showing a dreamy moon under the stars for the left. The nose was cut from brass and bolted to the face to form the gnomon. The letters N and S were shaped from aluminium and stuck to the sides of the nose, whilst E and W were cut out from two brass cat-discs which were suspended by brass wire as earrings

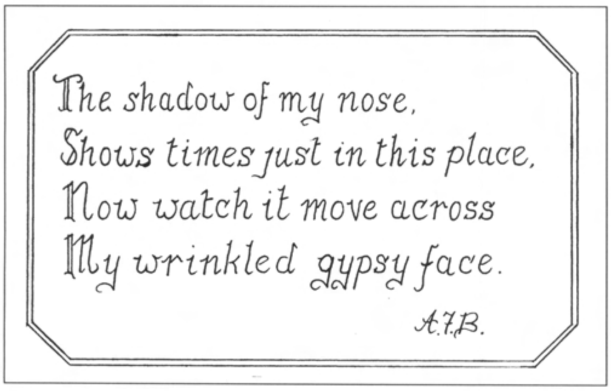

Fig.2 The Motto

Fig.3 The completed dial mounted on the wall

Fig.4 Lucy and Edward, Gregory's first two pupils

A white formica cutout of the mouth and teeth was sandwiched between the copper lips and the plate, a small rectangular biscuit bearing the word 'lunch' being glued in the mouth, spanning the noon line. A separate shaped neckerchief was bolted behind he face. All parts were lacquered before assembly to prevent possible reaction between the different metals, and the whole dial was re-lacquered after completion, the scarf being pained red with white spots. The dial was finished with a name plate cut from aluminium and a motto engraved on a rectangle of the same metal (Fig.2). Finally it was all mounted on a south-facing wall.

If Gregory does his job properly, then the B.S.S. should be assured of its membership until at least the middle of the 21st century.

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Goring on Thames
Oxon, RG8 OHL

SHADOW CLOCKS AND SLOPING SUNDIALS OF THE EGYPTIAN NEW KINGDOM AND LATE PERIOD: USAGE, DEVELOPMENT AND STRUCTURE

ANDREW SOMERVILLE MEMORIAL LECTURE, MAY 1998

SARAH SYMONS

Examples of two distinct types of Ancient Egyptian formal sundials survive to the present. The earlier type is referred to as a 'shadow clock', 'L-shaped shadow clock' or 'shadow stick', and existed from at least as early as the XVIIIth dynasty (1550-1307 BC) in the Egyptian New Kingdom. The later type is the 'Egyptian sundial' or 'sloping sundial' which occurred from the Late Period through to the Ptolemaic era (712-30 BC) .

The Egyptian religion was greatly concerned with the sky, concentrating first on the stars in early dynastic times and later, increasingly, on the Sun and its nightly journey through the region known as the Duat. For this reason, formal time-keeping instruments were developed in early times using the stars, and, by the beginning of the New Kingdom, using water to find the hour of the night in order to trace the events which the Sun-god experienced each night.

The development of informal time-keeping methods which would be used for practical purposes would have followed a different path. Scant evidence remains for these informal methods. The existence of water-clocks preceding the earliest surviving example, of the time of Amenhotep III (1391-1353 BC) in the XVIIIth dynasty, may be inferred because a text[1] which describes the invention of the seasonally adjusted water-clock implies the existence of non-seasonally adjusted water-clocks. It is not certain, however, that such devices were in secular use rather than confined to the temples, or that the devices would have been used during the daylight hours as well as during the night.

Informal sundials are assumed to have existed, but have left little trace either physically in the form of identified objects, or linguistically. It has been suggested[2] that certain of the many different types of staff or sceptre which were carried by individuals holding some office were to be used for time-keeping. Sundials fashioned from a board with a string stretched between two vertical posts existed in rural areas until the present century, and are believed to be the descendants of similar instruments used from the very earliest times for agricultural purposes[3]. These methods, and others of a similar nature, have in common a lack of uniformity of construction and of calibration. Thus, while useful for marking off certain periods of time, standardisation of construction and of the resulting time periods would not be either desired or possible. Also, there is little or no reference to such time-keeping methods in the surviving literature, making it impossible to assess these methods for meaningful information about Egyptian ideas of time.

A popular candidate for a time-keeping device dating from the earliest times is the obelisk. Obelisks are solar offerings which the pharaoh presented to the sun god. Their upper part, and in some cases their entirety, was originally covered with electrum (gold and silver alloy). Their great height was desirable because it was wished that the earliest Sun would reflect from their electrum plated tips, before the morning light had reached ground level.

The argument for obelisks as sundials is mainly based on their potential as gnomons. Their shape and size seems to suggest this usage, as does their solar associations.

Much evidence disagrees with the theory, such as the lack of a calibration system for any obelisk, but the strongest case against obelisks as sundials comes from reading the inscriptions on obelisks. The inscriptions contain the names and epithets of the pharaoh who commissioned them, and an offering text to the sun god in one or more of his forms. The text is often presented in the form of a speech by the king, and sometimes contains information which is practical in nature, for example the location for which the obelisk was intended or some information about the manufacture of the object.

These inscriptions provide a major argument against obelisks as sundial gnomons because the texts never imply that any obelisk was intended to be used as a sundial gnomon.

An inscription on the base of one of a pair of obelisks erected at Karnak on the command of Hatshepsut (ruled 1473-1458 BC) illustrates the Egyptian official view of the purpose of obelisks in the New Kingdom. The queen says that she made them 'for her father', she swears that they are

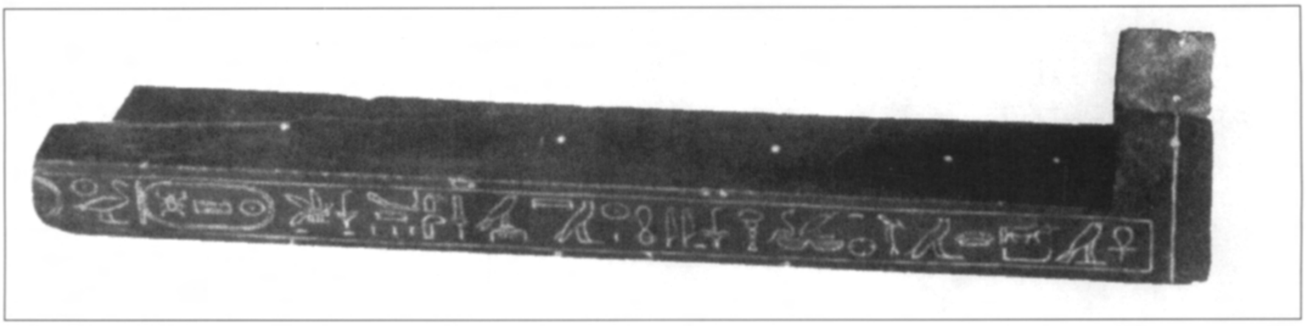

Fig. 1

each a single piece of granite and states that it took seven months of quarry work to make them.

She also speaks directly to those in the future who might wonder about their purpose. She answers them forcefully: the obelisks were 'Wrought with electrum by my majesty for my father Amun, In order that my name may endure in this temple, For eternity and everlastingness'[4].

This text and others state clearly the features and thinking that were important in the commissioning and manufacture of an obelisk. There is room and stylistic opportunity for mention of timekeeping properties, but none is made.

The first evidence for formal solar time-keeping dates from the New Kingdom. By the XVIIIth dynasty, an instrument had been invented which divided the time of daylight into ten periods. Analysis of this instrument, the shadow clock, can provide information about the motives and thinking behind Egyptian time-keeping, and the nature of Egyptian time itself, due both to the survival of some more or less complete examples of the instrument, and the existence of a text describing the manufacture and usage of the instrument.

The earliest surviving example of a shadow clock is Berlin Museum 19744 (Figure 1), dating from the time of Tuthmosis III (1479-1425 BC). The inscription gives his name and epithets. The base rod is around 20 cm long and is inscribed with five small circles making up an hour scale. Some damage has occurred to one end of the base rod.

The best preserved example, Berlin Museum 19743 (Figure 2), is some 500 years younger. It is constructed from two pieces of green schist, the base rod and the vertical block, held together by a mortise joint. The base rod is around 30 cm long.

The vertical block has a hole and reference line indicating that a plumb bob was attached to the instrument. The existence of the bob is well attested in the hieroglyphs used as determinatives for words to do with shadow clocks. The later instrument also has two small holes on the top surface of the vertical block, indicating that something was fixed to the top of the block.

The text concerning shadow clocks occurs in relief on stone slabs which form the pitched ceiling of the Sarcophagus Chamber of the Osireion at Abydos, built by Seti I (1306-1290 BC)[5]. The entire western half of the ceiling is of great interest astronomically[6], but one portion deals specifically with the shadow clock. The diagram which heads the text is reproduced in Figure 3.

The caption above reads "[knowing] the hours of the day and the night, an example of fixing noon."

The diagram is a picture of a shadow clock illustrating the shape of the instrument and the markings on the scale. The symbols between the marks are the numbers 3, 6, 9, and 12 (from left to right), which are described in the text situated below the diagram as being 'from the rule (law)'.

