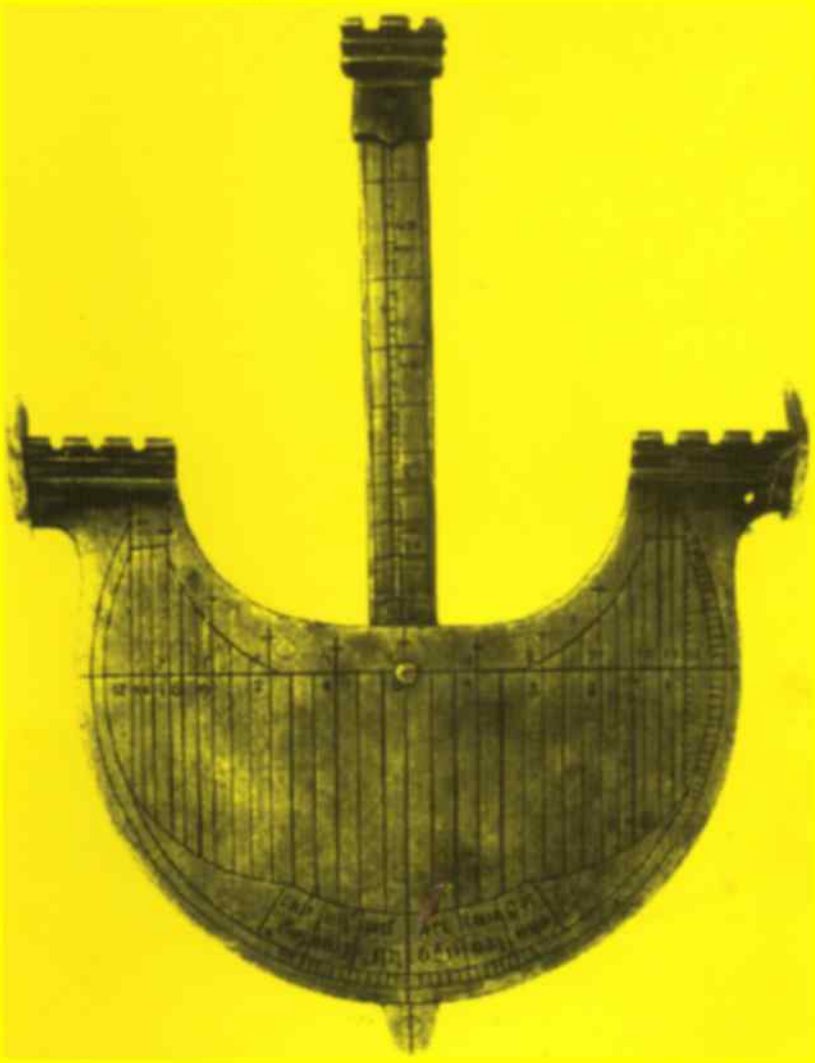
The British Sundial Society



BULLETIN

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Cover Illustration - See the article by John Moore commencing page 12.

René R.-J. Rohr

On 25th October, 1995 M. René R.-J. Rohr achieved the grand old age of 90 years. He received mention on the very first page of the very first British Sundial Society Bulletin when he honoured the new Society by becoming its first Vice-President, as is recorded by our first Chairman, Dr. Andrew R. Somerville.

Since our other Vice-President, Dr. Marinus R. Hagen, has already written an eulogy in respect of him for *De Zonnewijzerkring*, we can do no better than repeat it here:

> *We wish to congratulate M. Rohr and wife and wish them a festive day with their family.*

At the same time there is another festival, for in 1995 there appeared an article by M. Rohr in the periodical *La Chasseur Francais* - "The Time on Your Wall". That was the first text from his pen on the subject of sundials, and this was the digging of a well which has still not run dry. In the intervening forty years he has written a stream of articles and books on dialling in the English, French and German languages, and even a translation into Italian of his great book.

And not only sundials, his contributions are alternated with books about life at sea, his experience as Captain on great ocean voyages, and his adventures in the Arabic world. I cite only two here, *Palmiers, Sites at Archipels* and *Entre Mousson at Alizes (Peregrinations et Escales entre les Tropiques)*.

M. Rohr would recount things in an attractive way. When he gave a talk at a meeting, everyone was dead quiet and would listen with excitement.

In addition I have learnt much from his letters, a thick bundle of tiny sheets, very closely written in crabbed writing (originally in the old German script) so that it was necessary to use a lens to decipher it.

Many honours have been bestowed upon him. Among others he is an honorary member of our associated German Dialling Society - the Arbeitskreis Sonnenuhren. A few years ago he was given the Gold Medal of the Deutsche Gesellschaft für Chronometrie, in which the Arbeitskreis Sonnenuhren is included. On the founding of the British Sundial Society, he was invited to become Vice-President.

It was an honour for our Society (De Zonnewijzerkring) that he became a member shortly after it was founded, thereby greatly complementing our Bulletin (as he often did) -at that time the only periodical in the world devoted to sundials - to which he so splendidly contributed later, whereby our members sometimes had the prior mention of his ideas.

Our friend Rohr can look back on a rich and well spent life. We wish him and his dear wife Antoinette a good and blessed evening to it.

MARINUS HAGEN

☆ ☆ ☆ ☆ ☆

This eulogy is but a brief account of the fascinating life of M. Rohr. I have corresponded with him over many years and can confirm much of what is written by Dr. Hagen. I too have a large folder of his almost indecipherable letters, and had to type them out before I could read them! In turn he has done me the honour of binding my letters written to him. Alas, in spite of our best attempts, we have not managed to save the world from its follies, but M. Rohr's letters are always of great interest. I personally regard him, not for his age, but for his knowledge, as a pioneer and the doyen of the dialling world. It has been a very great privilege to have been able to correspond with him and his charming wife.

On behalf of the British Sundial Society members, thanks are expressed for his valuable and erudite articles which he has contributed to the BSS *Bulletin*, together with congratulations on reaching the magnificent age of 90 years, and the sincere hope that his day of festivity was a very happy one. Long may he and his charming wife Antoinette continue to prosper.

CHARLES K. AKED

DIALOGUE

DE ZONNEWIJZERKRING

An obituary on Dr Philipp of Freunde Alter Uhren is given describing some of his many achievements.

An article follows on "Hybrid" dials. These are derived from equatorial dials and analemmic dials where the gnomon is moved during the year. A number of calculations and diagrams are given as well as literary references. There is a note on terms used in the middle ages to denote compass directions in Holland which differ greatly from the present ones. Examples are given including the directions of the North Sea which lies to the west of the country and is called "north" and the Zuiderzee (south sea) was actually to the east. The suggestion is made that these terms may have been derived from comparison with a similar erection to Stonehenge somewhere in Holland, now lost.

An article on double hybrid dials begins with one that was formerly at Herstmonceux and is now at Cambridge. The scale is on a circle with equal divisions each of 15°. The circle has its lowest point to the south and is inclined for latitude. The vertical gnomon is moved according to the date. A horizontal gnomon can also be used but ires its own date scale. If the same date scale were it would need its own dial. The next item discussed alemmic dials based on a cube and provided with gnomons.

short description of a cross wire dial at Bogatell Barcelona is given where the east/west wire is in the of a parabola. A table gives important happenings ıe year "95" in each century relating to sundials or s. Attention is drawn to the same illustration of a al appearing in 1787, 1721 and 1669. There follows cussion on a model meridian indicator and on clock compared to sundial time together with the time at ocal meridian. Sundials used to tell the time by the ı as at Queens' College Cambridge are then ssed.

ıe list of sundials in the Netherlands in continued the review of literature includes the annual cation of Freunde Alter Uhren 1994 and the new list als in Germany and Switzerland published by the che Gesellschaft für Chronometrie. Bulletins of the ish and North American Sundial Societies are wed as well as other publications.

E.J. TYLER

A SUNDIAL SOIRÉE IN THE NORTH WEST

On Sunday evening, 5 February 1995, a small group of BSS enthusiasts gathered at the Higher Poynton, Cheshire, home of Anne Somerville to indulge in a discussion on dialling. With her usual hospitality Anne provided her visitors with a splendid table of refreshments to start the evening's serious business.

The session began with a detailed analysis by Graham Aldred of a Pilkington-Gibbs dial which he has recently restored. As a most sophisticated piece of early 20th century dialling equipment it was most interesting to learn not only about its constructional principles and mathematical secrets, but also to see pages from catalogues showing the range of sizes and designs which were available from its Preston-based manufacturers. Several of these instruments are still 'in situ' in the North West and are receiving Graham's kind attentions. The most recent of these is at Houghton Tower near Preston, whose owner wishes to have it working but does not want the green verdigris surface corrosion to be removed!

The second speaker was our host Anne, who presented and discussed a marvellous set of slides taken some years ago when she and her husband Andrew visited the famous observatories of Delhi and Jaipur in India, constructed early in the 18th century by Jai Singh II of Jaipur (1686-1743). The giant equatorial (or *equinoctial* - as our Chairman prefers!) dials, known as *Samrat Yantra* (at Delhi some 68 feet high and at Jaipur nearly 90 feet) were, perhaps, the most impressive of the various architectural and sculptural instruments seen, with which the West has nothing comparable to show at this early date. Some of the instruments were, indeed, at first sight difficult to understand in their astronomical complexity, but the chance to see them and the descriptions by Anne were unforgettable. Let us hope that a larger membership of the BSS might have a similar opportunity to see these photographs at some time in the future.

Finally Roger Bowling of Macclesfield got our minds into action on the problem of determining how a cube of dressed stone bearing three adjacent dials (gnomons missing) had been fitted on to a private 16th century house near Barnsley in Yorkshire, and what exactly its co-ordinates must have been. The house itself was presumed to have been built using stones from the nearby Monk Bretton Priory after its dissolution, and Roger intends, in due course, to restore the dial to its original (or supposed) position, and later to publish the details. Just how the dial was originally sited proved to be a knotty problem for which the assembled guests were unable to provide entirely satisfactory answers, though the top of a buttress or porch seemed to be the most logical solution.

On my journey home at the end of the evening I felt that this meeting had been one of the most enjoyable, interesting and informative sessions I have experienced since the BSS was formed. This was not surprising as it was in the home of our founder member Andrew Somerville, and our sincere thanks are due to Anne for her enterprise in making the arrangements for it.

ALAN SMITH

DR. -ING PHILIPP

A brief mention of the death of Dr. -Ing Philipp was made in on page 1 of BSS Bulletin 94.1 before details about him had been obtained. The following is a brief outline of his many dialling interests:

He was born in 1925 in Gräfenroda, Thuringia. He

served in the German army in the last war, was captured by the Russians and was in a prisoner of war camp for some time. After leaving the army he studied engineering in Darmstadt, later to become involved in measurement techniques.

He joined the Sundial Group of the Deutsche Gessellschaft für Chronometrie in 1982. By 1985 he was elected as Chairman of the Sundial Group. He introduced computer methods into dialling calculations and enlarged the interests of the group to include dials in East Germany and abroad. He wrote many articles on sundials which were published in many publications, and he also designed and constructed many dials in Germany.

His contributions to the subject of dialling were recognised by the Deutsche Gessellschaft for Chronometrie in 1993 by the award of their Gold Medal.

His name will always be associated with the Catalogue of Sundials in Germany and Switzerland which has been in preparation for many years and is one of the largest of such catalogues ever prepared.

His death occurred quite unexpectedly on 29th January 1995, just a few weeks after the publication of this monumental catalogue to which he had contributed so much of his knowledge and experience in dialling.

On behalf of the members of the British Sundial Society and BSS Council extends sincere condolences to Dr. Philipp's family.

E.J. TYLER

LA BUSCA DE PAPER

Bulletins numbers 17, 18 and 19 were received recently, these are all double numbers which contain sections of the on-going listing of dialling terms, pages 47-58, pages 59-70 and 71-82 in seven languages, mainly entries under "D", "E" and "F + part of H". When complete it will be a fine vocabulary, a really monumental work.

These latest Bulletins are the first not to include English summaries, and no one in the BSS has offered to translate the Catalan or Spanish texts.

Bulletin 17 deals with an article by Salvador Morató i Via about the dials of the Sol del Penedès. The first illustration is very dark but the base of a round pillar can just be distinguished which is cut obliquely at an angle appropriate for the latitude. Four more (and clearer) illustrations show examples of dials in the region. The article contains a total of almost one page of sundial mottoes.