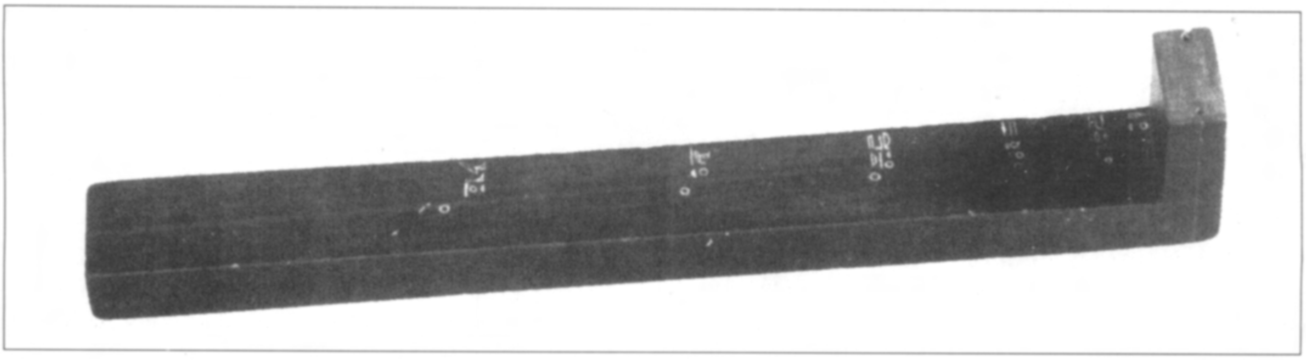

Fig. 2

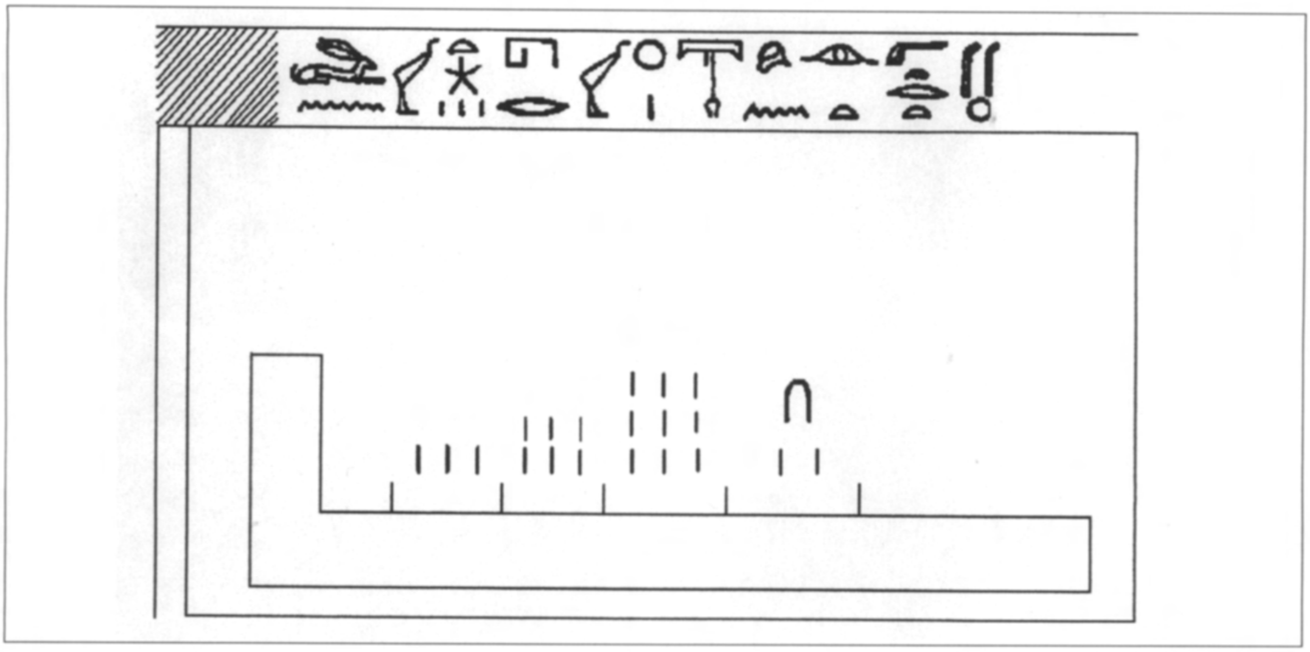

Fig. 3

The diagram shows the marks graphically almost evenly placed on the scale, but in the examples of this type of instrument which have survived and which retain hour marks, the marks are separated in this 3, 6, 9, 12 proportion and also extend the principle to another mark 15 units from the last. The surviving instruments do not have the gap between the gnomon and the first mark shown on the picture. Thus the distance from the base of the vertical block to the first mark is three units, from the first mark to the second is six units, from the second to the third is nine units and so on.

The Egyptian artistic style shows the contents of the horizontal face hovering above it following the convention for portraying three dimensional objects. The portrayal of the hour marks fairly evenly placed along the scale, rather than in the proportion suggested by the figures and confirmed by surviving examples, is also a feature of Egyptian art, which preserved relationships between elements, rather than distance.

Parts of the text beneath the diagram are missing, including portions from the description of the dimensions of the instrument. The preserved phrase '5 palms in its length' indicates the instrument would be nearly 40cm long. Another fragment reads 'its .... 2 fingers in its height'. The gap here is not caused by damage to the ceiling, but by a space in the text. It seems that gaps were left in the carving where the original papyrus, from which the text was presumably being copied, was damaged. This measurement (about 3.75cm) could be assumed to be the height of the gnomon, but not with certainty: the figure could refer to the height of the base rod, a dimension insignificant to the timekeeping properties of the device. The following is a translation a section of the text.

'Branded upon this instrument :

you should put 12 from the rule for the first hour
you should put 9 there for the second hour
you should put 6 there for the third hour
you should put 3 there for the fourth hour'

The text is describing how to lay out the four hour marks shown in the diagram using a 'rule' (in the sense of a law or procedure). The units are not stated. If fingers are assumed to be the intended unit, there being four fingers to the palm, the total length between the gnomon and the fourth mark is 3 + 6 + 9 + 12 = 30 fingers or around 56 cm, which is longer than the stated length of the instrument. Fingers were subdivided into fractions, and it seems that some fraction of a finger must be the intended unit.

The text continues:

'You should reckon at noon the hours until the sun will set:
4 hours, like the rule before.
The total is 8 hours because
2 hours pass in the morning (when) the sun does not shine,
2 hours pass after the sun sets to establish a place for the night hours'.

This extract explains why there are only four marks shown. The hours around sunrise and sunset are clearly not thought to be part of the day proper. In the surviving instruments, only ten hours are measured.

The phrase 'at noon' is a difficult translation. The word for 'noon' does not hold the connotations of an instantaneous moment of time in the same way that our word 'noon' does. The phrase could be translated as 'at the hottest'.

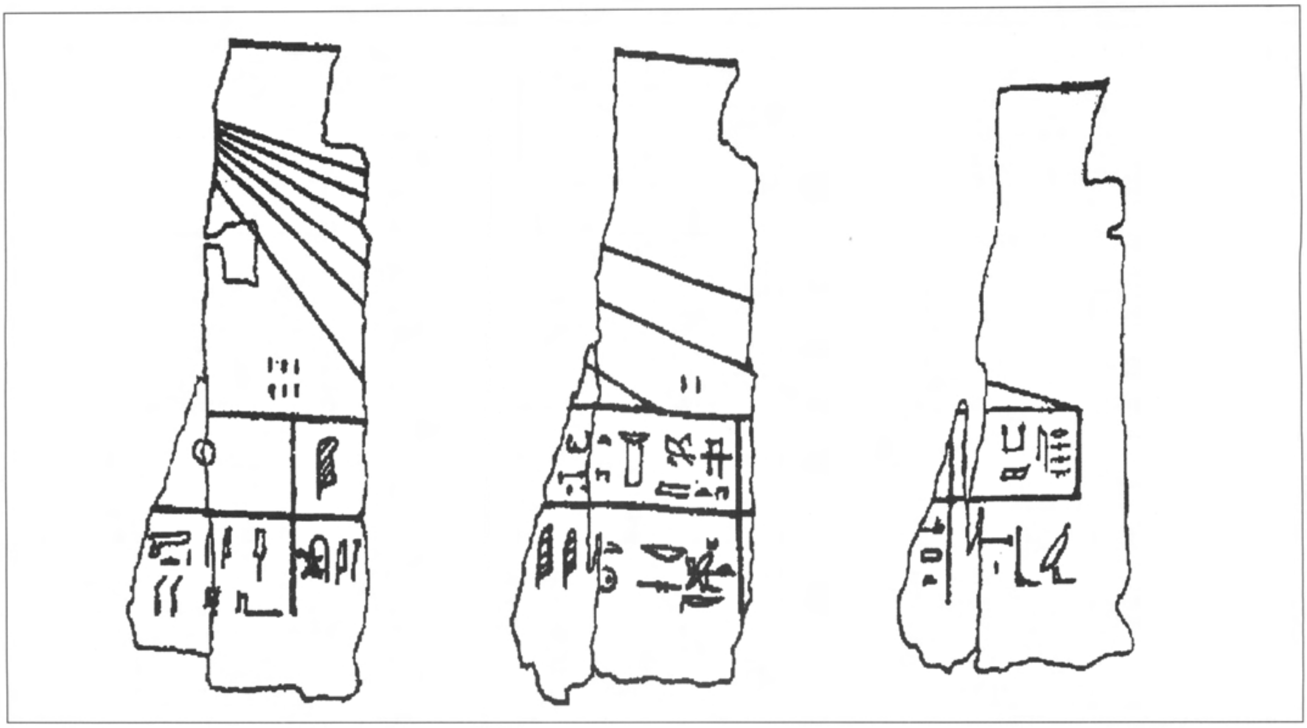

Fig. 4

A second text dating from the Roman period (after 30 BC), discovered at Sân in the Tanis area, consists of three papyrus fragments forming part of a diagram of a shadow clock (Figure 4). Unfortunately, not much of the text surrounding the instrument survives, neither does the portion of the diagram showing the form of the gnomon.

Two numbers are preserved. Near the lost gnomon, there is a 6, and in the second fragment there is a 2. These numbers probably refer to the hour being measured at those points, the 2nd hour being in the morning and the 6th being near noon when the shadow is shortest.

The diagonal lines which run from each hour mark to a point of convergence are of interest, but one cannot take this point to indicate a large relative gnomon height because although Egyptian diagrams show the relative placing of every element, the concept of scale is lost.

In addition to the elements that are to be found in existing shadow clocks, namely a base rod with hour marks, and a vertical block with a hole and reference line for a plumb bob, it has been conjectured by Ludwig Borchardt in 1910[7], and generally accepted to the present day, that the instrument should also have an additional attachment called a cross bar. This extra member would be of similar dimensions to the base rod but would be fixed at the midpoint of its long side to the top surface of the existing vertical block, so that the cross bar lies at right angles to the base rod.

Borchardt's crossbar hypothesis consists of two elements, firstly the physical addition of the crossbar, which either by substitution or by rearrangement can be made to have three different heights, and secondly a manner of usage: In the morning, the instrument is aligned exactly east to west, the crossbar being in the east. It then marks the end of the first hour when the Sun's shadow crosses its longest marking, the end of the 2nd, the 3rd, 4th and 5th hours are in turn indicated by the hour marks. Noon occurs at the end of the sixth hour. The Sun, now perpendicular to the instrument, throws no shadow and that is the signal for the sundial to be turned end for end, to mark off the hours of the afternoon as the shadow once again lengthens.

The chief benefit of the hypothesis is stated to be that with the interchangeable crossbars, the hours marked are seasonal[8]. While no crossbars survive, support for the hypothesis is gathered from this benefit and by a sympathetic translation of the text in the Osireion.

There are several arguments against the crossbar hypothesis[9]. Firstly, the diagram heading the Osireion text and the hieroglyphs of sundials, which will be discussed shortly, do not portray the crossbar. A crossbar instrument would probably have been depicted as a "T" shape with the hour markings visible on the base rod. Instead, the instrument is shown as an L-shape with, in the case of the Osireion diagram, the markings hovering above the base rod.

Secondly, the periods of time which the instrument marks are not comparable with any degree of accuracy with seasonal hours. Bruins' assertion[8] that the accuracy is within 1% is clearly a wrong conclusion from the data he presents.

Thirdly, the small size of the surviving instruments indicates that they were portable, personal instruments, designed to be consulted at will. The crossbar hypothesis dictates a fixed datum line which limits the use of the sundial to certain locations only. An instantaneous East-West orientation cannot be produced using the instrument alone and is not a trivial undertaking using other methods. Also, if the instrument were to be set on a flat surface in order to be aligned East-West, the provision of a plumbline becomes unnecessary.

Fourthly, the portion of the Osireion text which describes the instrument being turned is open to other interpretations. The text becomes difficult at this point because of the introduction of special terms for parts of the instrument which are not completely understood. The action of turning could, as Borchardt suggests, be a single motion at noon, or could imply a continuous motion following the Sun.

Finally, the ratio of lengths between hour marks 3:6:9:12 speaks of invention rather than the observation that is implied in measuring seasonal hours. The only known device capable of calibrating the crossbar sundial which was available during the New Kingdom was the seasonal outflow water-clock. Use of this instrument is very unlikely to have produced the 3:6:9:12 ratio. Also, the only surviving New Kingdom water-clock is calibrated for the hours of the night, which seems to have been the intended use for water-clocks up to the Greco-Roman period.

If the crossbar hypothesis is discounted, the most likely method of using the instrument, which can be reconciled with the description in the Osireion text, is to point the vertical block towards the Sun, and use the plumbline and reference line to level the sundial. The Osireion text states *'If you have used this instrument rightly in the sun alignment,… then the shadow of the sun will be exactly on this instrument'*. The alignment of the shadow clock can be corrected by ensuring that the shadow of the vertical blocks falls across the entire width of the base rod.

The shadow clock then would be a portable, self-contained instrument which could be consulted at any time, in any location.

A further source for the study of sundials in Egypt is the pictorial hieroglyphic script. In addition to reading a word using the phonetic values of hieroglyphs, the reader is aided by the convention of adding one or more signs called determinatives at the end of all but the most common words. These determinatives have no phonetic value, but serve to clarify the meaning of the word that has been spelled previously. Nouns would sometimes carry as determinative a picture of the object itself, and for unusual objects in shortened form, this one sign alone could sometimes be used to represent the word without any phonetic signs preceding.[10]

Hieroglyphs dating from the Greco-Roman period denoting shadow clocks display plumb bobs or holes for attaching them. Figure 5A shows an instrument similar to the Berlin shadow clocks. Certain signs show additions to the New Kingdom L-shaped clock, for example the sign Figure 5B shows an additional curved block, possibly added to

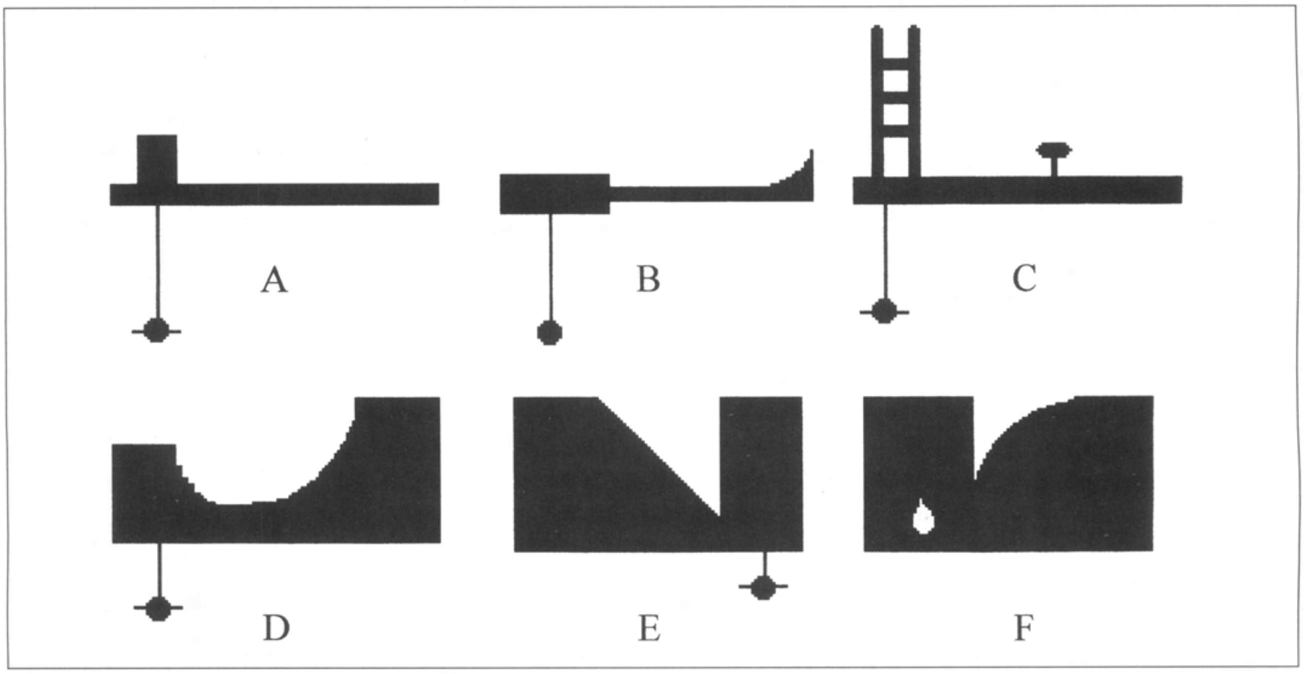

Fig. 5 a, b, c, d, e, f

incorporate the hours at the beginning and end of the day to read all twelve day hours, and the Figure 5C shows a strange ladder-shaped gnomon and what appears to be a peg on top of the base rod. This indicates that certain additions could be made to the sundial for some purpose, possibly for using the instrument at different times of the year. A structure of some sort may have been the reason for the two holes on top of the gnomon block of the later Berlin shadow clock.

The development of the second type of sundial, the 'sloping sundial' can also be traced using hieroglyphs. The sign Figure 5D seems to be a development of Figure 5B, and Figure 5F shows a convex surface on which the shadow would be cast. The hieroglyph Figure 5E resembles closely existing sloping sundials. Hieroglyphs therefore provide evidence for variant designs of sundial, and of the probable evolution of sloping sundials from shadow clocks.

The typical configuration of a sloping sundial is exemplified by a complete sundial dating from between the XXXth Dynasty and Ptolemy II (from 380 to 310 BC) found at Qantara. Figure 6 shows a plan and elevation of the instrument with dimensions. The device was used in a similar manner to the shadow clock, being pointed towards the Sun and levelled using a plumb line.

The sloping face of the instrument was inscribed with either dots along, or slanting lines crossing (in the case of a sundial now in the Petrie Museum, UC16376), seven parallel month lines running down the sloping face. Each of the seven lines would be labelled with either one or two month names (the two outer lines having only one month name each).

The month names on the Qantara sloping sundial indicate that the month Pharmuthi contains the summer solstice, and Phaophi the winter solstice. The months used are lunar, and so slippage of the lunar months against the solar year means that sloping sundials constructed at different dates have a different disposition of month names. For example a sloping sundial now in Paris (lot 456 of the Hoffmann Collection, missing the gnomon block) dating from Roman times (later than 30 BC) has Choiak containing the winter solstice and Payni as the month of the summer solstice.

The complete Qantara dial can be used to analyse the time periods this type of sundial would have measured. Given the height of the gnomon (35mm), the angle of inclination of the scale (approximately 37°), the distance from the base of the gnomon to each of the hour marks on each of the month lines, and the latitude at which the instrument would have been intended to work, presumably that of Qantara, the altitude of the Sun that would have caused a shadow to hit each hour mark length of these time periods can be found. Hence the length of each hour can be calculated.

Note that a correction for the alteration of the obliquity of the ecliptic which is caused by the precession of the Earth's

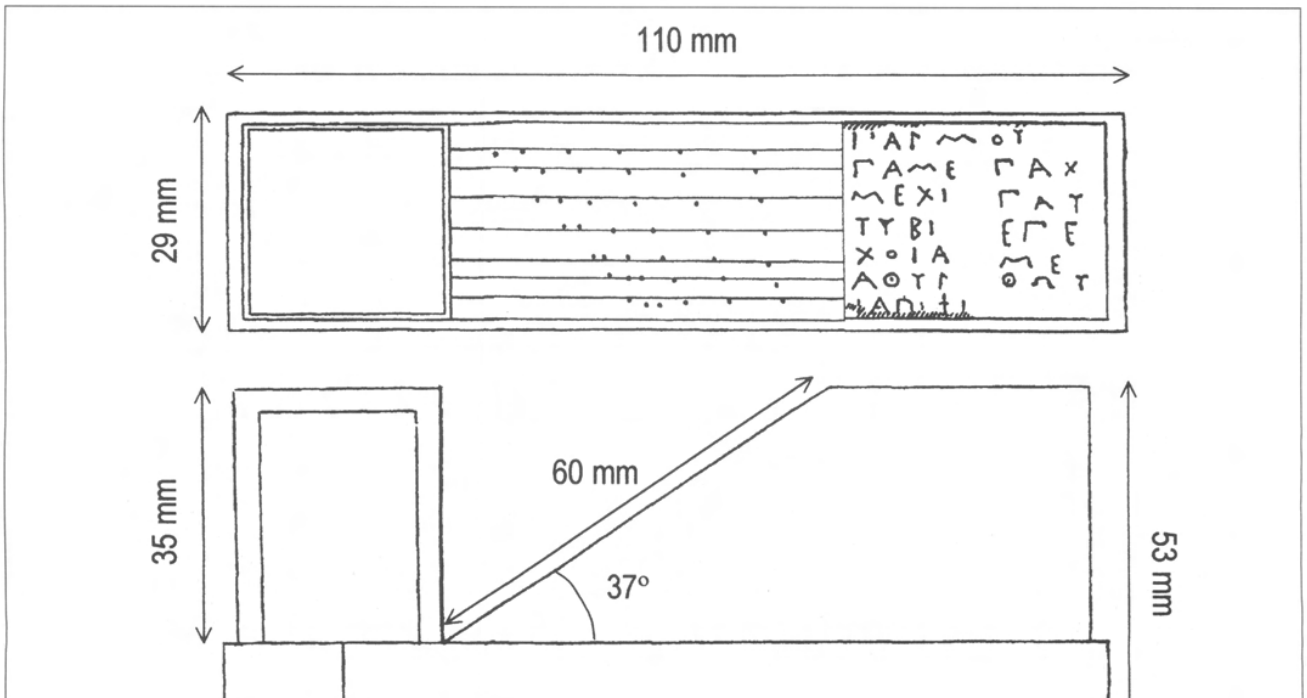

Fig. 6

axis can also be included. It is estimated that this sundial dates from 350BC and we find that the obliquity was 23.13 degrees. In comparison with the scale of the sundial and the accuracy with which it was made, the effects of this correction are negligible.

The Sun does not achieve sufficient altitude to cast a shadow on the mark nearest to the gnomon during seven months of the year from the autumn equinox to the spring equinox. For this reason, data can be gathered only for certain hour lengths during the year.

The hour lengths calculated using data from the Qantara dial give a day length of about $12^1/_4$ hours in Pharmuthi and about 9 hours in Phaophi. The hours are not uniform throughout any one day. The longest hours registered are 101 minutes long, the shortest 36 minutes, with an average length of hour of 65 minutes. The noon hour, when the shadow passes beyond the mark nearest the gnomon block, is subject to the greatest variation in length.

To gauge the validity of these results as a true indication of Egyptian time periods, the accuracy to which these instruments were made must first be considered. The major problem in assessing the instruments is that those that survive might not have been intended to be working clocks. They would have been grave goods or, particularly in the case of sloping sundials, offerings. In the case of shadow clocks, it seems most likely that working clocks would have been made of wood and have mainly perished, but special clocks, for funerary purposes, gifts or offerings would be made of stone. Although the attributes of a working sundial are contained within them, one cannot assume that such items were manufactured to a high standard of accuracy.

The accuracy to which these surviving sundials were produced therefore cannot be gauged, and data must be taken from them with this reservation. However, even if only the overall design is considered, it is still clear that the sloping sundial does not produce hours which conform to any known time standard This has also been noted to be the case with the shadow clock. This behaviour is to modern eyes undesirable in a time-keeping device, but need not necessarily have been recognised as such in ancient times.