Bulletin 18 contains two articles. The first is the Solar Clock at La Placa de Sant Jordi at Matadepera and deals with the project and construction. It is a very large public dial sited at Latitude 41°36'13"N and Longitude 2·01°01'38"E. The plaza in which it is place is 57·50 metres in length and 24·00 metres in width. A large line diagram gives an example of how to read the hour lines and calendar indications. The gnomon has the appearance of a very large tail fin of an aircraft. The whole assembly must look very impressive and is reminiscent of the Guernsey monument to celebrate the freeing of the Channel Islands from the German occupying forces, unveiled this year in the Channel Islands. Five illustrations and two line diagrams complement the text.

The second article is the mention of a book Curiositats del Port de Palma de Mallorca, by Rafael Soler i Gayà, chapter 6 of which is dedicated to sundials. Brief details are given of about six examples, two of which are illustrated. The Editor does not trust his translating abilities to be able to give precise details of these sundials.

Bulletin 19 is mainly devoted to the large bifilar sundial at Bogatell (which is to the north of Barcelona. The metal parts are of stainless steel and rest on a base 6·8 metres in diameter. The calculations for the two wires are shown in full. The method of reading the hours is given, with an illustration.

A book review is included - Els Rellotges de Sol, author Miguel Gil i Bonancia, Girina, 1991. It contains 66 photographs of sundials, with 498 described, giving location, state of preservation, and other details.

If there are any errors in this review, these are caused by the lack of knowledge of the Catalan and Spanish languages by the Editor, and the loss of the English summaries from the publication.

More details of the Catalan Society can be obtained from:
Societat Catalana de Gnomònica. Centre d'Estudis del Rellotge de Sol, Carrer Atenes núm. 3, 08006 BARCELONA, SPAIN.

ABOUT TIME

This small but well-conceived exhibition was held at the Sainsbury Centre for Visual Arts in the University of East Anglia, Norwich, from 5th June until 9th July 1995. It dealt with many aspects of Time in a limited amount of space, the exhibits ranging widely over geographical areas, cultures, and historical periods. Each item was chosen to make a particular point, so that the visitor could glimpse the surface of many topics without being overwhelmed by a wide diversity of objects.

The eye was caught on entry to the exhibition by a copy of the Aztec Calendar of 20 'months', each of 13 days. The calendar, used for rituals and predictions, was spread out on a long table, looking rather like a colourful strip-cartoon. Mounted on a wall nearby was a pair of meshed wooden cogwheels (visitors were invited to turn these) to illustrate the Chinese 'cyclical' conception of Time, as compared with the European 'linear' concept. The wheel with 12 zodiac animals being geared with the wheel of five 'elements' (earth, water, fire, wood and metal, so that the cycle of Time was repeated after each 60-year period.

Timekeeping on a shorter span was illustrated by a plaster cast of the Kirkdale Saxon Dial, an 18th century hour glass, and a ¼ scale working model of a clock built in the 14th century by Richard of Wallingford, Abbot of St. Albans: and also by a beautiful 18th century longcase clock by Page of Norwich. The practice of hourly-paid shift working originating with the Industrial Revolution was shown by a factory 'clocking-in' clock, with an 1872 Factory Notice setting out hours of work and the time allowed for meal breaks. The importance of accurate time-keeping was shown by a fine photograph of Linford Christie winning the 100 metre race at the 1994 European

Games, as recorded by a Seiko watch reading in one-hundredths of a second.

The life of communities which have opted out of Time - the Amish and the Shakers - was indicated by a few artifacts and photographs. In another aspect of 'timelessness', collections of objects to be buried in an underground time-capsule made an eye-catching exhibit. Children visiting the exhibition were invited to select items for burying in such a time capsule.

A reminder of travelling time was given by a ship's chronometer and a railway time-table. Fictional time-travel was demonstrated by an assemblage of objects in a display case, including the book 2001, Space Odyssey, and Dr. Who's police telephone box. Nearby a display showed an equally fictitious activity, foretelling the future by a crystal ball, tarot cards, zodiac signs and palmistry.

In a darkened corner of the exhibition there was a continually running, (not infallibly) video 'collage'. Time-lapse photography and speeded-up playback entertained the viewer: snowdrops opened, fireweed petals curled back, and the flower turned to fruit and dispersed its seeds. Shipping in Dover Harbour rushed in and out, like traffic in Piccadilly Circus. Because of the scarcity of captions, the viewer was uncertain exactly what point was being made. A scan of the map of southern England from east to west was meant to illustrate the difference between solar noon and clock noon, but the numbers and letters of the captions at each longitude were badly designed and unclear to the point of unreadability. The omission of the video programme would not have been a great loss to the exhibition.

Dialling enthusiasts who visited the exhibition would have become aware just how circumscribed their interest in Time might be, merely the measurement of time in portions of days, not even months, years or centuries: and even then limited to daylight hours in sunshine. This thought-provoking exhibition must have helped to widen the conceptual span of the viewer in ideas of Time.

MARGARET STANIER

EDITOR: It is regretted that details of this exhibition were not received in time to inform BSS members so they could attend in person.

COMPENDIUM

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

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

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

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

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

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

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

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

THE AMBASSADORS

CHARLES K. AKED

FIGURE 1: *"The Ambassadors"* signed ioannes holbein pingebat 1533, hanging in Room 2 of the National Gallery, London. Inventory number 1314.

On a tour around the National Gallery in London, the variety of themes and presentations in the paintings on show is enough to give mental indigestion to all but the strongest of artistic intellects. Yet most of the marvellous two dimensional depictions are given no more than a passing glance, a painting has to be out of the ordinary in such a galaxy of treasures to compel the viewer to stand and contemplate it in minute detail. Such a painting is "The Ambassadors" by Hans Holbein, the Younger (see Fig 1); it is one of the few on view which includes objects familiar to the diallist. Before looking at these, and they may be read about in Peter Drinkwater's article "The Dialling Instruments depicted in Holbein's Painting ..." in Bulletin 94.1, pages 28-9, an outline of the painter himself, a brief history of the painting, and some of the secrets hidden in this enigmatic painting will, I hope, be of interest.

HANS HOLBEIN THE YOUNGER

He was born in the cultural city of Augsberg in 1497, which was then the foremost centre in the world for the production of all kinds of time-measuring instruments, including portable sundials. He became a pupil of his father, Hans Holbein the Elder, who was a painter of repute. The son rapidly developed his own style of painting once he had mastered the elements of his craft, and became independent. He worked in the Swiss city of Basle for some years but failed to obtain the commissions for which his talent was fitted. As a result of friendship with Desiderius Erasmus (the Dutch theologian, 1466-1536, who lived in Basle 1521-29), Holbein visited London in 1526 at the age of twenty-nine, carrying with him a letter of introduction to Sir Thomas More from Erasmus. who had resided at More's house from 1508-11. Through this influential person, Holbein secured commissions for painting portraits until his work became better known. Yet two years later Holbein returned to Basle, where he still failed to get the commissions he sought, and therefore, much disappointed, he returned to England in 1531.

By 1536 Holbein had obtained the position of Court Painter to King Henry VIII, who had a great regard for the painter's talents, and referred to him as Mr. "Haunce" (Hans). By this time at the height of his powers, Holbein was painting English dignitaries, German merchants of the Steelyard (1), and producing the great series of drawings now preserved in Windsor Castle. Alas a great deal of his work such as the great murals at Basle, the great fresco

showing King Henry VIII with his father and mother, which was in the Palace of Whitehall, and other great masterpieces, have been destroyed by neglect and fire. Many of his portraits are now abroad and lost to England for ever.

Holbein had little time left. for in 1543 one of the minor recurring visitations of the Black Death resulted in his death at the early age of 46 years. He painted until the very end until he could no longer hold a brush.

The present subject - "The Ambassadors" - was painted in 1533 when Holbein was the best portrait painter of the period.

THE AMBASSADORS

This painting demonstrates the excellence of Holbein's draughtsmanship and if one looks through a pinhole at a coloured reproduction of the painting, it is as though one is looking at a photographic reproduction, so faithful is the use of perspective. The care taken in reproducing the most trivial object is meticulous and because of this, the painting can be examined to reveal all kinds of detail which are quite remarkable. But within this context of obvious truths, allegories are included which are clear only to those with a classical education and a profound knowledge of the contemporary events of the time. The arrangement of the various objects forms part of a grand design which is meaningless to the casual observer. Even for the most informed modern viewer, there are aspects which cannot now be interpreted, for the meanings are lost in the past. As an example, look at the object at the centre lower part of the painting which has a vague resemblance to a fish. What this peculiar object is will be revealed later but it took many years to unravel the clearly obvious.

A brief history of the painting will now be given. It was commissioned by the man standing on the viewer's left and as he was a Frenchman with a diplomatic appointment, no doubt the painting was taken by him to France on the termination of his office in England. From 1533 until 1787, very little is known of the whereabouts of the painting, but it was in the collection of the French millionaire M. Nicholas Beujon and acquired by M. Lebrun when Beujon's collection was sold by his wife at auction in 1787.

Lebrun published a catalogue "Galerie des Peintres 1792", (Gallery of Painters 1792) in which he included an engraving of the painting with a short description - "L'estampe offre les portraits du MM de Selve et d'Avaux; l'un fut Ambassadeur a Venise, l'autre le fut dans le nord" (The engraving shows the portraits of Messires de Selve and d'Avaux, one being the Ambassador to Venice, the other in the north). In the same year it was acquired by an English art dealer resident in Paris, Mr. Buchanan. He kept it in his possession for the next sixteen years until he sold it to the second Earl of Radnor in 1808 for the then not inconsiderable sum of one thousand guineas (£1,050). It then crossed the English channel for the second time and remained in the Earl's family possession until 1890 when death duties forced the family to dispose of three paintings: 'Admiral Pulido Parejo' by Velasqez, the 'Nobleman' by Moroni, and 'The Ambassadors' by Holbein. The trio of paintings were bought for the sum of £55,000 (then about 200,000 dollars).

There had been a search for about eighty years for the exact identity of the two men in the painting, completely without success. The acquisition of the painting by the Nation proved to be a catalyst in the resolution of the long-standing mystery. There were several letters published in *The Times*, where many views were aired, but the identity of the two men defied disclosure until in 1895, Miss Mary Harvey, in glancing through an old copy of the *Revue de Champagne et Brie* dated 1888, noticed a reference to an item for sale in the catalogue of M. Saffroy, an antiquarian bookseller of Pre-Saint-Gervais.

The catalogue entry contained details of a seventeenth century parchment which contained a description of a painting of "Messsire Jean de Dinsville, Chevalier, Sieur de Polizy ... qui fut Ambassadeur en Angleterre pour le Roy Francois premier ez annees 1532 et 1533. Et aussi represente audict tableau Messire George de Selve, Evesque de Lavaur ... eux deux ayant recontre en Angleterre un excellent pienctre holandois l'employerent pour faire iceluy tableau". [M. Jean de Dintsville, Chevalier, Knight of Polisy .., who was Ambassador in England for King Francis I in the years 1532 and 1533. And represented also in the said picture is M. George de Selve, Bishop of Lavaur - these two having met in England, an excellent Dutch painter was employed to make this picture]. In spite of the long time since the item had first been offered for sale, Miss Hervey made enquiries which revealed that the parchment was still available and she purchased it after convincing herself that the parchment was a description of The Ambassadors painting.

The parchment was pronounced genuine by the experts in the British Museum and thus the mystery of the two men in the painting was brought to an end. Miss Hervey took her researches into France and in 1900 published a book entitled *Holbein's Ambassadors*, proving once and for all that the two men portrayed in The Ambassadors are indeed Jean de Dinteville (1504-1555) and George de Selves (1509-1541). Miss Hervey generously donated the parchment to the National Gallery, where it remains to this day.

Jean de Dinteville was the head of an ancient family of Polisy who, in the autumn of 1531 was sent to London on a confidential mission by the French King Francis I. He was still in England in 1533 to be present at the coronation festivities of Anne Boleyn and Henry VIII after their secret marriage, for which Henry was excommunicated by Pope Clement VII, resulting in the dissolution of the English monasteries, the breaking away from the Church of Rome after almost eight hundred years, and the monarch becoming Head of the Church in England, a state which still remains to this day. At this ceremony, which he attended in an official capacity, Dinteville rode with Archbishop Thomas Cranmer, then newly appointed Archbishop of Canterbury by Henry for carrying out the illegal (by Church Law) marriage ceremony.

The other man, George de Selve, equally came from an illustrious family, and was one of six brothers, five of whom acted as ambassadors. He was the son of Jean de Selve, Premier President of the *Parlement de Paris*, who had rendered great service to Francis I by arranging his release from captivity following the Battle of Pavia in 1525. In gratitude Francis I nominated the son George to the Bishopric of Lavaur, near Toulouse. The son was then only eighteen and could not be consecrated in his post until the age of twenty-five years by Canon Law, nor could he wear episcopal dress in 1533 when the painting was being executed. George de Selve remained in London on ambassadorial duties until 1540 when he was allowed to return home to Lavaur, probably because of recurring

illness. Never a strong man, he died in the following year at the early age of 32.