The Ancient Egyptians had two reasons to measure time: for ritual purposes and for practical purposes. In both cases, the Egyptian philosophy permits us to assume that the time-keeping instrument *defined* the time, instead of just *marking* the time in the way we expect clocks and sundials to work today. Such concepts as external calibration and standardisation were not within the mandate of these devices.

The survival of the two types of sundials in the form of grave goods and offerings also tell us that, beyond these types of device having some practical application, they were also considered to have great symbolic meaning.

These small instruments, regardless of modern standards of accuracy which we sometimes wish to force upon them, were to the Egyptians a representation of the continuing vitality of the Sun god himself and the eternal cycle of time.

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SUNDIALS: THE SILENT VOICE OF TIME

MILUTIN TADIĆ

A paper 'A Protest Sundial' in 'Rundschreiben' May 1992, dealing with the sundial in Sarajevo, warned the citizens that war was at hand in autumn 1991; it was published also in BSS. Bull. 92.1. Unfortunately the foreboding came to be true. The unsparing civil war started on the territory of the former Yugoslavia. I will not write about that war, for it is hard to be objective. I just want to say that no one and nothing has been spared; even sundials.

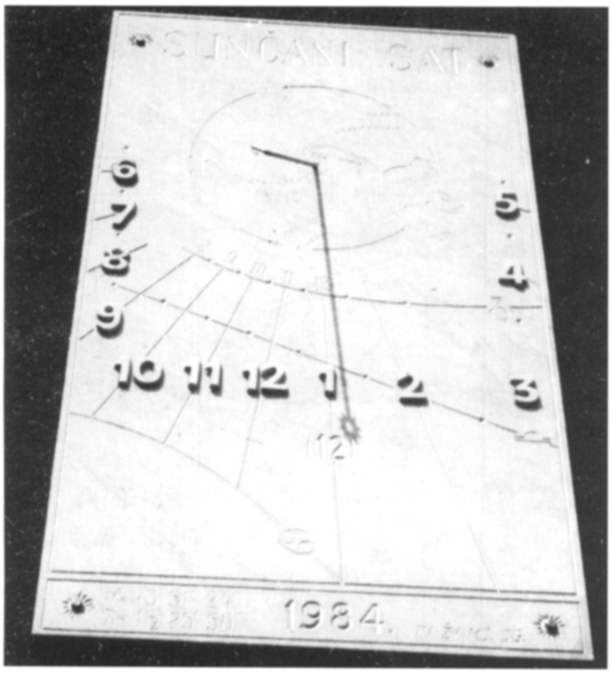

Fig.1 Sundial on Library 'V.Foht', 1984.

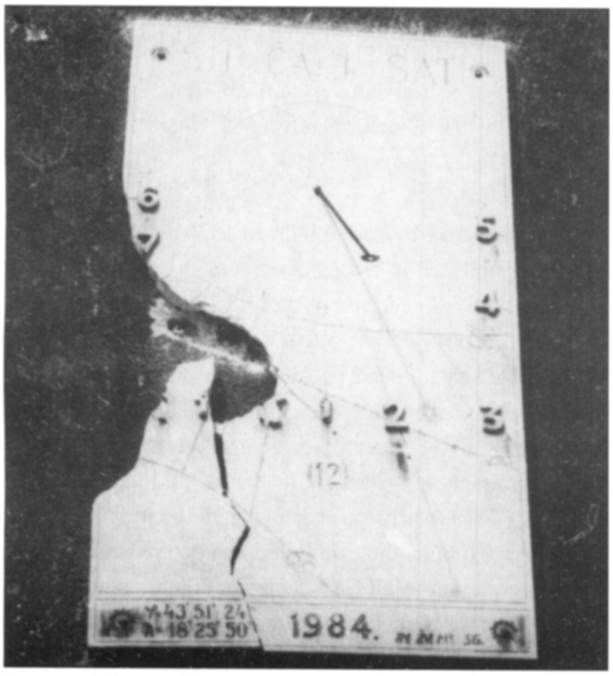

Fig.1a The same sundial taken during the war, 1994

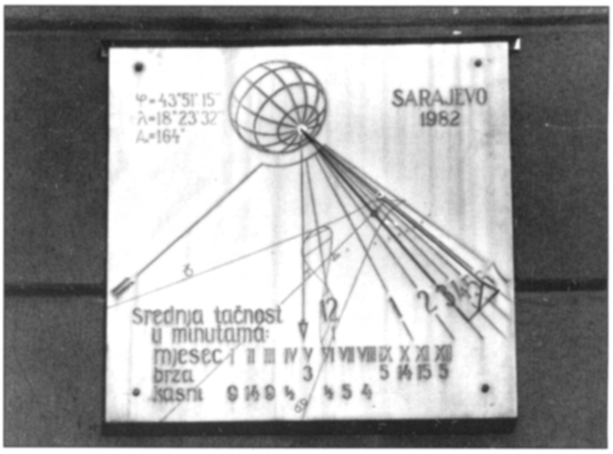

Fig.2 Sundial on Faculty of Science Building, taken at an equinox before the war

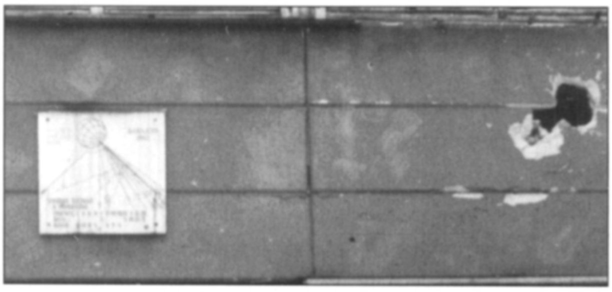

Fig.2a The same dial taken during the war, 1994

The first pair of photographs (Fig.1, 1a) shows the vertical sundial set in 1984 on the library 'V. Foht' in Sarajevo. Ten years after it was built, the marble slab of the sundial was broken by a shell fragment. (Whose shell was it? We shall never know.) It is almost incredible that the shell fragment broke the slab by the equinox line. It means that the fragment flew in the plane of the celestial equator

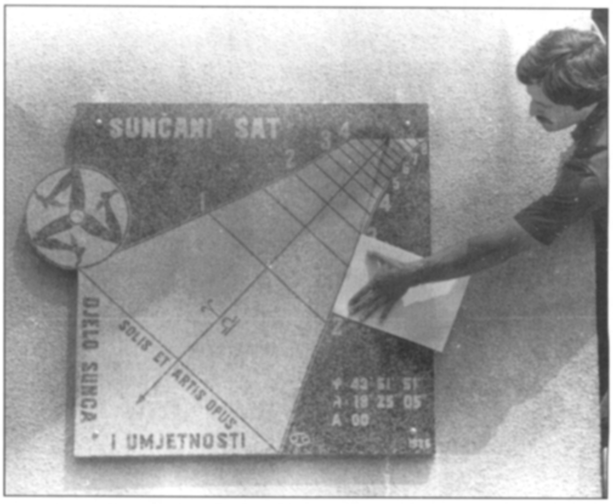

Fig.3 Sundial on stone-carving workshop of M.Sego taken during summer solstice in 1986

The second pair of photographs (Fig.2, 2a) show the vertical sundial set in 1982 on the Faculty of Science in Sarajevo. Snipers were firing from that ground-floor building during the war, so it became a target too. One of the artillery shot balls hit quite near the sundial as can be seen in Photo 2a.

Fig.3 shows the vertical sundial on the direct west-facing wall of the stone-carving workshop of M.Sego in Sarajevo. There was no sundial on the wall after the war (Fig.3a). It is not known what happened to it.

These photographs are one of the illustrations of the civil war on the territory of the former Yugoslavia. Or, as Robert Hegge (1624) said.... 'These sundials are the silent voice of time' ....one unfortunate time

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Fig.3a The wall where the sundial had been placed; photo taken after the war.

REVIEWS: OFFPRINTS

ANGLO-SAXON SUNDIALS IN RYEDALE
J. Wall
Yorkshire Archaeological Journal, 69, 93-117, (1997)

Dr. Wall's thorough study of Saxon Dials in his chosen area of North Yorkshire is admirably lucid and readable. After his initial reference to older authors, Haigh, Collingwood and Green, Dr. Wall takes us through the various known types of Saxon dial and describes the octaval system of day-divisions, called 'tides', a word derived from a Saxon word for a period of time (and not used for the periodic rise and fall of the ocean until long after the Norman Conquest.). Four of the 'tides' would occur in daylight hours, each one, at the equinox, lasting for a period of three (modern) hours. Sundials were marked with these four main daylight divisions, each of which might subsequently be divided into 'half-tides' and then into 'quarter-tides'; or into a duo-decimal system , when each 'tide' would be divided into thirds. A 'decimal' division of daylight is extremely rare: only one example in Ryedale and one elsewhere in Britain.

Dr. Wall goes on to describe each of the nine Saxon sundials of Ryedale, the most famous, as well as the best-preserved, being the St.Gregory's Minster dial in Kirkdale. Several of the dials, including St.Gregory's, have inscriptions providing important documentary evidence of their origins, and the author carefully unravels the history of each. Three of the nine are so badly eroded that Dr.Wall has had to base his description on that of Haigh (1879) or Collingwood (1911); but good clear drawings are given of all the dials where this is possible.

Perhaps the most interesting point made in Dr.Wall's article concerns the period of overlap, or merging, of the octaval 'tide' system of day-divisions and the duo-decimal system acceptable for the 'Roman' church practice which came to dominate religious observance after the Synod of Whitby in 664 A.D. The variety of the Ryedale Saxon dials enables dial-hunters to see within a small area this transition from a 4-tide daylight to a 12-hour daylight now universal. This article is a good read, for all gnomonic historians.

M.S.

ON THE ANCIENT SCANDANAVIANS' DIVISION OF THE TIMES OF THE DAY:
Finn Magnusen, translated by John M'Caul.
Memoires of the Royal Society of Northern Antiquaries. Vol. for 1836-37, pages 165-194.

This extraordinary monograph dated 1836 and appearing in a journal published in Copenhagen came to us from Robert Sylvester who had received it from BSS member Rex Klette of Newlyn, Cornwall. Mr. Klette bought it some years ago, (at a sale of second-hand books and pot-plants!). Mr.Klette sent it to the Membership Secretary, surmising that it might be of interest to the Sundial Society membership.
The monograph is written in the formal and verbose style customary in scholarly journals in the 19th century and later. The writer explains the origin and use of the octaval day-division common to all Scandanavian countries and based firmly on the four cardinal compass-points and their intermediates, NE, SE etc The following quotation gives a flavour of the style of the work.

'These peoples....divided the heavens or the horizon first into 8 grand divisions....and secondly into 16 minor divisions, each of the grand divisions being bisected into equal portions by intervening lines.....' They 'divided the times of the day according to the sun's apparent motion through the above-mentioned divisions of the heavens. They supposed that the sun percurred each of the grand divisions in 3 hours...'