It would seem that Jean de Dinteville commissioned the painting by Holbein, since in the painting, prominence is given to him and his qualities.

DETAILS OF THE PAINTING

Imagine yourself standing inside the National Gallery, viewing the painting. First you can see it is a very large picture, it is approximately 208 cm square (82 inches). It is in excellent condition and painted upon ten oak sections joined together to make up the whole panel, one of the largest of Holbein's portrait paintings. This made it possible to reproduce the two men exactly life-sized, as with the objects in the foreground. The freshness and vigour of the painting after four and a half centuries is very striking.

To the writer's mind (although an artistic primitive), the painting does not make a unified whole, and George de Selve appears to have entered the picture on the right hand side of the viewer as an afterthought. On this basis, an analysis of the painting shown in Fig 1 will be made.

Take a suitably sized piece of dark paper or card and cover over the right-hand side of the illustration, or even just over George de Selve. The figure we see on the left in isolation is portrayed as a resplendent character in a black velvet cloak trimmed with ermine, covering a slashed doublet of vivid rose-red satin. His right hand holds the sheath of an elaborately engraved dagger, to which is attached an opulent gold and green tassel. His black cap is set a jaunty angle and carries a small badge of silver set in a gold surround, depicting a death's head or skull. His attitude is that of a man truly confident of his own power and position, a supreme extrovert. He appears poised ready to step out from the painting into the real world. At his breast he wears the Order of St. Michael, showing him to be a Frenchman, and we now know him as Jean de Dinteville.

If you now cover up the left-hand side of the painting, we are confronted with a very different impression, for the figure on the right is much more quietly dressed in a long gown of brocade lined with sable. He looks as though he would like to disappear from our gaze into the background. He carries no indication of his high office, for he merely holds a pair of gloves in his right hand. The attitude of the two men is almost that of master and servant than the equals and friends which history records them to have been. The man is of course, George de Selves, a brilliant classical scholar, and whose demeanour is that to be expected from a pious man of God.

And now to outline a few details which would take any student of this painting a very long time to discover and a great deal of research.

THE ANAMORPHIS

Across the lower centre of the painting is a mysterious grey-white shape to which the eye is constantly drawn and which no amount of study will enable the mind to resolve it into a meaningful object. It was not until 1873 that Dr. Woodward, in a letter to The Times, explained that it was a an anamorphis which was a very popular device with artists in Tudor times. This is a picture which appears distorted in a frontal view but which if viewed from the correct position and angle will resolve itself into meaningfulness.

To see this detail correctly in its true perspective, it is necessary to view the painting from the right-hand side at a slight angle to the plane of the picture and along the long axis of the mysterious object, see Fig 2. The correct point for the painting is at the intersection of a line joining the eyes of the two men extended to the right and the long axis of the anamorphis extended. A hole was usually cut into the frame of the picture to enable the correct viewing point to be easily located. This frame has been lost.

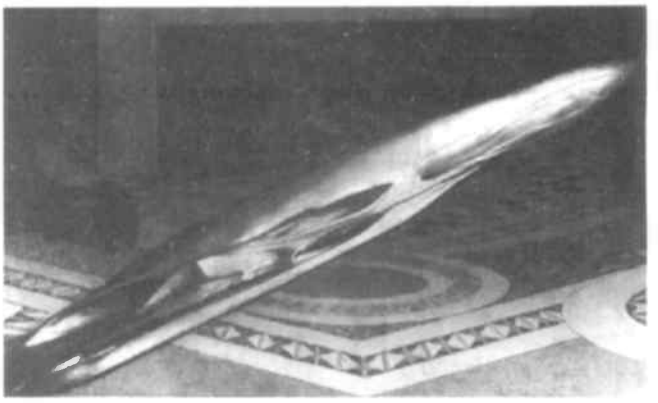

FIGURE 2: The mysterious object in the foreground of "The Ambassadors" - known as an Anamorphis, very popular in Tudor paintings.

Looking at Fig 2 usually causes a surprise because one is confronted by a rather unpleasant looking skull (don't ask me why one skull should look more unpleasant than another) see Fig 3. Thus the mysterious object turns out to be no more than a pun of the Death's Head symbol carried on de Dinteville's cap. This allegorical theme of life and death is continued in the silver crucifix almost hidden in the

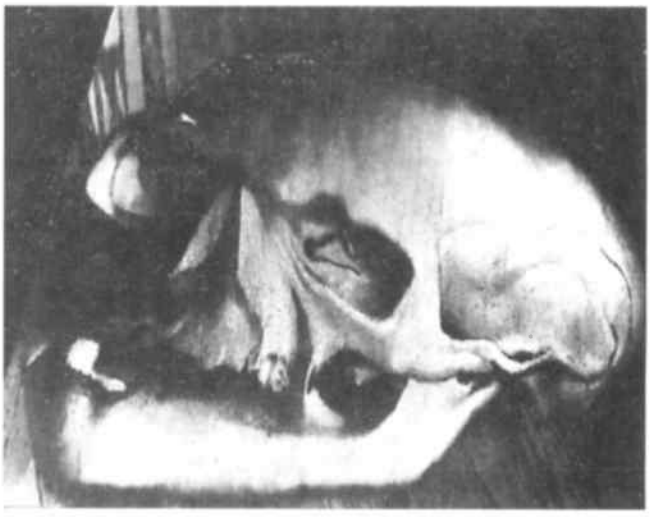

FIGURE 3: The Anamorphis seen from the viewing point which restores the correct perspective and reveals it to be a grotesque human skull.

folds of the green damask curtain just above the right shoulder of de Dinteville. It seems clear then that the painting is designed to illustrate de Dinteville's learning, his tastes, his attitude to life and eventual death. The objects placed on the two-tier table are intended to accentuate these points.

The table is a rather crudely constructed piece of furniture which stands on a mosaic floor depicted with such faithfulness that it is possible to identify it as similar to that of the Sanctuary of Westminster Abbey, which was laid by Italian workmen for Abbot Richard Ware in the thirteenth century.

THE INSTRUMENTS

These will be identified here for convenience and in reference to Fig 4, but for an amplified description and use of the sundials depicted here, consult P. Drinkwater's article in BSS Bulletin 94.1, pages 28-9. The rather primitive table is covered by a rich red Turkish carpet which were then only to be found in the possession of the very rich and in those days were either hung on walls or placed on tables, not in general use as floor coverings. The German connection is emphasised by swastikas in the pattern.

The upper tier carries its most prominent object on the left, a celestial globe of vivid light blue. It was made by the foremost artist of the period, the celebrated Peter Apian, Professor of Mathematics and Astronomy at Ingoldstadt in Bavaria. His globes were world-famous for beauty and accuracy. There are several star constellations to be seen depicted: Galacia - The Milky Way, Pegasus, Andromeda, Cepheus, etc. The bird with outspread wings is Gallina - the Hen. The globe is so realistically rendered that it could be a photographic reproduction, one can feel the globular surface.

The rest of the instruments on the upper tier are dialling or astronomical devices which will be referred to briefly only. Close to de Dinteville's left hand is a small portable sundial, a Shepherd or column dial, complete with its string to hold it in the vertical position for taking an observation, see Fig 8 for an example of the period.

Adjacent to this (see Fig 4) is a device termed the "Horarium Bilimbatum" or two-scaled dial similar to the one described in Peter Apian's *Instrument Book*, the movable arm carries the signs of the Zodiac and is used to sight a heavenly body. An attached plumb-bob can be seen on the right of the instrument to set it upright in use. But see Mr. Drinkwater's article for an analysis of this

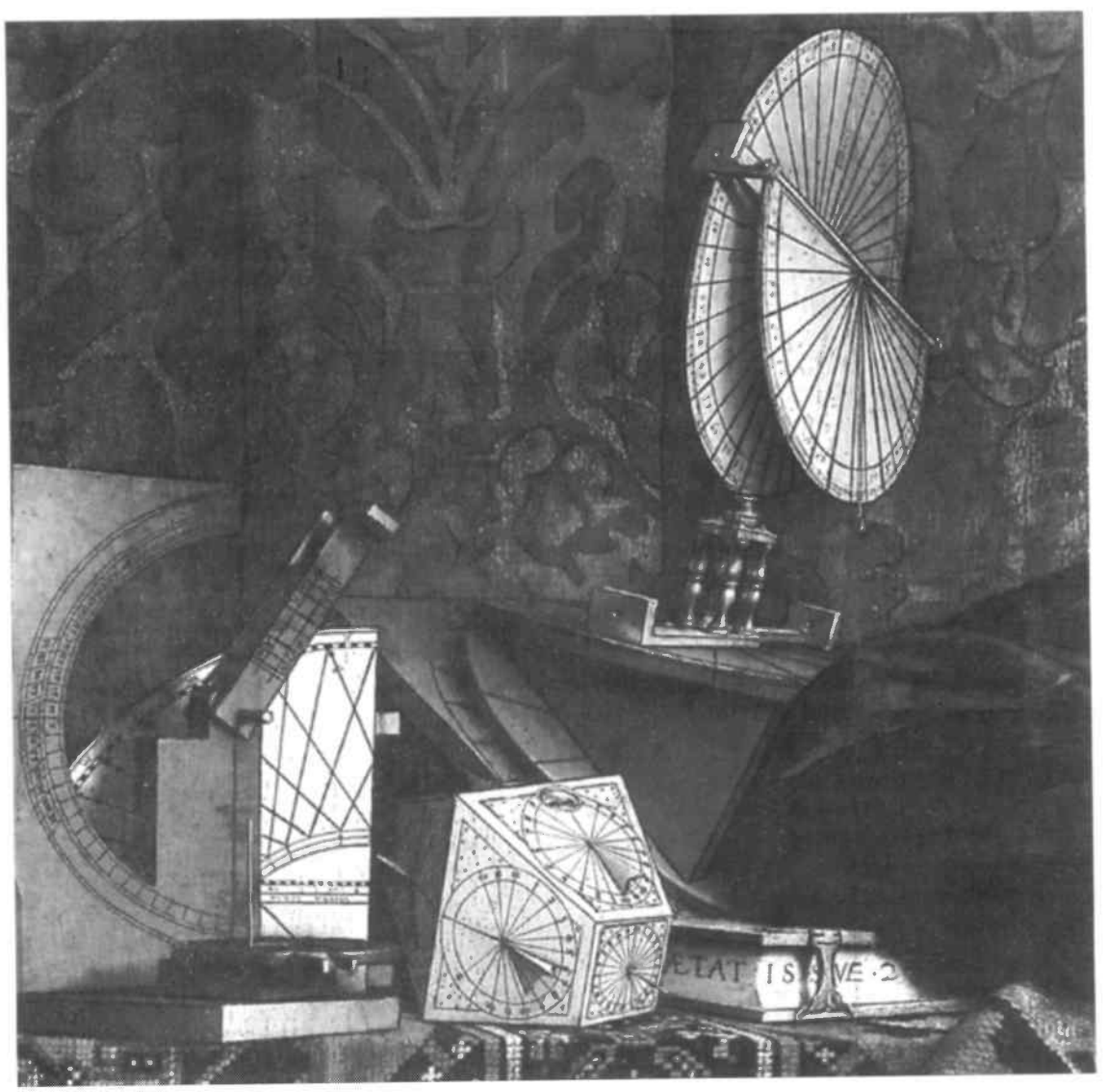

FIGURE 4: The Dialling and Astronomical Instruments included in "The Ambassadors"

instrument. Behind this instrument is a white painted quadrant (possibly card or paper pasted on a board) with straight hour lines.

To the right of this is a Torquetum which is very similar to the one Peter Apian's *Introduction Geographica* but more finely executed, see Fig 5. All the scales and figures are faithfully delineated in the painting. This instrument was used to record the position of any heavenly body by day or by night. It seems a clumsy structure, especially for use at night.

The remaining instrument in the foreground is a polyhedral sundial, all the hour lines being faithfully detailed. A magnetic compass is inset on the uppermost surface near the top edge. The needle of this compass indicates that North is to the left of the observer, it is approximately aligned to the top edge of the dial, hence the dial is not set up for use.

Turning now to the lower shelf of the table, in contrast to the astronomical and time measurement theme of the upper shelf, it is devoted to earthly things, including music and learning. Again there is a globe, this time a very fine terrestrial globe made by Johann Schoener of Nuremburg. Such is the detail that one can see the fine line drawn by the Borgia Pope Alexander VI dividing the Spanish and Portuguese possessions in the New World. Two little ships are shown near the Equator, one north, the other south of this line. On this globe can be found slight departures from the actual globe for Holbein has added several place names: *Leon*-Lyons, *Paris, Baien*-Bayonne, and Polisy, a hamlet in Burgundy, in deference to the commissioner of the painting - de Dinteville. These details were, however, not visible until the painting was cleaned for the first time in 1891 and the darkened varnish removed. No other country is named on the representation of the globe. Much of the writing is upside down on the globe, was the painting turned upside down to carry this aspect of the work out?

In front of the terrestrial globe is a partially opened book, the cover being propped open by a large wooden square. Because of the veracity of the painting, the exact page has been identified, the book being Peter Apian's work - *Well-grounded instruction in all Merchant's Arithmetic*. The other, fully opened-out book is the tenor part of the famous hymn-book published by Luther in 1524 in Wittenberg. On the left page is Luther's version of the "Veni Creator Spiritus", on the right hand page is his shortened version of the Ten Commandments, but here only the introduction is shown where he urges men's obedience - "Mensch Wiltu leben seliglich und bei Gott blibene". [Men should live happily and by God's rules]. Here the use of the German language instead of the more appropriate Latin has been suggested as indicating the schism between the Roman Catholic Church and the Lutheran Church in their beliefs, in which George de Selves was trying to heal the breach. Every note of the music is shown exactly.

In the background under and in the shadow of the lute, is a metal pair of dividers intended for measuring the distance between two points on the terrestrial globe. The lute itself is so convincingly painted, with the graduated shadows below making the body of the lute appear quite three-dimensional. One of the strings of the lute is broken (hard to see in a photograph). Miss Hervey suggested that this alludes to the breaking away of the Duke of Milan in 1533 from the League of Cognac formed in 1524 between

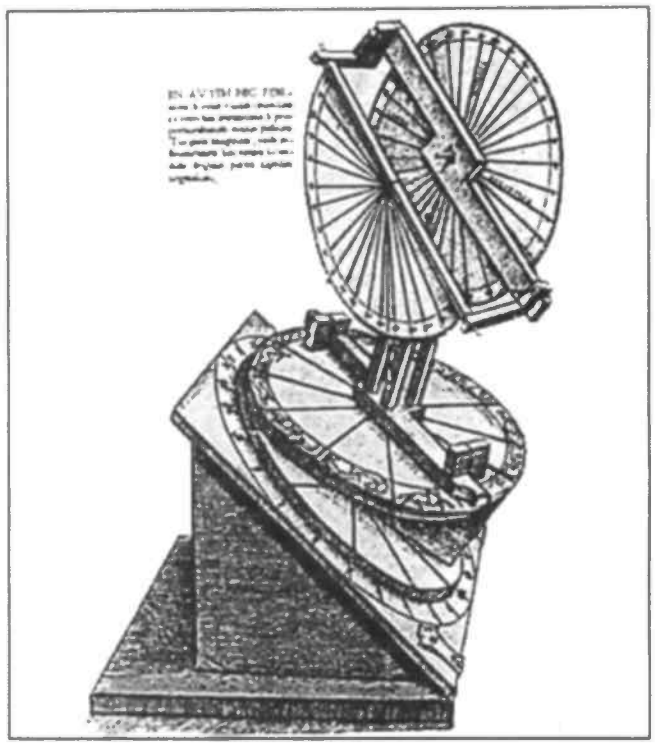

FIGURE 5: The Torquetum illustrated in Peter Apian's *Introduction Geographia*

England, France and the Italian Princes.

Andrea Alciatti, in his *Book of Emblems*, published in 1532 at Augsburg, chose a lute as the emblem of a treaty since it is an instrument of harmony or concord. But if one string breaks, the accord becomes discord. Again on the right of the lute is a case of flutes, where the harmony of the whole can only come from each individual playing his part correctly. Deep in the dark shadow under the table is the lute case, no doubt also having some meaning which is hidden as well as the object itself.

This foregoing description covers most of the objects visible in the painting although it is likely that the illustrations will not be good enough to allow the reader to see all these clearly. In the actual painting, the large size and colour contrasts make it much easier to see the details. No doubt those familiar with medieval fabrics and objects could add much more to the account given here. For example what does the letter "S" by de Dinteville's hand signify? Nothing shown by Holbein is without meaning, even the light from the hidden window to the upper right of de Selve is used to give a slight halo around his hat to emphasise his bishopric. The skull in the foreground also throws a substantial shadow from this source of illumination, yet there must also be another source of light coming almost from the front since de Dinteville's shadow falls behind him, although faintly. No shadow from this source is made by the skull, but whatever allegory is portrayed by this lack of shadow is not clear to the writer.

Finally, as far as the painting is concerned, the polyhedral dial indicates 09.30 am, see Fig 4. Of course with the dial not being orientated correctly this indicated time may be meaningless, but in the opinion of the writer, it had significance for the subjects of the painting. The date is given by the shadow on the column dial - April 11th, and the year by the signature at the base of the picture - Joannes Holbein Pingebat 1533. Thus the painting is intended to show an instant of time at 09.30 am on the 11th April 1533,

possibly in the Sanctuary of Westminster Abbey. This must have had some significance for the two men portrayed but the writer cannot find it.

A close inspection of the gold sheath of de Dinteville's dagger reveals that his age is given there - Aet Suæ 29 (close to his index finger), and on the unidentified book on which de Selve's elbow rather contrivedly rests, is his age - Aetatis suæ 25, the figure 5 almost lost in the shadow of the sleeve. Note that the leaves of the book can be distinguished.

Examination of other Holbein paintings reveals that a similar carpet to that in The Ambassadors was used elsewhere, as in an earlier portrait of Georg Gisze painted in 1532, where the same rose-red satin sleeves of de Dinteville are also shown. More importantly, in the portrait of Nicholas Kratzer, painted by Holbein in 1528 at the end of his first stay in England, and now in the Louvre, Paris; (see Fig 6) is shown the identical polyhedral sundial but not yet complete for it lacks gnomons, some hourlines and the magnetic compass. The same bilimbatum and column sundial rest on a shelf behind Kratzer's head. The object standing on the base of the bilimbatum in The Ambassadors was not identified until Peter Drinkwater solved the problem, but it is shown more clearly in the foreground in Kratzer's portrait and its intended use on the hinged arm of the bilimbatum made more obvious. The portrait of Georg Gisze is clearly based on the earlier painting of Kratzer, but utterly fails to repeat the singular sincerity clearly shining from Kratzer, and instead shows a rather furtive person. But then Kratzer was Holbein's bosom friend and he would wish to show him in a favourable light. As far as Holbein's patron, King Henry VIIIth was concerned, Kratzer's value for his diplomatic skills and his ability in relaying information from the German-speaking countries of Europe, rather over-shadowed his dialling abilities. This is evidenced by the small number of sundials from Kratzer, and there is not one single real masterpiece which one might have been expected from a diallist appointed by the King himself.

From the evidence of The Ambassadors and other Holbein paintings, see Fig 7 for another aspect of his work, the isolation of Holbein from any particular school of painting places him apart from the conventional painters of the time. We see from his paintings that he saw the scene in front of him as the modern camera does, reproducing all the things in view in the minutest detail, he was not a creative painter in conjuring scenes from his imagination although he could create allegories from simple juxtapositions of ordinary objects. No other painter of the period could show such exquisite detail over such a vast surface and convey the textures of the various materials. One can feel the pile of the carpet and the brocaded curtain, the hardness of the tiled floor, and so on; yet for all this technical mastery the painting lacks composition, the eye constantly strays around the four main areas of the painting, the two men in turn, the array of instruments and the anamorphis. It is impossible to take in the whole as one harmonious display because the observer's eye is constantly flitting from one object to another. If there is a focal point, it is the flamboyant figure of Jean de Dinteville. However we must be grateful for Holbein's meticulous rendering of the dialling instruments from Kratzer's hands, which puts flesh on to the spidery sketches included in Kratzer's own notebook. This record of dials is the best of those in the sixteenth century, especially in England.

FIGURE 6: Nicholas Kratzer by Hans Holbein, dated 1328, now in the Louvre, Paris

FIGURE 7: "Death carries off a Child". From Holbein's series *The Dance of Death*, designed by him but the woodcut executed by Hans Lützelburger c.1525

The next time you visit the National Gallery in Trafalgar Square, look at this great painting closely. Armed with the information in this article, it will give you a closer insight into the artist's intentions than is possible for one in a thousand of the ordinary dilettantes of the art world. Marvel how the artist has captured a brief moment of time of almost five hundred years ago, and demonstrated the state of the art of dialling in 1533 so clearly that you could replicate the instruments from the details shown.

And now, for a fuller understanding of these dialling instruments, consult the earlier articles written by Mr. Drinkwater, where he was the first to outline the use of the instrument with the hinged arm, with the unknown accessory resting on the base which was not even recognized as a scale belonging to the bilimbatum by former dialling experts.

There is a print of The Ambassadors available for purchase at the National Gallery, it is a beautiful reproduction of the original and much more convenient to hang in the modern home. The writer has bought many copies of this print over the years but has given them away as rapidly, in fact one of these now rests in the museum of the NAWCC in America. It is only recently that he achieved his ambition of actually placing one of these prints in a frame (the square picture is not easily accommodated in a standard frame). One can only say that it is a most striking adornment and fits in well with modern decor quite comfortably. Every diallist worthy of the name should have a copy of Holbein's painting on his walls as a gentle reminder that all earthly glory is as passing as the transient shadow on a sundial. Take the writer's advice and purchase the print just prior to leaving the Gallery, it is an awkward object to carry around and the Gallery attendants do not like anyone to be carrying things about within the exhibition galleries. There is also a transparency available but the quality of it is not as good as one taken directly by a camera. Photography is allowed in the National Gallery before opening hours but special permission must be obtained and strict conditions are imposed. It is best to make enquiries before making any plans to take your own photographs, and those available from the Reproductions Section of the National Gallery are probably superior to any you may take for yourself, and probably cheaper in the case of black and white prints. Authorisation to publish pictures, either from the National Gallery or your own, must be obtained from the Trustees, and a fee may be payable.

If any member has any thoughts on this painting, the writer would be glad to hear of them, for each person sees things in a different perspective. An article could written about each of the dialling instruments, for example the polyhedral sundial construction and hourline delineations seem rather strange with the magnetic compass positioned where it is, indicating that this particular face should be horizontal, whereas the small dial below would be of use only at the North Pole where it would have no utilitarian purpose whatsoever. For a more scientific analysis, please consult the article by Mr. Drinkwater in BSS Bulletin 93.2 pages 8-9, with a working drawing of the polyhedral dial on page 9. Here we have the dilemma that Holbein was an accurate delineator of the objects he painted, and Kratzer was supposed to be a leading diallist of his day. Holbein also wished to indicate the time of day, although in this respect he used his artist's licence to show this on an unaligned dial with no direct sunshine falling upon a plane which is misplaced from the horizontal. It would have been just as easy to have had the polyhedral sundial correctly orientated and aligned.

The photograph shown in Fig 4 is also shown by Frank Cousins in his work *Sundials*, 1969, page 107. Apart from the caption under the illustration, there is no other mention, similarly with the column sundial reproduced on page 168, the only reference is given in the name index under "Holbein".

Previously in this article it was mentioned that the magnetic compass indicated north to the left of the observer, but at the angle of tilt shown, it is unlikely that the needle would have the freedom to swing properly, and in fact is shown exactly as it would if levelled correctly, and therefore incorrectly. As the King of Siam said: "It's a puzzlement ...".

Holbein, from the evidence of other drawings and letters, was greatly interested in timekeeping. He also drew sundials of his own design, for examples see BSS *Bulletin* 94.1, page 13, although those shown are equinoctial half-dials to include a sundial in a restricted space, more ornamental than utilitarian. Therefore Holbein was familiar with the principles of dialling, and this conclusion is amply reinforced by the realistic reproduction of the devices such as the column dial (see Fig 8 for an example), quadrant, bilimbatum and torquetum. It takes close examination to see such things as "SODIACI" and "LINIA [ECLIPTICA]A" painted on the rear scale of the torquetum with only the "A" of ECLIPTICA visible, and only someone aware of their meaning would bother to reproduce these minutiæ knowing that not one person in a thousand will be able to see them or recognize the significance.