The author explains that each major division was called an *eikt* and each minor division a *stund.* He continues:

'In order to know and settle these divisions of time, the inhabitants of each place carefully observed the diurnal course of the sun, and....they accurately noted the terrestrial objects over which it seemed to stand when in each of the above-mentioned celestial points....In Norway, Iceland and the Ferroe Islands, all of them mountainous countries, it was in general easy to find crags, hills, rocks, cascades, reefs, or to raise pyramids etc whereby fixed points were obtained for each time of the day. Such natural or artificial objects were called *daymarks....* In Iceland each separate farm or estate had its own daymarks'

The author considered that the most ancient inhabitants were led to fix the daymarks by dividing the horizon according to the principal winds. 'But they were also guided by the wants of their domestic economy' There is a long discussion about the rising time of the shepherds at half past four in the morning- '.and which down to this very day has continued to be the rising time of the workpeople in the hay-making season'

Confusion was introduced into the ancient octaval system and thus into the names of the various eikts and stunds 'particularly during the Catholic times, by the daymarks or their appellations being altered so as to adapt them to the Mass hours....' Gradually there was formed a 'new and incorrect system which by colloquial intercourse got a fixed footing in the country particularly in maritime districts where clocks and compasses were in use'

The author asserts that 'the counting of time by means of sundials and hourglasses..,nay even watches and clocks, was not unknown to the Northmen in the 11th century. After the introduction of Christianity such instruments naturally became indispensable for the use of the clergy'

Much of the monograph is devoted to comparative linguistics; giving the nomenclature for the compass-points and times of day in Iceland, Ferroe and Norway: matters of no particular interest to diallists. Of some interest to historians of gnomonics, however, is the antiquity of the octaval system , familiar in Britain as the 'tides' of Saxon sundials; and its gradual merging with a system dependent on the times of masses, just as Dr. Wall has shown in the context of the Rydale dials. Readers of the Bulletin, through the articles of Arnaldi and others, are familiar with mass-dials, times of prayer in the Benedictine Rule, medieval time-keeping and the names of hours throughout southern Europe. This monograph extends our horizons northwards, and introduces us to a well-established pagan tradition of time-keeping, fixed by wind-directions and landscape daymarks, and accepted over many centuries.

M.S.

OLD SUNDIALS IN SERBIAN LANDS:

M. Tadic.

Publications of the Astronomical Observatory of Belgrade, No.60 218-225 (1998)

Dr. Milutin Tadic has been studying old (and making new) Sundials in Serbia for a number of years. In this interesting paper he pieces together the history, admittedly fragmentary, of the sundials of this area of former Yugoslavia. The history starts with a 7th century Roman sundial discovered in 1981 in the ruins of the Roman town of Sirmium: marble 'life-size' figures of 3 Roman gods holding a hemispherical sundial on their shoulders. Next in chronological order is a late 12th century dial in the Studentica Monastery, carved on a doorway pillar of the south vestibule of the church. This is a semi-circle containing twelve equally-spaced radii as hour-lines (Fig.1,) the 'mass-dial' style common on church buildings throughout medieval Europe. Though only one such dial has so far been found in Serbia, the existence of others can be deduced from manuscript accounts of events recorded as having taken place at a certain hour of the day.

Leaping forward to the early nineteenth century (1828) we have an interesting wall dial at Zemun; its gnomon has a two-part arc support making it adjustable to any wall-declination. Sadly this dial has become badly damaged in recent years (Fig.2 a & b). To the mid-19th century belongs a handsome painted mural dial at Sombor, (Fig.3). Time is depicted as a winged angel holding the gnomon in his left hand. The designer was a Serbian monk, teacher and lecturer, Jovan Coker, who is considered to be the first Serbian amateur astronomer.

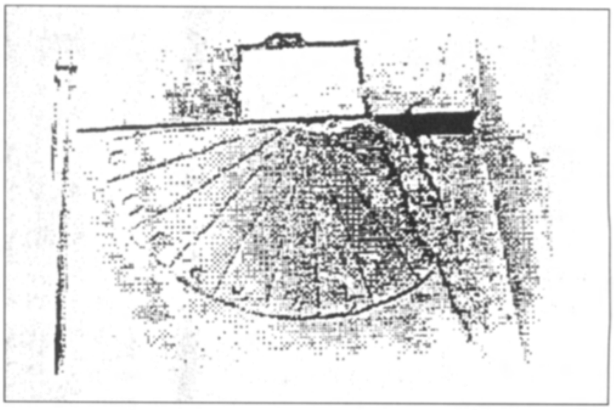


Fig.1. Sundial at Studentica Monastery, c.1190

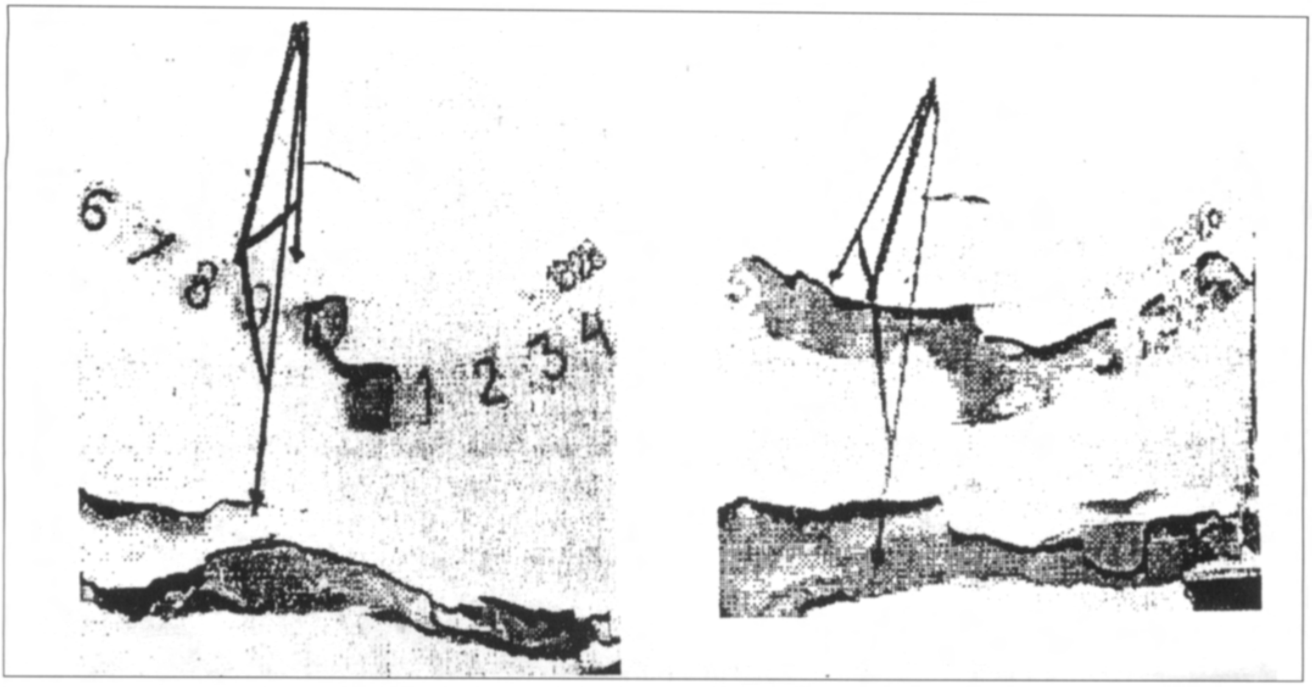


Fig.2. Wall Sundial of 1828 at Zemun, in 1987 and in 1997

When the Astronomical and Meteorological Observatory was founded in Belgrade in 1887, sundials were seen as a useful means of checking the time-keeping of clocks. A large horizontal stone dial was constructed on the Observatory's meridian in 1933. It is still in place but without its gnomon. Two wall-dials, constructed for a boarding-school in Belgrade in 1934, and a monastery in Zica in 1938, complete the list of pre-Second-World-War dials in Serbia.

Dr.Tadic writes that during many years of Turkish rule, Serbian lands were cut off from communication with the rest of Europe, and thus with the general cultural progress that was making great strides elsewhere. This, he suggests, is one of the causes of the scarcity of ancient sundials, though it is still possible that future finds may help to fill the gaps of the fragmentary history. The scarcity makes those dials which do survive the more precious, and deserving of recording and protection. In this article Dr.Tadic has performed a valuable service to gnomonists, especially to those of eastern Europe.

Fig.3. Painted Wall Dial at Sombor, c.1850

We hope to publish in a future issue of the Bulletin Dr. Tadic's illustrated account of sundials in all the territories of the former Yugoslavia.

M.S.

JOURNAL REVIEW

COMPENDIUM, JOURNAL OF NASS

Volume 5 no.2, June 1998 opens with an article by J.M.Bores of Madrid, Spain, describing a type of sundial 'new in Gnomonics': a conical shape lying on its side, with axis parallel with the earth's axis; 24 hour-lines are spaced uniformly along the sides of the cone radiating from the apex. The dial measures the hours since sunrise (Babylonian hours) and the hours since sunset (Italian hours). The sun illuminates half the cone, the other half being in darkness, so on the cone's surface there are two interfaces between light and dark, one marking Babylonian and the other Italian hours, the one on the higher number being Italian. The idea has the simplicity of genius and the author provides instruction for making a cardboard model enabling readers to test the idea for themselves. The author also points out a number of possible lines of development of the design such as modification to horizontal and equatorial dials. He promises in a further paper to describe its modification for sidereal hours. J.M. Bores submitted a dial of this kind for the design competition for Christ Church, Oxford. He also gained an award for a conical sundial for the Municipal Sundial Park in Genk, Belgium. We shall probably see and hear more of conical sundials in public places in future. One great advantage is that if built of any solid material the design is almost vandal-proof.

An article entitled 'De Temporibus' by Robert L. Kellogg reveals that the Venerable Bede was a cosmologist and geographer, in addition to his role as historian, teacher and scholar.

Bede's works on geography and solar observation, written down by his pupils, survived Danish raids of the 8th and 9th centuries, and were translated by a mid-nineteenth century scholar Rev T.O.Cockayne. Kellogg gives us a version of the Old English text of the key passages relating to day-length, together with his own translations of the O.E. Bede was aware that day-length at the summer solstice varied in the different places on the earth's surface, and that this was due to the earth's 'roundness'. He records, from travellers' accounts, the hours ('tides') of daylight from 'Ethiopia' (Gulf of Aden), Alexandria, Rome, and in Northumbria (his own monastery), as being 12-and-a-half, 14, 15 and 17 'tides' at the summer solstice. This is remarkably close to the numbers of hours'daylight at these places as computed from latitude and the sun's declination; which implies that the O.E. 'tide' is indeed equivalent to the modern 'hour'. Bede also went northwards to 'Thule' (possibly the Shetland Islands) about 6 days' journey by sea from the Northumbria coast; and notes that 'there be'th light in night in summer that night seems as dawn, since the sun be'th so far north that it but slightly goeth under where the earth ends, and then right away goeth up'.

There is to be a regular feature in 'Compendium' entitled 'Sightings', describing a dial of interest, either from the archives or encountered by one of the Society's members. There is in this issue a good description, together with a diagram and 3 photos, of the famous Jaipur Sundial of the 18th century, seen by Fred Sawyer. He also saw on his journey eastward the striking modern dial of Sultan Qaboos University, Muscat, Oman, depicted in a photo on the cover of this issue.

M.S.

BOOK REVIEWS

QUESTIONING THE MILLENNIUM
Stephen Jay Gould,
Pp. 179 (Jonathan Cape,) £12.99

'The lights flashed, the crowds sang, the sirens screeched, bells pealed, bombs thundered, rockets blasted skywards, and the new century made its triumphant entry'.
If we were to read this in a newspaper dated 1st January 2000, we would not be surprised. What is surprising is that the above is an actual report from the New York Times of 1st Jan 1901. It seems that the inhabitants of the 20th century are being short-changed with a 99-year version. How did this come about?