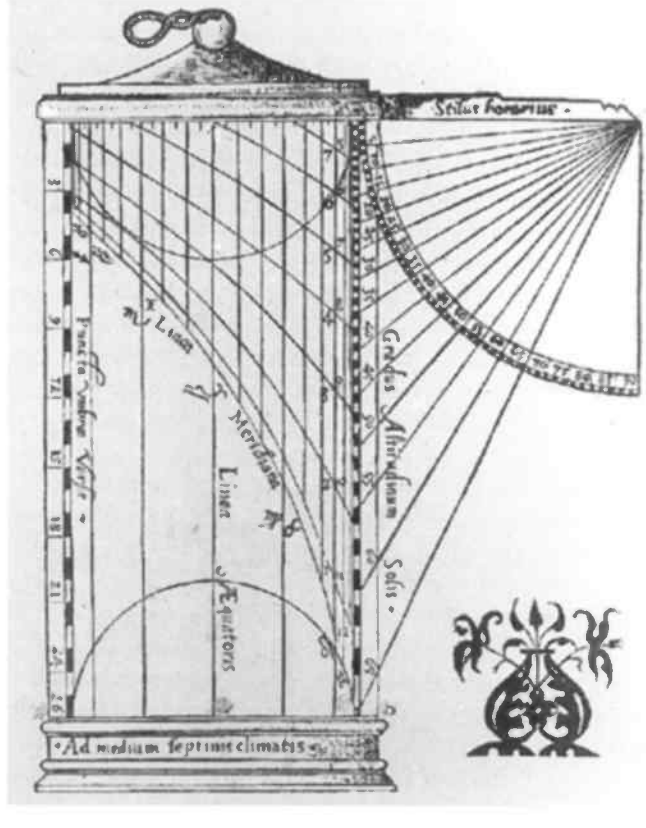

FIGURE 8: Column sundial depicted in *De Solaribus Horologiis* by Oronce Finé, 1560.

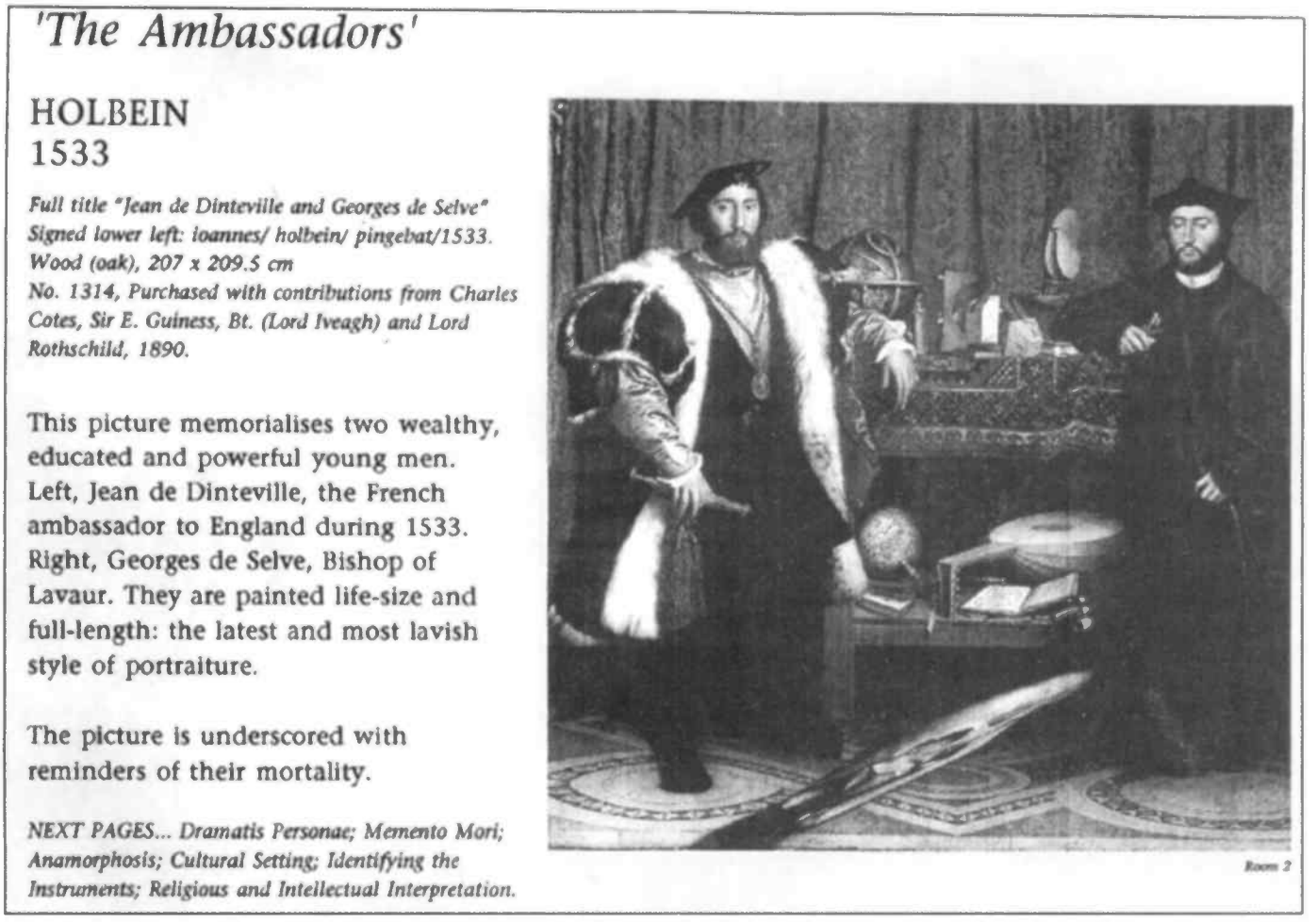

FIGURE 9: The first page of the sequence on "The Ambassadors" painting viewed on the monitor in the National Gallery, there is a touch screen facility which allows identification of individual items in the painting

Do not worry if you cannot see these details, it is unlikely that the illustrations provided here will be able to reproduce these faint outlines. And so it is in the National Gallery, the viewing distance of the actual painting to appreciate the whole scene is such that these details fade into insignificance. Nor is the ordinary visitor allowed to approach near enough to examine the painting more closely, more than one person has fallen over the guard cord, limiting the approach of the viewer, in his (or her) concentration of viewing.

In the Courtauld extension to the National Gallery are facilities for studying individual paintings on a screen in an individual booth, with means to select the parts of interest and take photocopies of the illustrations and texts at a low cost. There is a good treatment of The Ambassadors available and it is worthwhile spending an hour or so examining the information given, which will complement and expand that given here. See Fig 9 for the opening page of the sequence available on "The Ambassadors.

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1. The Steelyard was the name given to a community of foreign merchants, mostly German, who settled in London in the thirteenth century under the protection of Royal Charters. In 1579 all these rights were lost and on 4th August 1598, the German merchants were forced to leave London. Some of these German merchants were very rich and were able to commission portraits with the finest painters. Since Holbein was of Germanic origin, he became their favourite artist.

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SUNDIALS, Frank W. Cousins, published by John Baker, London, 1969. No reference is made in the text to either of the two photographs showing small sections of the painting. See pages 106 and 168.

THE AMBASSADORS, Alistair Smith. A pamphlet published by the National Gallery Publications Department, London 1974. (Acquired only after the writer had published his article in *Antiquarian Horology*, which would have saved him much time and effort).

PORTABLE DIALS - ALTITUDE AND CELESTIAL

JOHN MOORE

Many of the earlier forms of sundial used the sun's altitude to record the passage of time and season. The first and simplest altitude dials were no more complex than a stick in the ground. These recorded both the sun's position and its altitude. It must have been from the time of the earliest civilisations that man first realised that the altitude of the sun changed throughout the year, being low in winter and high in summer. The sun was also found to follow a regular pattern from year to year, and by knowing its altitude and the date, it was possible to deduce the time from the length of the stick's shadow as well as from the position of its shadow. For a fixed dial, on a public building or in a garden, an altitude dial was unnecessary, the sun's position giving the most convenient readout on a clock-like dial. It was when dials started to travel that altitude dials were most commonly made. One of the main problems in using a portable dial is the requirement to align it correctly to face south, or north in the southern hemisphere. Many were fitted with a magnetic compass to achieve this aim, but this was not always the most convenient device to use or keep in good order. In the pocket it had to be protected from damage by a glass or mica cover and was therefore somewhat fragile, bulky and likely to damage at some time. In the altitude dial, the direction of south was unimportant, as it would normally be found as a byproduct of setting the dial. It could therefore be made much more robust and was relatively simple to use. The original calibrations, however, were somewhat more difficult requiring not only hour lines but also date lines crossing them.

The Pillar Dial was perhaps the earliest to be found, followed by the Cup or Scaphe Dial. For use on board ship and for navigation the altitude dial was often preferred as it could also give the latitude of the observation, usually taken when the sun was at its zenith. For navigational purposes various forms of dial were produced over the centuries including the Cross Staff, the Backstaff or Jacobstaff, the Quadrant, the Mariners Astrolabe and the more complex Planispheric Astrolabe, plus Octants, Quintants and Sextants. Many of these instruments were used basically for measuring angles but that angle once found was readily converted into time by reference to the appropriate tables.

THE PILLAR DIAL

This was a compact, robust and easily carried portable dial. It was not designed to travel over great distances, being made for a fixed latitude. Figure 1 shows a simple French pillar dial in boxwood made around 1700. This has a thin brass folding gnomon that would be safely stored inside its hollow cylindrical body. In use, the top cap is pulled off and the gnomon is hinged out. To operate correctly, the gnomon must be positioned above the current date that may be found inscribed around its base. The dial would then be rotated until the sun's shadow was vertical, the correct time being indicated by the tip of the gnomon's shadow. As with all altitude dials, it is not possible to distinguish between the readings in the fore or the after noon and another reference is necessary to determine this fact. In addition to the hour lines, (these are the lines sloping down from left to right), there are vertical lines projecting from the calendar scale at 10 day intervals so that a fairly precise setting of date could be made. Once the summer solstice was reached the months would retrace the path of the first half of the year as a mirror image. Additionally symbols are given for the signs of the zodiac corresponding to the calendar scale. A further vertical scale shows the sun's altitude in degrees. In this example it reads from 0° to 65°. With suitable tables, this could also give the time at noon for any latitude.

Pillar dials were made from a wide range of materials but most commonly in wood, ivory or metal. Some of the finest to be found are in ivory with silver or silver gilt attachments. The design is not unique to any particular country, being found throughout Europe, and it was made over a long period of time, even into the twentieth century. Many of the later dials were made of wood with applied printed paper scales.

FIGURE 1: French Pillar Dial in Boxwood, c1700

FIGURE 2: German Perpetual Calendar in Silver

THE PERPETUAL CALENDAR

Although this is not a sundial in its own right, a very small number of them were made with a simple, fixed latitude, altitude dial. The silver perpetual Calendar in Figure 2 was made in Germany in the late 17th century. It is typical of many such calendars made throughout Europe at that period, mostly in Germany, France and the Low Countries. Its unusual feature is its altitude dial on one face. To find the time, the dial is supported by its suspension ring, with its sharp pin gnomon folded out at right angles. The arm supporting the gnomon is set against the current date on the left hand scale and the dial is carefully turned until the gnomon's shadow can be seen to pass across the hour scale on the right. It also carries a lunar volvelle in its centre with simple representations of the moon's four phases.

RING & POKE DIALS

These are also forms of altitude dials. The subject of these was separately covered in an earlier article in this series.[1]

REGIOMONTANUS, OR UNIVERSAL RECTILINEAR DIAL

This rather complicated dial is occasionally found, but due to its complexity, it did not seem to gain great popularity. Most extant examples come from Italy. Bion[2] shows the dial and describes its construction and its use (Figure 3). The triple jointed arm, shown to one side is normally pivoted from a convenient part of the dial plate, with its plumb line hanging vertically. It is a universal dial, capable of being used from the Equator to 60° North. In use, the tip of the arm where the line is joined, is positioned on the upper vee shaped section at a point agreeing with both the latitude and the current date. The dial is then tilted so that the bead on the cord crosses the Zodiac signs on the right hand edge, and is adjusted to the position of the correct one. The dial is now ready for use. The two sights on the top edge are used to line up with the sun, and the point where the bead hangs shows the time. This dial also incorporates a quadrant so that altitudes may be measured. To do this, the arm is positioned at the point crossed by both the 0° and 90° lines, on the upper right hand side.

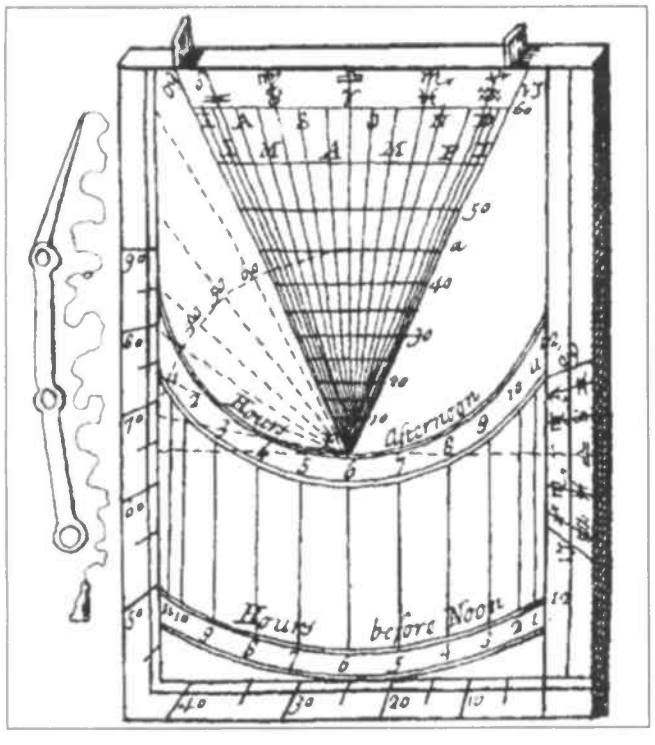

FIGURE 3: Regiomontanus Dial as describe by Bion

A simpler version of this dial, for a fixed Latitude is sometimes found. This has the cord suspended from an anchor point in an angular sliding slot, the position of which is calibrated for date. The bead hangs across an hour scale that is attractively curved, from a point on the left at midday to widely spread lines at sunrise and sunset on the right. The outline produced is similar to the head covering of a Capucine monk, and gives it the alternative name of Capucine dial. Between the lines correction must still be made for the date, although little error is introduced by ignoring this setting.

LITTLE SHIP OF VENICE, OR NAVICULA (NAVICULA DE VENETIIS)

These dials are particularly rare, with only three being known.[3] Their style of construction in the form of a sailing ship is particularly attractive (Figure 4). They were made in late Medieval times in England, this one between 1400 and 1450, their curved dial plates being extended to support the two sights. With the central arm vertical, the general shape is that of a ship, and their makers have added typical poop and forecastle ornamentation to complete the effect. In construction and operation they are very similar to the Regiomontanus dials already described. The mast of the ship is pivoted and the keel end is set against a date scale. The slider on the mast is set to a scale of latitude. From the slider, a cord would be suspended with a bead hanging over the horizontal hour scale below. The bead would be set to the angle of declination (or date) shown on the right hand side of the ship. This particular dial is marked on the reverse of the mast with five English towns and their Latitudes, from Wintonia 51°0', now Winchester to Eborac, 53°20' now York. On the reverse of this dial is a shadow square and curved lines of planetary hours.

SCAPHE DIALS

The Scaphe or Cup Dial is uncommonly found but its form dates from early Greek times. Some very beautiful Cup Dials are known, made of precious metals, and these are frequently formed like a chalice.[4] One immediate problem becomes evident with this type of dial. If the cup is much more than a shallow bowl, it is impossible for the sun's shadow to reach very far down into it, especially at northern European latitudes. This problem was ingeniously solved by making the dials function only whilst the cup is filled with water. A ray of light striking the surface of the water is refracted downwards illuminating the cup's interior to a much greater depth. In the centre of the cup is normally a vertical pin gnomon that throws its shadow on the inside of the bowl against the appropriately engraved scales. Some of these dials were also dials of direction with a compass sunk into the foot.

QUADRANTS

The Quadrant comes in many forms and will often carry a great deal of information. In its simplest form it is only a 90° segment of a circle marked with a scale of degrees from 0° to 90° around its circumference. A plumb bob is suspended from its apex so that when it is held with one edge aligned with a distant feature, the line hangs against the angle scale around its edge. The Gunther's or Horary Quadrant is the one most often found and of interest to horologists. It carries an hour scale and usually a flat representation of the night sky with certain prominent stars marked on it. Virtually all quadrants have the same 5 stars

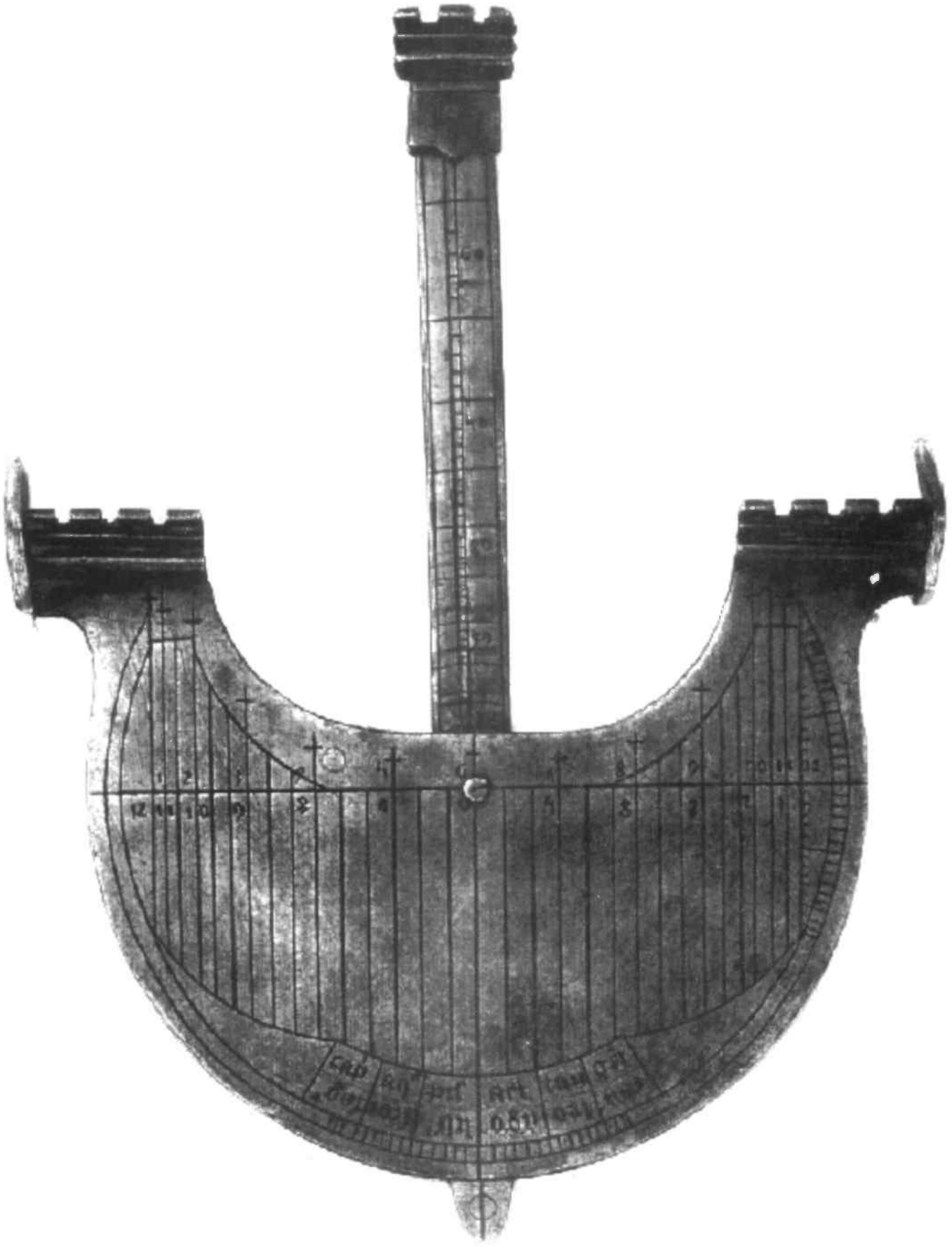

FIGURE 4: Little Ship of Venice or Navicula Dial - 15th century

marked, often with their latitudes tabulated. These are 'PW' = Pegasus Wing, 'Arc' = Arcturus, 'Lh' = Lions Heart, 'Be' = Bulls Eye and 'Vh' = Vultures Heart. The Quadrant is in effect similar to an astrolabe but with the whole night sky folded into just one 90° segment. Figure 5 shows a typical English boxwood quadrant of around 1750. Around its outer edge is the degree scale and on the right edge are two pin hole sights for accurate sighting of an object. It could therefore be used for measuring the altitudes of stars, the sun or even buildings and mountains. Even with these small pin hole sights, looking directly at the sun is a dangerous task with the risk of permanent eye damage. The Quadrant was therefore used in the hand so that the sun's light would shine through the first sight and project its small spot onto the lower one. With a steady hand this spot of light could be adjusted to fall exactly into the hole of the lower sight. At this moment the thumb would be used to press the line of the plumb bob against the scale to record the exact time by using a sliding bead already set to the correct date. The information carried on the astronomical scale seems at first sight rather complicated. Quadrants carry a representation of the ecliptic, that is the portion of the sky through which the sun travels throughout the year, being ±23.5° either side of the equator. The curved line from the top left to the bottom right is the sun's path from the Vernal Equinox, the first point of Aries, ♈, through to Midsummer and back to the Autumnal Equinox, ♎, followed by the smaller arc for the Winter months. Along the lengths of these two arcs are marked the appropriate zodiac signs. The plumb line from the apex point, missing in this example, is used for all measurements, either against its sliding bead or directly on the angular scale. When the Quadrant was used, the position of this bead would give the time by tracing its position along the nearest hour line to the Roman hour numerals marked at each end of it.

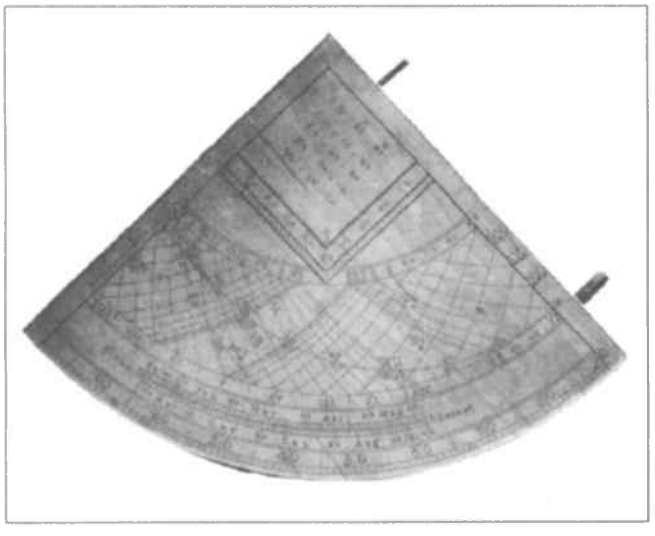

FIGURE 5: Typical English Boxwood Quadrant

A further scale is given just inside the degree scale. This is a calendar scale and could be used to check the altitude of the sun at noon. It tells us a lot about this Quadrant. It gives us an idea of its date by telling us that it conforms to the new Gregorian Calendar that was adopted in Britain in 1752. In this calendar, the Vernal Equinox is on 21st March and this is exactly opposite to the date of the Autumnal Equinox of September 23rd. If it had been the earlier Julian Calendar the dates would have been 11th March and the 13th September, although some small variations on these dates are sometimes to be found. It also tells us that this Quadrant was probably made for the latitude of London. This is found by drawing a radial line from the equinox at 21st March to the degree scale along its outer edge. This gives 38°30', being the co-latitude of 51°30', the figure usually quoted for London.

Another interesting scale often shown on Quadrants is the shadow square. This is the square nearest the apex, in this case calibrated from 0 to 50 in both directions. On others the calibration may be 0-10 or 0-100. It is used for finding the height of buildings, mountains, depths of wells or valleys etc. It works on the principle of triangles of proportion. Basically, if a reading were obtained on the horizontal scale of 40, the height of the object would be 50/40 of the distance from it. Similarly, a reading of 20 would give 50/20 times the distance. Allowance had to be made for the height of the observer in these calculations.

The other scales drawn on the Quadrant are mostly astronomical and are beyond the scope of this present article.

Most boxwood Quadrants are quite small, having a radius of around 5" (120mm). Larger Quadrants are sometimes found in observatories up to several feet in diameter but these are often fixed and used for precise astronomical observations. One boxwood Quadrant from the late 17th century, is known with a radius of 12½" (318mm). This is a most unusual Quadrant, being engraved not only with the usual scales and stars but with some ornate patterns and a beautiful image of a fish or eel in the bottom right hand corner. As with most Quadrants, it is unsigned, but, from its quality, it is made by one of the best instrument makers of its day. On its reverse is a volvelle engraved with a horizontal dial, but its original gnomon is missing. The inclusion of a sundial on the reverse of a Quadrant is not uncommon. Figure 6 shows an example in brass, c1700, where the sundial may be rotated within a 360° scale. This type of dial was probably used for surveying. Once the time was known from the quadrant on its reverse, this same time could be set on the shadow from the horizontal dial with one edge of the quadrant lined up with perhaps the edge of a building, thereby giving its precise angle with reference to true north. It could also be used for checking the angle of a building for setting up a vertical sundial. The gnomon of the horizontal dial supports a plumb bob allowing it to be set perfectly level. Some of these dials also carry a scale for the plumb bob so that it could be used over a small range of latitudes.