The trouble all started, this engaging book tells us, with Dennis the Short. This vertically-challenged 6th century monk was instructed by Pope St. John I to prepare a chronology. Western mathematics of the time had no concept of zero, so he began with Jan 1st AD 1. This conflicts with the idea that calendars, like babies, should be considered zero years old until their 1st anniversary.

On the basis of the Dennis chronology, logic dictates that centuries change between '00 and '01. However, common sensibility (*not* sense) favours the '99 to '00 change. (Here the author reminds us of our compulsive delight in observing car mileometers in the act of changing from 9999 to 10,000,say).

The debate over century transitions has long been waged, the first major hassle being at the 17c to 18c passage. The debate splits into two camps; high culture going for logic and pop culture going for common sensibility. As if all this were not enough there is good reason for saying the Millennium has already passed, around 1996. If Jesus and Herod overlapped, as the gospels have it, then Jesus must have been born in 4 BC or earlier, by Dennis's chronology!

Of particular interest to diallists is a chapter on calendrics, explaining how Western societies have tried to overcome the problems arising from the non-coincidence of Lunar and Solar 'years'.

Stephen Jay Gould predicts that there will be many books written about the Millennium. I will go further and say that of all of them 'Questioning the Millennium' will be the wittiest and the most informative.

John Moir

A DOZEN DIALS
Peter Ransom.
Pp56 £7.00 (obtainable from author, address below)

Sundial Oil, that magical liquid concocted by the late Noel Ta'Bois, must flow in Peter Ransom's veins. His enthusiasm, which shows in every page of this little book, caused his children (he tells us) to describe him as SAD: (Sundial-Active Dad). Peter is a Maths teacher, and the book is a compilation of short articles he originally wrote for the newsletters of the British Society for the History of Mathematics. Subjects include scratch, cross, analemmatic, horizontal and vertical dials, meridian lines, and Newton's sundials.

The book is cram full of historical facts, comments and musings, and continually invites its readers to participate by writing to the author if they can supply information missing from his own data-base. This is a great idea in that his future publications on the subject can be that much more comprehensive.

Do not be put off by the fact that this book is written by a Mathematician; here you will find nothing more frightening than some very elementary geometry and trigonometry. There are 56 pages, almost as many diagrams and photos, a useful bibliography and a comprehensive index, and it slips easily into the pocket. All this can be yours for a reasonable £7 inc. p & p, from Peter Ransom, 29 Rufus Close, Rownhams, Southampton, SO16 8LR,Great Britain.

John Moir
24 Woodcote Road, Wanstead, London,
E11 2QA

DIAL DEALINGS

MIKE COWHAM

The Summer months are times for getting out into the countryside in search of dials, (in spite of our poor Summer weather this year), but it has not been the time for dial hunting in the salerooms. Summer is usually the low season for Scientific Instrument Sales, so it is a good time to look at some of the dealers around the world who regularly offer dials for sale.

LONDON, ENGLAND.
Trevor Philip & Sons, of Jermyn Street carry a wide stock of fine scientific instruments. They always have a few interesting dials for the discerning collector. Trevor Waterman and his son Saf run the gallery and pride themselves on being able to find some of the finer and rarer instruments. Their stock includes pocket dials, garden dials - often on their pedestals, quadrants and sometimes dialling accessories.

Stuart Talbot has a small stand in the Portobello Market. He occasionally has dials, and if he knows of your particular interests he will look out for these for you. He also exhibits at the bi-annual Scientific Instrument Fair in London.

Arthur Middleton of Covent Garden normally specialises in globes, but occasionally he has a dial or two. He can also be seen at the Scientific Instrument Fair.

For books on dialling, contact Rogers Turner Books of Greenwich, Rita Shenton of Twickenham or G.K. Hadfield of Derbyshire.

PARIS, FRANCE.
Librarie Alain Brieux at rue Jacob on the 'left bank' specialise in scientific and medical books. They also have a few fine instruments, often including a few dials, for sale. They publish an annual catalogue, mostly of books, but with a few instruments too. I note that in the 1998 edition they feature a Moroccan Planispheric Astrolabe, and an Islamic wooden quadrant. Alain Brieux was an expert on astrolabes, and since his untimely death a few years back, the business has been kept running by his widow Dominique.

A few other shops in this area of the 'left bank' often have dials for sale, so a good scout around is recommended.

Another possible place for to hunt for dials is in the Galleries du Louvre, just opposite the Louvre museum. This building houses many small antique shops, and even in the absence of dial, it makes for interesting browsing.

Bertrand Thiébault has a small shop in the Marché Biron, part of the famous flea market adjacent to Port Clignancourt. Although just a tiny shop, there are usually a few dials amongst his range of scientific instruments. At my last visit in March, his stock included a fine oval silver dial by 'Cremsdorff à Paris', a couple of standard pattern Augsburg dials and a French 19C wooden pillar dial. If you don't want to go all the way to Paris to see him, he normally takes a stand at the Scientific Instrument Fair in London.

A visit to the flea market is a great but tiring way to spend a day. There are many bargains to be found, and some wonderful 'junk' to be picked over, but there are also many objects of dubious quality, so caveat emptor! Finally keep a close hand on your bags and wallets as the area does get very crowded.

NEW YORK, USA.

Tesseract of Hastings on Hudson are worth contacting. They have a regular stand at the Scientific Instrument Fair, and can be relied on to have at least a couple of rare dials. David and Yola Coffeen also produce a well illustrated Catalog four times each year. It costs $7, but is free to regular customers. A quick skip through their Summer 1998 Catalog shows a fine ring dial by 'John Worgan', (see the last issue of Dial Dealings), a French 'watch case sundial', an early low latitude dial signed by 'Henricus Sutton, Londini fecit 1661', a magnetic compass dial in an ivory case by 'S. Porter', c1825, an early sundial c1700 - probably of German origin, an oval silver Butterfield dial and a dialling compendium/rule. The rule is sufficiently rare that a full description is warranted. I quote verbatim from the Tesseract Catalog.

"SOPHISTICATED DIALLING COMPENDIUM COMBINING MINIATURE QUADRANT/SQUARE, GRAPHICAL RELATIONSHIPS, AND SERLE'S UNIVERSAL RULE, English, third quarter 17th century. This unsigned brass rule is 9-7/16" x 1-5/8", with one bevelled edge and pierced with two holes for using a small plumb line with the quadrant or the shadow square. The front face is finely hand divided and engraved with seven scales (Hour, Incl., Latt., Pol., Cho., etc.) just as specified by George Serle in his Dialling Universal of 1657." [Ref.1]

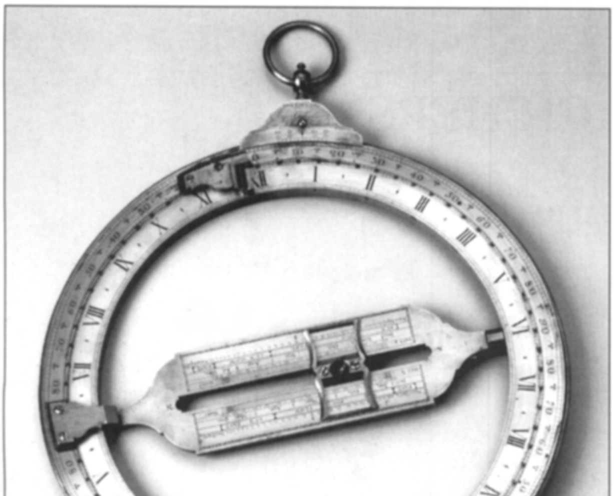


Fig.1. A fine ring dial by G. Adams sold by Trevor Philip & Sons.

Fig.2. A rare altitude dial, c1700, sold by Trevor Philip & Sons.

"They permitted a sundial maker to lay out the correct hour lines "on all sorts of Planes whatsoever, and in any Latitude."

A small (1-1/2" square) quadrant is placed beyond Serle's scales, and has an arc of a quarter circle divided every degree from 0° to 90° and back, plus a shadow square also divided by degrees. Placed within the open space of the quadrant is a fascinating graph (a remarkable early use of such, especially being engraved directly on a scientific instrument), apparently a plot of Hours (from 9 to 12 and back to 3), divided every quarter hour, as a function of latitude (from 34° to 56°, and thus covering most of Europe). The reverse is equally fascinating, finely engraved with an array of six graphs (Az:A, Az:B, Stil:Ver., Incl. Ver., Stil:Mer., and Incl. Mer., each versus latitude from 50° to 56° only, thus covering in depth all of England plus southern Scotland), plus six scales (Si, Se, Eq, Ta, -, and F:C). Two other examples of this compendium rule are known, both signed by Walter Hayes, both in museum collections.

The rule is important not only for its sophisticated mathematics and rarity as one of the few known tools used to layout sundials throughout the land, but also for its remarkable presentation of the variables, allowing one to read out by direct interpolation the many aspects of sundial geometry for one's locale".

GENEVA, SWITZERLAND.

Antiquités Scientifiques run by Marc-André and Marylyse Perret may be found in the old quarter of Geneva. They carry a wide range of scientific instruments which normally

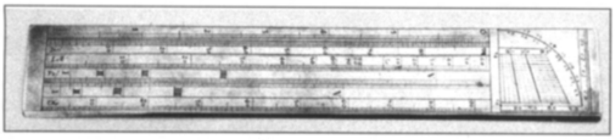


Fig.3. Brass dialling compendium/rule from Tesseract.

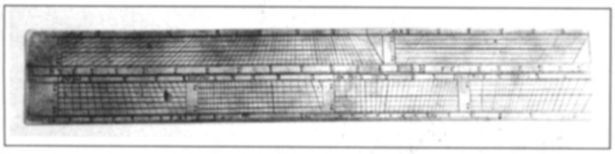


Fig.4. Reverse of rule from Tesseract.

includes a few dials. Their Spring 1998 Catalogue has a magnetic compass dial by T. Straight (usually spelt Staight) of London, a brass Butterfield and an Augsburg dial by Grassl. Their Catalogue is available bi-annually for Sfr15.

There are many other dealers around the world who occasionally carry good antique dials, but space here is limited. I therefore apologise to any who have been omitted, and promise to give them a mention in a future Dial Dealings if they would like to provide me with details of their stocks.

I would like to thank Trevor Philip & Sons and Tesseract for kindly supplying the photographs and some text for this article.

The dealers mentioned above may be found at the following addresses:-
Trevor Philip & Sons Ltd., 75a Jermyn Street, St. James's, London SW1Y 6NP.
Stuart Talbot, 65 Portobello Road, London W11.
Arthur Middleton, 12 New Row, Covent Garden, London WC2 4LF.
Rogers Turner Books, 23a Nelson Road, Greenwich, London SE10 9JB.
Rita Shenton, 142 Percy Road, Twickenham TW2 6JG.
G. K. Hadfield, Rock Farm, Chilcote, Swadlincote, Derbyshire DE12 8DQ.
Librarie Alain Brieux, 48 rue Jacob, 75006 Paris, France.
Bertrand Thiébault, 173 Marché Biron, 85 rue des Rosiers - 93400 St-Ouen, France.
Tesseract, Box 151, Hastings-on-Hudson, New York 10706, USA.
Antiquités Scientifiques, 19 rue du Perron, 1211 Genève 3, Switzerland.