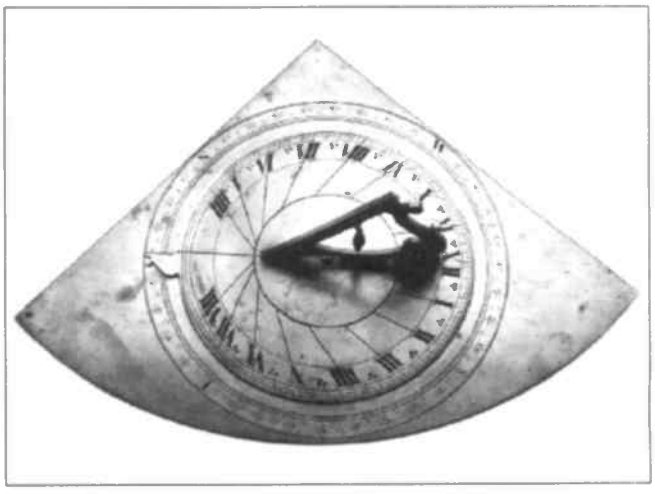

FIGURE 6: Large brass Quadrant with Sundial on its reverse

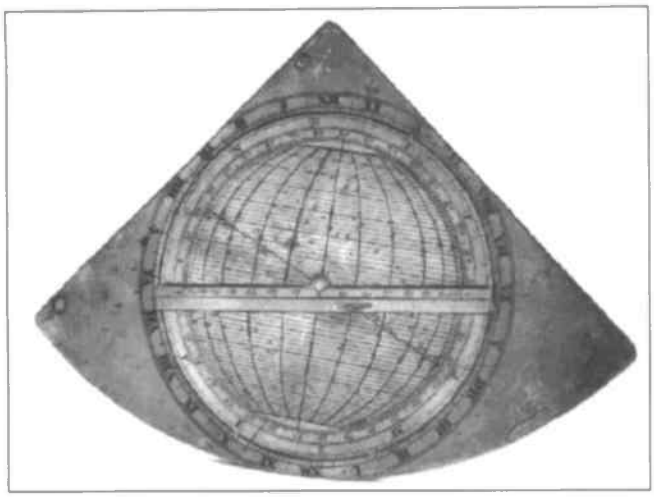

FIGURE 7: English Quadrant with Rojas Projection on its reverse

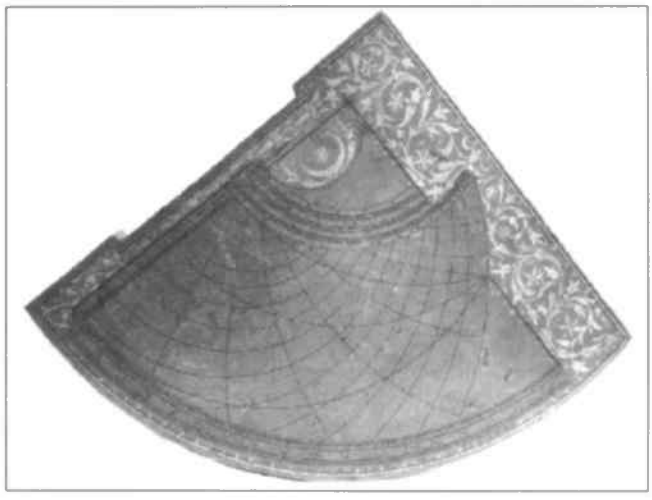

FIGURE 8: Islamic Quadrant, by Zuhdi

FIGURE 9: Islamic Astrolabe by Jajji Ali, c1795 A.D.

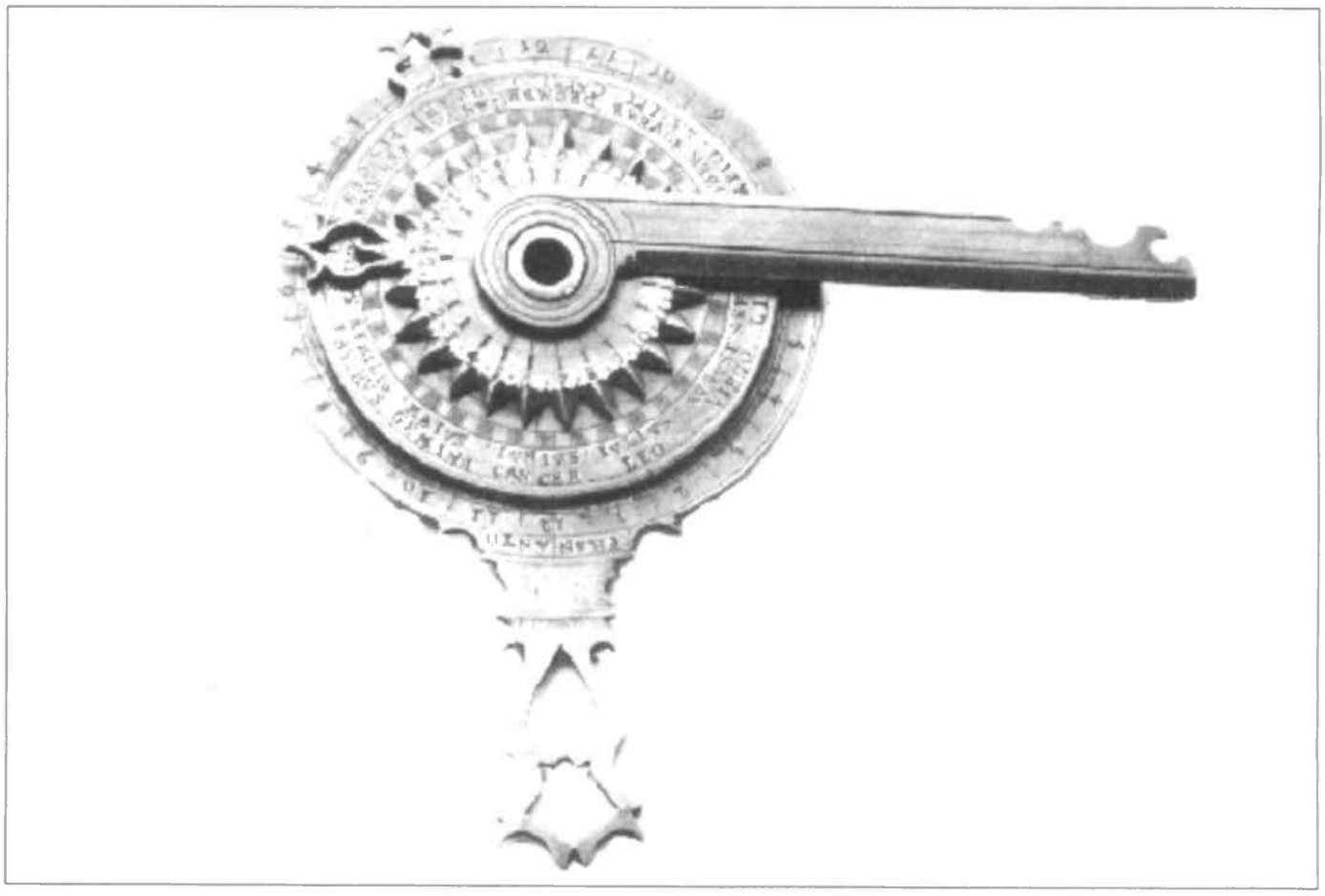

FIGURE 10: Brass Nocturnal by FRAN ANTO

Many Quadrants are plain on their reverse, but in addition to the occasional horizontal dial there is sometimes a volvelle with further astronomical information. Figure 7 shows a quadrant with a Rojas projection of the heavens on its reverse side. Again it is unsigned, but it is English and is very similar to Quadrants made by John Prujean of Oxford in the last years of the 17th century. In this Quadrant (and Prujean's), the stars depicted have been joined up to form the shapes of their constellations.

The Quadrant was also made in other countries for time telling and astronomical purposes. In particular the Arabs were very interested in astronomy and are known to have made many very fine instruments. The Quadrant in Figure 8 is of Arabic origin and was made by Zuhdî in the year A.H. 1294, (A.D. 1877/8). It is similar in many ways to the standard European Quadrant apart from its ornate gold decoration and of course the Arabic inscriptions. On its reverse is a scale of sines and cosines.

CROSS STAFF, BACKSTAFF AND MARINERS ASTROLABE

These are all mariners' instruments and were not normally used directly for time telling. They allowed not only the altitude of the sun to be taken on the rolling deck of a sailing ship but also altitudes of stars. They could even be used horizontally for taking angular measurements. Time could be found from their readings by reference to astronomical tables.

PLANISPHERIC ASTROLABE

This is undoubtedly the most attractive and yet mysterious instrument ever made. The earliest extant Astrolabes date from around 1100 and their manufacture was continued in Europe into the 17th century, and in India and Arab countries until the end of the 18th century. The Astrolabe is a very complex calculating instrument giving not only time measurements but altitudes, times of sunrise, sunset, twilight, day length and much more. Its great advantage was that it could be used both day and night to obtain exact time information. Astrolabes, especially those from Arab countries, were used much to provide astrological information. This was most important, especially for determination of religious festivals. Figure 9 shows a gilt brass Arabic Astrolabe made by Hajji Ali, 'his twentieth work', in Isfahan, Persia around 1795.

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1. J. Moore. Ring Dials. *Bulletin of British Sundial Society*. 94.2 June 1994.
2. M. Bion. *The Construction and Principal Uses of Mathematical Instruments.*
3. Three Navicula dials are known.
   a) Museum of the History of Science, Oxford.
   b) National Maritime Museum, Old Royal Observatory, Greenwich.
   c) Trevor Philip & Sons, Jermyn St., London.
4. F.A.B. Ward. *A Catalogue of European Scientific Instruments in . . . . The British Museum.*

EDITOR'S NOTE: A Navicula dial was in the Science Museum but has been "lost".

ACKNOWLEDGEMENTS

The Author would like to thank Trevor Philip & Sons for the photograph and information about the Navicula dial.

Continued from page 18

the pinhole) is one half of that subtended at the centre of the enclosing circle. Figure 2, taken from Hope-Jones' paper, has been verified and a scale bar added. It may therefore be copied at an appropriate size for a given ring - although I am willing to supply numerical data to any serious constructor enclosing an SAE. The origin of the curve is where the horizontal full line crosses the vertical full line joining March and September. If the scale is engraved on a separate piece of thin metal, this should subsequently be curved and secured to the inside of the ring with this origin positioned on the equatorial diameter and the December end towards the northern end of the axis. It will be noted that the width of the ring must be at least one fifth of its diameter to accommodate the analemma and numerals, with the names of the winter months placed inside the curve.

If construction is contemplated it might well be thought that, as accuracy is dependent on the size of the ring, the latter should be made larger in proportion to the clock-face than is shown in Figure 1. A ring 125 mm in internal diameter and 25 mm wide would seem about right for a table dial - but a wise craftsman makes a cardboard mock-up first!

NOTES AND REFERENCES

1. W.E. Cooke (1863-1947), in *Australian Dictionary of Biography,* edit. B. Nairn and G. Serle, Melbourne Univ. Press, 1981, Vol. 8, pp. 102-3.
2. F. Hope-Jones, 'The Sun-Clock', *J. Sci. Inst.* **2** (1924-25) 329-331.
3. D.W. Hughes, 'An Introduction to the Equation of Time', *Bull. Brit. Sundial Soc.,* 1993 No. 3, pp. 8-12.
4. A.A. Mills, 'More About the Equation of Time and the Analemma', *Bull. Brit. Sundial Soc.,* 1994 No. 1, pp. 30-31 & 40.
5. F.W. Counsins, *Sundials,* Baker, London, 1969. Plates on pp. 63, 65, 67 and 194.
6. P. Husty, *Zeit & Mass: Sonnenuhren und Wissenschaftliche Geräte,* Salzburger Museum C.A., 1994. Plate 4, p. 8.
7. It must be pointed out that because an instrument may be *read* to better than ± 1/2 minute, it does not necessarily follow that its *accuracy* is within the same limits. In the present case, taking into account the drift of the mean analemma with the leap year cycle, backlash in the gears, etc., an overall accuracy of ± 5 minutes of time would appear to be a realistic estimate. It would be hard to obtain the date to the day, especially in June and December.