FORTHCOMING SALES IN 1998.

Christies South Kensington.	17 December
Sotheby's	28 October
Phillips	15 September, 8 December
Bonhams	November
Scientific & Medical Instrument Fair.	The Radisson SAS Portman Hotel, Portman Square, London W1. Sunday 25 October 10:00 - 16:00

REFERENCES.

Ref.1. Dialling Universal by George Serle, 1657 or the 1995 reprint by the North American Sundial Society Press edited by Frederick W. Sawyer III.

CROSS-BEAM CIPHERS

KARLHEINZ SCHALDACH

INTRODUCTION

The sundial at St. Peter's church in Gelnhausen, Hesse, Germany, (see Fig. 1); the interest calculation tables written on wax tablets from the Nuremberg Castle, dated about 1425, and preserved at the *Municipal archives* (Stadtarchiv), (see Fig.2); the sundial on the wall of the church at Remsfeld, Hesse, (see Fig. 3); and the sundial on the church wall at Ober-Ofleiden, Hesse (see Fig. 4) all show us several variants of cross-beam ciphers. The most important types of the vertical variant are shown in Fig. 5. They all have one item in common: they put the emphasis on a mostly vertical stem with straight or curved lines branching off from it.

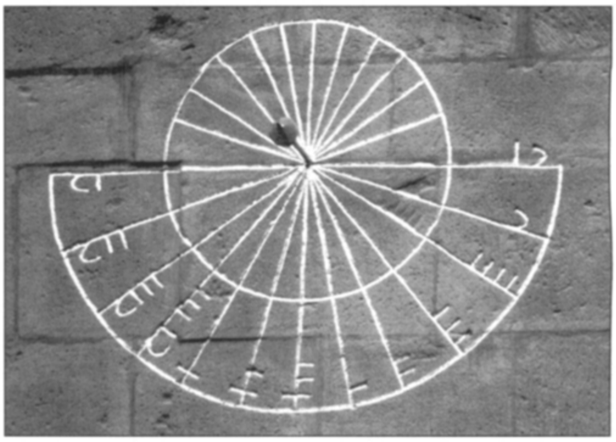


Fig. 1. Sundial on St. Peter's Church, Gelnhausen

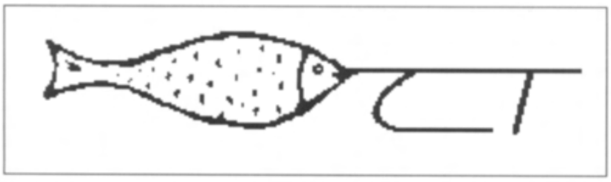


Fig. 2. Item from tablets for calculation of interest, Nuremberg

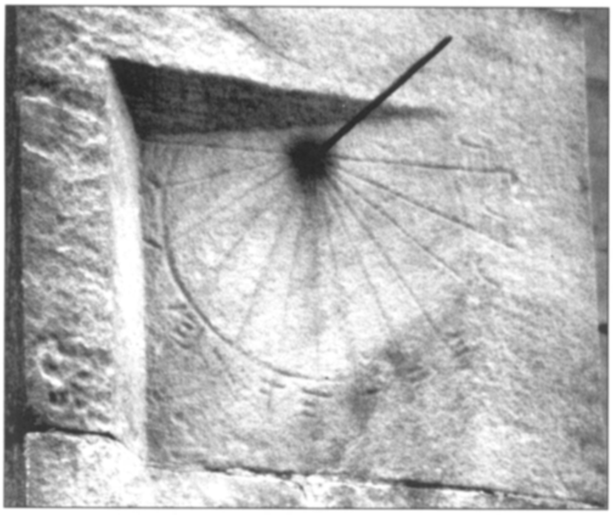


Fig. 3. Sundial on church in Remsfeld

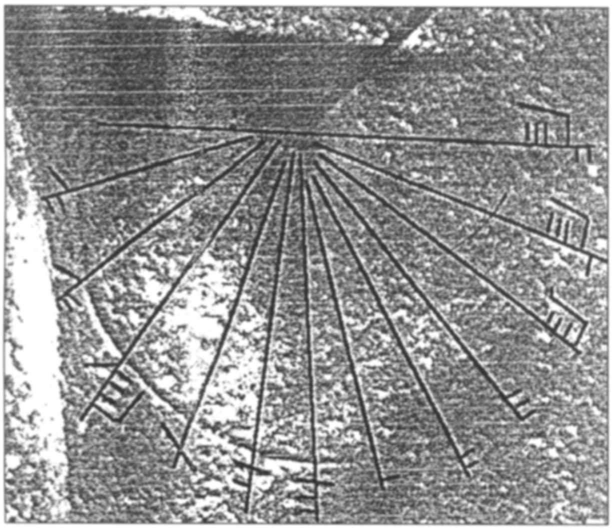


Fig. 3a. Sketch of Remsfeld Sundial

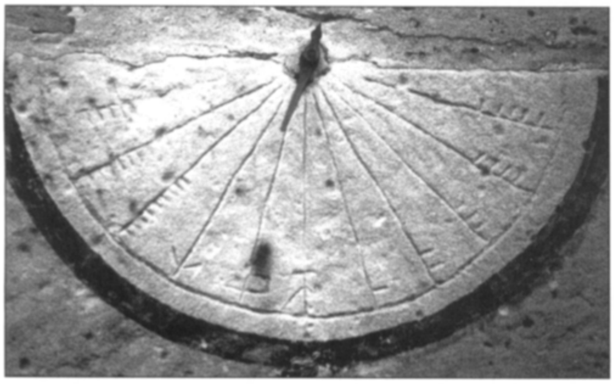
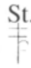


Fig. 4. Sundial on church at Ober-Ofleiden

This system of representing numbers may be continued beyond the number 12. Here are two examples. On a chalice dating from the end of the 15th century which, at the turn of our century, had been preserved in the church at Schnett, Thuringia, Germany, before it was made part of the war chest and was melted (probably around 1915), there was an inscription which, translated from the modern German equivalent, ran as follows:

For St. Oswald's church at Schnett this chalice was made for  *Schock* and its weight is IX *Mark* and III *Lot.*[1]

(*Schock* is an old and obsolete term for coins; *Mark* and *Lot* are weights.)

The title page of an incunabulum from the 15th century (see Fig. 6) shows a counting frame with a calculation scale and a supplementary cipher representing 100.[2]

In nearly all of the examples known to us there occurs a characteristic symbol: a hook for representing the numeral five. In the older sources the form of the curved hook is almost circular; there are, however, angular variants as well, reminding us of the Roman numeral five - these latter ones occurring chiefly on wooden calendars.

Another unique cipher is to be found among the numbers on the Remsfeld sundial. Besides a V-shaped cipher representing the numeral five, there occurs, mainly in the sequence of the afternoon hours, the cipher for four (see Fig.3a) - and, based on it, more hour numbers - represented by a numeral resembling our Arabic symbol for four.

This simple type of notation which, in an almost archaic form, also occurs on two sundials in Alsace (Fig. 7 shows the Marlenheim sundial), could be understood even by illiterates and therefore this notation was widespread: it has been found all over Northern and Central Europe between the 14th and the 16th century.

And thus it is all the more surprising that up to now these ciphers have been of only limited interest to researchers.

HISTORY OF RESEARCH

The German art historian Bickell was the first scholar to recognize the unusual character of these ciphers. In the context of the large sundial on the transept of St. Peter's at Gelnhausen, he wrote "The unusual way of rendering the hour numbers reminds one of *carpenters' numerals*. For the history of these tools - which were of some importance at least at the time of their instalment - a careful compilation [of texts and of pictures] of all older and otherwise curious

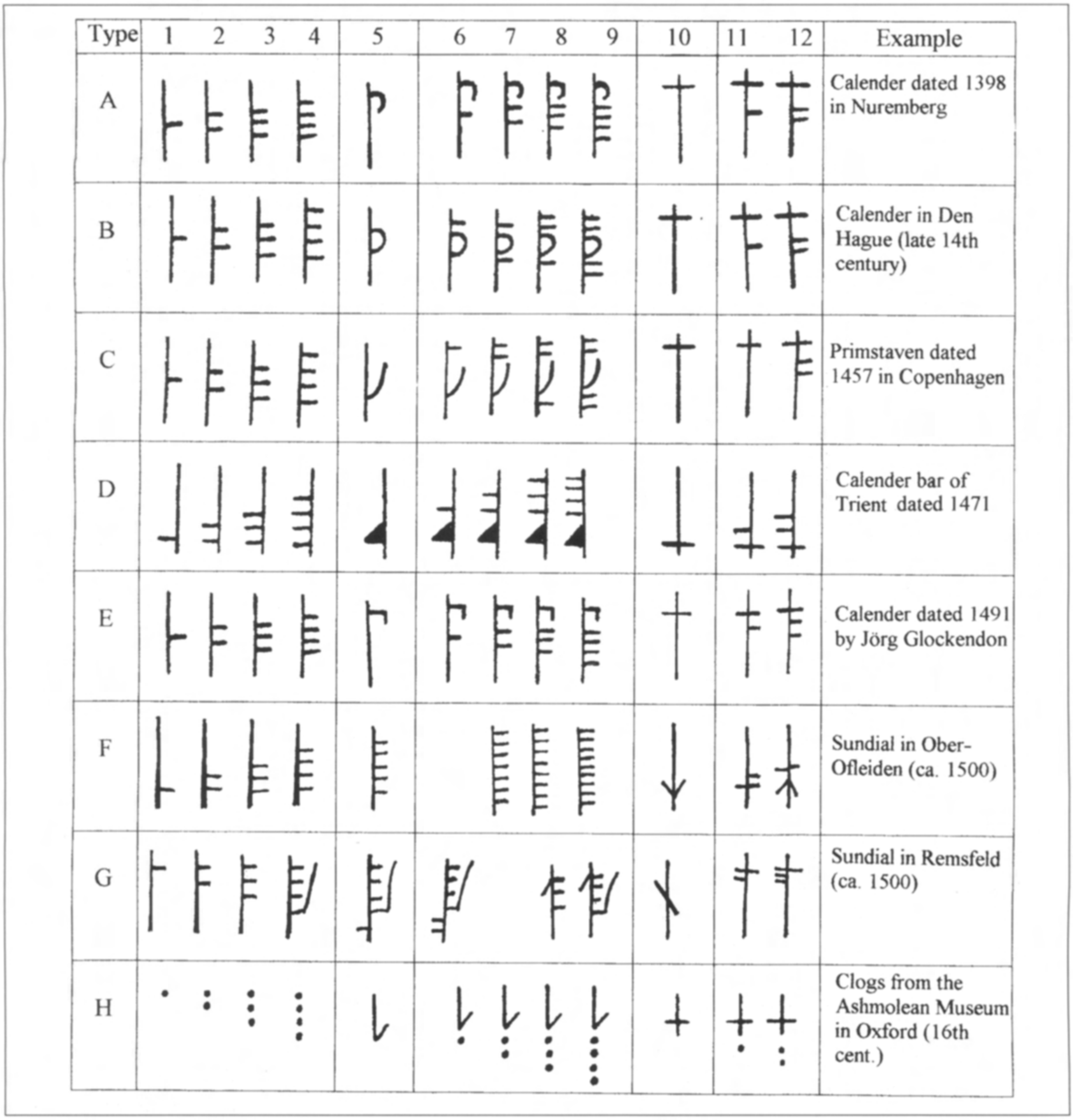


Fig. 5. Types of Cross-beam Ciphers

comparable pieces, which up to now have been only of little interest, would be highly recommendable."[3]

In 1935, the historian of astronomy Zinner visited Gelnhausen. He discovered Bickell's description of the sundials, and probably as a consequence of this discovery, he introduced the term of *carpenter's numerals* (Zimmermannszahlen) for this type of cipher.[4]

However, yet another scholar had been struck by these ciphers in a different context: Olaus Worm, the founder of scientific runology, found them on the *calendar bars* (runstaven) of his native Denmark.[5] Later on, they were also discovered on English, French, and German printed calendars and wooden calendars, and finally the conjecture was proffered that they'.... might have been invented for the very sake of being used in calendars and possibly were not used anywhere else'.(König; Heitz/Hoebler; Schnippel)[6]

False quoting and uncritical adoption of these ciphers led to their being called *Styrian ciphers* (steirische Zahlzeichen) on a calendar dated 1398 and written on parchment which is now preserved in the Germanisches Nationalmuseum in Nuremberg.[7] And it is under this label that they continued to be handed on in the literature.[8]

However, these ciphers have just as little to do with carpenters - as the term given to them by Zinner might

Fig. 6. Part of title-page of printed book of 15th century

suggest - as there is any connection between them and Styria. Evidence for this comes from a letter from the *Cultural Office* (Kulturamt) at Graz emphasizing that Styrian ciphers of this form are unknown. It is also stated that there was but one hint given by a cultural anthropologist, saying that the number 47 is called *Styrian number,* since this was, in former days, the number of the Graz lunatic asylum, and as such it had been used by the population of that town as a synonym of *mad.*

Neither is the term *farmer's numerals* ('Bauernzahlen') correct, as adopted by Menninger from Swiss cultural anthropologists.[9] At the beginning of the century, these researchers had discovered similar signs on old farm tools, part of which had still been in use in those days. The fact that these ciphers also occurred outside the limited area of agriculture was unknown at that epoch.

In the same way it is impossible to interpret an inscription on a stone plate found at Kensington (SE of Fargo, Minnesota, USA), and made by a mariner in the year , i. e. 1362 - under the assumption that the runic inscription is genuine - as a relic of rural culture and life style.[10] It is, however, very likely that this object is a 19th-century fake, and therefore we shall not deal with it in the following text.

Since the terms used so far are of little help for our matter, Weyss proposed to call them Holmzahlzeichen, *i. e. cross-beam ciphers.* One reason for this, he argues, is that the symbol for, say, eight, resembles the bar of a one-beam fire-ladder, provided with a hook to be hitched into the frame of an upper-floor window. Since up to now none of the historical sources gives a name to this cipher, I adopted this neutral term in two short studies on the occurrence of these ciphers.[11]

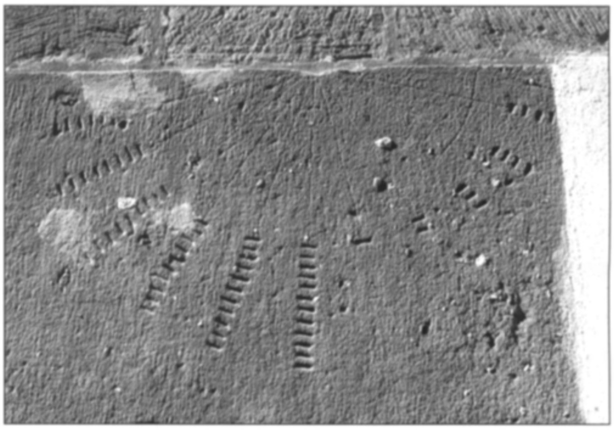


Fig. 7. Sundial at Marlenheim, Alsace

As to the sundials, nine pieces with cross-beam ciphers have been identified so far, mainly in Hesse and in Thuringia; (see Table 1 for a complete list). Without exception, their time of origin covers the epoch between *ca.*1450 and *ca.*1520.

Location and access
Castle Prösels near Völs (South Tyrol)
Crock (Thüringen), church
Gelnhausen (Hessen), St. Mary's church
Gelnhausen (Hessen), St. Peter's church
Homberg/Efze (Hessen), church
Ober-Ofleiden (Hessen), church
Schönebeck - Salzelman (Sachsen-Anhalt), church
Stelzen (Thüringen), church

Table 1

ORIGIN

In his study on the English calendar bars *(clogs),* Schnippel considered the shape of the cross-beam ciphers adapted to the carving technique as well as to their material, *i. e.* wood, and he maintained that the ciphers for five and for ten had been modelled, ... '..with a certain amount of good will,' on the Roman numerals V and X. Also Menninger, quoting from a scene of a *Shrovetide play* (Fastnachtsspiel) from Nuremberg, in which a ... '..number at a bar' is mentioned, took the vertical stem of the cross-beam ciphers to be ... '..the exact rendering of the old notched bar itself'. Following him, Ifrah[12] derives not only the cross-beam ciphers but even the Roman numerals from the *ciphers on notching bars* (Kerbholzzahlen) used by Dalmatian shepherds since times unknown as their common source, because their symbols ... 'for the numbers one, five, and ten were very similar to the Roman numerals I, V, and X as well as to the Etruscan numerals I, L, and X.

This theory seems to be plausible, but it leaves out of consideration an important point which contradicts this interpretation: In all of the older sources - as well as on the oldest known wooden calendar,. the Copenhagen *primstaven* dated 1457 - the hook representing the numeral five is always round. It is only on the later bar calendars as well as on the farmer's almanac that this hook becomes angular, most of these objects dating from the 16th century. Possibly this evidence is exclusively due to the lack of a reasonable amount of old source materials. There is, however, another possible explanation to this.

It seems as if the round variety of the hook was the result of a distinct tradition of craftsmanship, notwithstanding the fact that it was technically more difficult to notch this curved cipher on wood or to incise it on stone. It was only when this tradition subsided that one proceeded, according to the interpretation of Schnippel or Ifrah, to draw nearer to the Roman numeral V or, as in the case of the Remsfeld sundial mentioned above, to the Arabic numeral form of four.

Besides, there is something unsatisfactory about Menninger's explanation of the stem as a representation of the notching bar. It would have been easier to renounce at this stem altogether - as it was the case, later on, with the English *clogs*..

As an alternative, I therefore intend to put forward a new interpretation. The figure from the Augsburg incunabulum, the chalice from Schnett, and the interest tables on wax tablets from Nuremberg furnished me with the decisive evidence. These three examples have one point in common: There the cross-beam ciphers not only function to indicate the hours and serve as calendar numerals, but they are also used to indicate amounts of money.

Amounts of money, however, were calculated by means of counting frames called *abaci.* For this reason, lines were drawn on a table or a cloth on which calculations were carried out by means of small metal chips of no material value representing the numbers. Different basic patterns were employed for this calculation by lines. In our context we have to deal with the variant represented in Fig. 6. Imagine horizontal lines branching off from a vertical stem at one side of the abacus. The chips were put either on or between these lines, their value depending on the marks attached to the border line at certain relevant positions.

In general such a counting frame served for the execution of financial calculations,. above all addition (and subtraction) of sums (taxes, imposts) and the mutual conversion of different monetary denominations (hellers into pfennigs, into schillings, into pounds or into guldens). In our figure a man views a number representing 195. The striking point here is that numbers are rendered by groups of 30. The reason for this may be the fact that we are dealing with a conversion problem: from pfennigs into schillings, 30 pfennigs being equal to one schilling.

This would mean that a cross-beam cipher is nothing else than the border line of such a calculation frame in a condensed shape. These ciphers, then, would have made their way from calculating by lines (which was in common use all over Central Europe) to calendars and sundials. This would not only explain the sporadic occurrence of these ciphers, but would also give us a reason for their dispersal area: Cross-beam ciphers are found only in areas where calculating by lines was known - in Italy, for example, both were unknown.

CLASSIFICATION AND SYNOPSIS

Cross-beam ciphers are modified Roman numerals which arose, according to my theory, from a special variant of calculating by lines, and finally found their way to sundials and calendars.

So far, evidence can be detected for their use as numerals in calendars, as ciphers indicating the time of day, and for calculating amounts of money - putting down financial transactions - and this may serve us as a hint at their dependence on certain contexts. This and the fact that they were exclusively used by craftsmen and merchants (and in later times also by farmers) gives us an explanation why they do not appear in medieval mathematical texts, although those texts deal extensively with abstract numerals.

This narrow contextual dependence caused their falling into oblivion within a short time. Book printing as a new educational method and means of communication led to an enormous acceleration of the dispersal of the Arabic numerals. After the year 1500 this cipher script could maintain its position only in a few isolated cases such as in farmers' almanacs; relics of it could be found, however, on notching bars in the Swiss Alps at the beginning of our century.

ACKNOWLEDGEMENTS

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British Sundial Society

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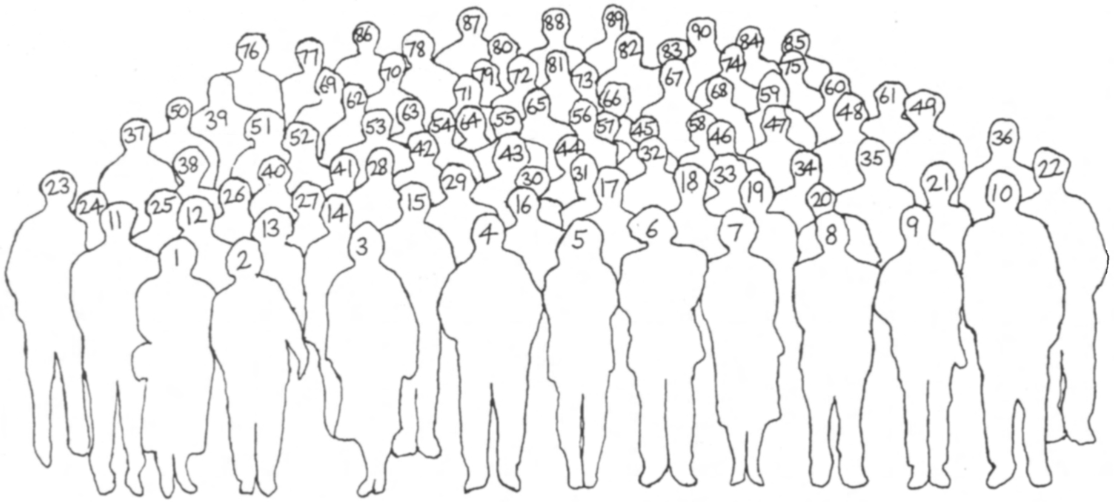

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3 Mary Isaacs, Berkshire
4 Mike Shaw, Merseyside
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6 Roger Bowling, Cheshire
7 Rosemary Kenn, Kent
8 Maurice Kenn, Kent
9 Mary Houseman, Cheshire
10 Roger Houseman, Cheshire
11 Doug Bateman, Berkshire
12 Walter Wells, Leicester
13 Mary Wells, Leicester
14 John Isaacs, Berkshire
15 Frank Evans, Tyne & Wear
16 Wilfrid Dukes, Suffolk
17 David Brown, Avon
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46 Gerald Stancey, Rutlandshire
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50 George Wyllie, Dumf & Gall
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