Author's Address: Astronomy Group, The University, Leicester, LE1 7RM

THE COOKE HELIOCHRONOMETER AND PERPETUAL CALENDAR

ALLAN A. MILLS

Some time around 1910 Professor William E. Cooke, the Government Astronomer of New South Wales,[1] invented an ingenious sundial that gave directly both civil time and the date. He never published any account of this instrument himself but, fortunately, when Frank Hope-Jones (well known in connection with the Synchronome electric clock) obtained an example he was sufficiently impressed to send a short paper to the *Journal of Scientific Instruments*.[2] Nevertheless, as this periodical is not normally associated with sundials, and the note appeared when there was limited interest in the subject, Cooke's clever design remains virtually unknown - even though it was awarded a gold medal at Wembley Exhibition of 1924.[1] It is not known whether any example of the instrument still exists.

Figure 1: The Cooke heliochronometer

The illustration accompanying Hope-Jones' article is reproduced here as in Figure 1. A brass ring is pivoted upon an axis that may be adjusted to the latitude of the site so that it points at the celestial pole. At one end of the equatorial diameter of the ring is a small hole, well countersunk on the outside like that in a conventional ring dial. Opposite, on the inner surface of the ring, is engraved a projected analemma.[3,4] The elevated end of the ring-axis is extended through its supporting arc to engage with spur gears driving two hands over a conventional clock dial fixed to the same arc. Although there are antecedents in the history of dialling,[5,6] Cooke's design is a considerable simplification and there is no reason to believe it was not independent invention.

To determine the time of day (assuming the instrument has been correctly oriented and adjusted) all that is necessary is to carefully move the ring manually until the spot of sunlight projected by the pinhole falls upon the analemma. Its exact position along the curve then indicates the date, and simultaneously the 'clock' tells the time.[7] The equation of time is both allowed-for and utilised, while the longitude correction required to give civil time is set once and for all by initially adjusting the phase of the hands with respect to the position of the ring by means of a bush and setscrew.

Construction of this elegant sundial would appear well within the capabilities of many amateur horologists. There must be a 1:2 step-up gear between ring and hour hand, with an intermediate idler to produce the correct sense of rotation when the instrument is used in the northern hemisphere. The minute hand might then be driven by a 1:12 combination from the hour hand spindle. All the gears must be more robust than is usual in small clocks to withstand the toque to which they will be subjected.

CALCULATIONS

The projection of basic analemma[4,5] must take into account the fact that the distance from pinhole to scale is in general a chord of the ring. This calculation is eased if one remembers that the angle subtended by an arc of a circle at the diametrically opposite point on its circumference (i.e.

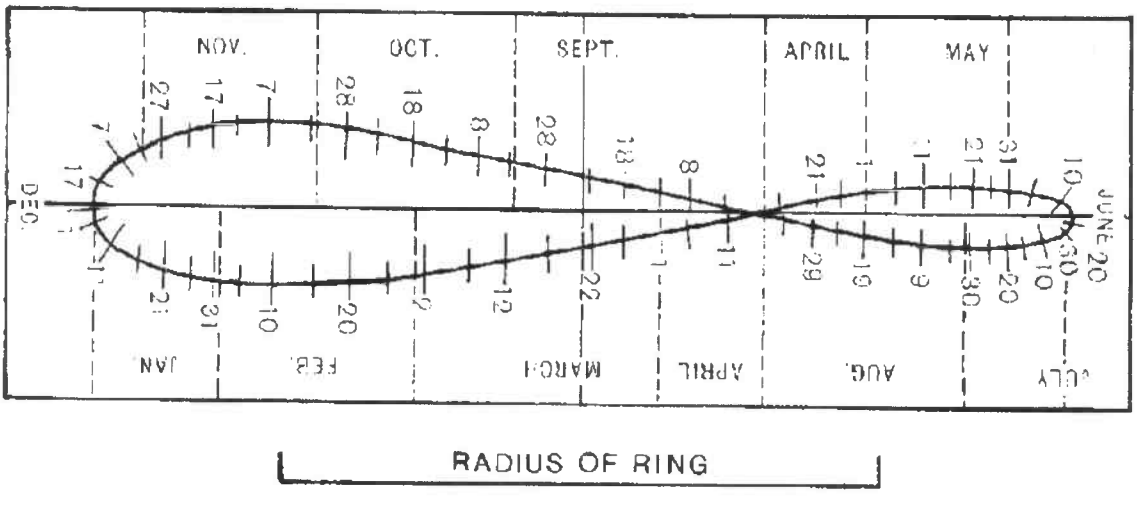


Figure 2: Analemma on the inside of the ring, after Hope-Jones[2]

Continued on page 17

CHALICE DIALS

ALLAN A. MILLS

Astronomy Group, The University, Leicester LE1 7RH, UK

SUMMARY

The chalice sundial may be of an azimuth or altitude type, calibrated for equal or seasonal hours, and scaled for use when empty or when filled with water. These elegant novelties flourished briefly in South Germany during the late 16th and early 17th centuries. Ten extant examples have been located and analysed: only four of the eight possible varieties are represented. One of the missing types has now been designed and constructed.

1. VARIETIES OF CHALICE DIAL

The chalice dial ('bechersonnenuhr') is an unusual - but potentially very graceful and intriguing - form of indoor 'novelty' sundial that appeared briefly in South Germany in the late 16th and early 17th centuries. As the name implies, it is based upon a tapering vessel containing a gnomon, with one or more time scales engraved upon its walls.[1,2,3]

Apart from the exact shape of the vessel, its decoration, and the latitude for which the article is designed, many variations of chalice dial are conceivable:

A) Azimuth[4,5] or altitude type.[6]
B) Equal[4,5] or seasonal[7,8] hour calibration.
C) Scaled for use empty (*i.e.* in air) or filled with water.[9,10]

Eight variants of chalice dial are therefore possible. Not all are represented by existing examples, but the methods of calculation given in the above references enable any model to be designed. A further variation is the 'gnomonless' chalice, where the shadow of the rim opposite the scale provides, at its lowest point, the time-telling index. However, it is felt that this variation, involving as it does a rather unsatisfactory visual estimation of the lowest point of a shallow curve, is insufficiently important to warrant a further subdivision. Major sources of information on chalice dials in the museums of Europe are the works of Zinner.[11,12]

2. AZIMUTH (DIRECTIONAL) TYPE

The familiar sundials of this type embody a sloping gnomon pointing upwards at the celestial pole. This orientation, if combined with an equal hour calibration, annuls the effect of the changing altitude of the Sun. Only its changing direction remains to indicate the time of day. It follows that the direction of the dial itself must be fixed: with portable dials (including chalice dials) this is usually accomplished by incorporating a magnetic compass in the bowl, foot, or other convenient place.

The entire length of the upper edge of such a sloping gnomon (its 'stile') throws a linear shadow upon a (normally) vertical or horizontal plane, and gives rise to a straight line (but not equiangular) radial pattern converging upon the point where the gnomon intersects the dial plane. The latter characteristics are seen in azimuthal chalice dials too. It is also possible to employ only the tip of a vertical gnomon (or, indeed, one pointing in any direction) as the shadow-casting index, but this does sacrifice some advantages. A common compromise on permanently-mounted outdoor sundials is to have a notch or mark ('nodus') upon a sloping gnomon, or implicitly use the tip of the latter to register the curves traced out on the days of the solstices and equinoxes.

2.1 6-POINTED STAR (Fig. 1)

The sloping gnomon form of chalice dial is exemplified by a 6-pointed star design in the Heimatsmuseum, Bamberg, Germany. The tip of the gnomon is situated at the centre of the rim-plane of the vessel, for if it were higher the sides of the latter could not accommodate the entire hour pattern, whilst if lower it would be lost in the shadow thrown by the rim when the Sun is low. Its stile slopes down at an angle to the rim-plane equal to the latitude of the place for which the object was designed. It meets the tapering wall of the vessel at one of its inner angles, and from Fig. 1 it will be seen that the hour lines do indeed appear continuous and converging on that point when viewed from a distance. A bowl for a magnetic compass is enclosed in the ornate base.

Zinner[13] dates this unique star-dial to about 1600. Its exact date and maker are unknown, and the latitude angle has not been published.

FIGURE 1: Chalice dial in the form of a six-pointed star. Directional. Heimatsmuseum, Bamberg.

2.2 HEXAGON (Fig. 2)

This gilded cup, once the property of Octavius Morgan, is now in the Horology Collection of the British Museum.

The sloping gnomon currently fitted is too short and slopes at an incorrect angle: it is an obvious replacement. A magnetic compass, set for a declination of 8°E, is fitted at the bottom of the cup. The attachment to the base is very poorly executed, and it may well be that the latter is another replacement.

The inscriptions within the bowl are in German, but do not include any maker's name or date. Ward[2] suggests early 17th century. There is an underlying resemblance to the Bamberg chalice. The calibration pattern too is similar: it contains straight radials for the equal hours 4 - 12 - 8 in air. There are also scales marked with the signs of the zodiac for reading the length of the day or night, marked TAG LENG and NACHT LENG respectively and numbered 8 - 16 and 16 - 8. Two further sets of lines, numbered 12 - 7 and 6 - 1 and radiating from the north and south points of the rim, mark the boundaries of the Houses of Heaven.[14,15] The title DO/MVS appears among these. LATIT:49 GR is also engraved inside the cup.

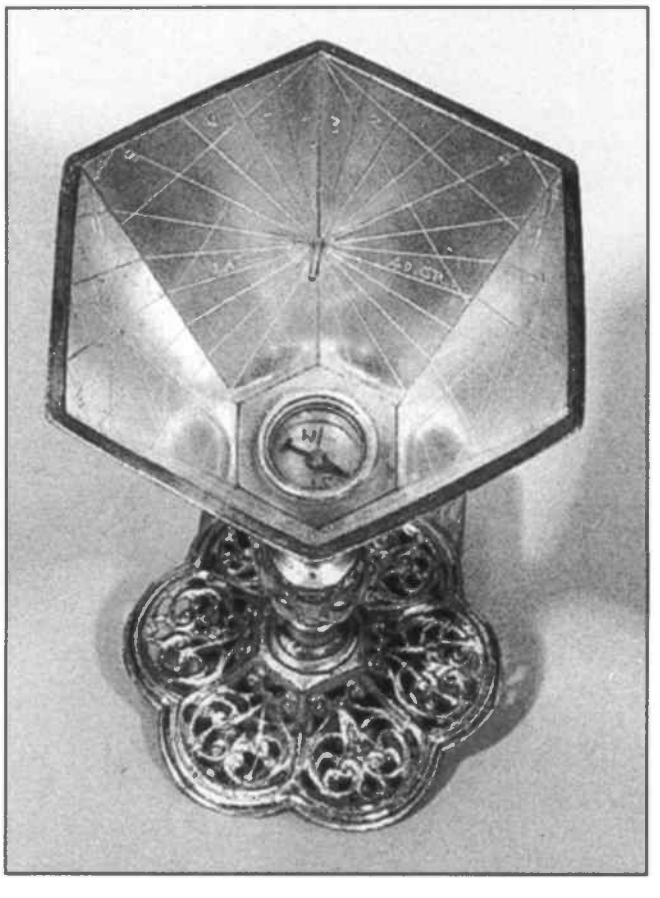


FIGURE 2: Hexagonal chalice. Directional. British Museum, No. 88 12-1 281. Height 137 mm, max. width 95 mm.

2.3 CONICAL CHALICES BY PURMANN

Markus Purmann of Munich (Marcvs Purman, Monachi, in its Latinized form) made many fine instruments between 1588 and 1616. However, he appears to have made a minor speciality of beautiful conical chalice dials in gilded brass, for at least five examples are known[11] and bear dates between 1590 and 1602. All are very similar in external form - a decorated conical cup supported upon a circular base including three raised bosses. One boss turns aside on a pivot to reveal the magnetic compass required for alignment. All are marked for a latitude of 48°. (The modern value for Munich is 48°08'.) Although always making directional dials Purmann never incorporated a sloping gnomon, preferring a graceful tapering vertical pin rising from the bottom of the vessel. Its tip, which must be coincident with the centre of the rim plane, is formed into a tiny ball rather than a dangerous point. Variation comes in the number and complexity of the scales engraved within the bowl.

2.3.1 *DEUTSCHES MUSEUM, MUNICH. 1602*

(Fig. 3)

Although late amongst Purmann's products this example bears the simplest scale pattern,[16] being calibrated for use in air to indicate equal hours. There is the standard numeration (12 noon at midday) and the Italian system (equal hours beginning at dusk). Zodiacal signs around the rim mark the changing declination of the Sun thorough the year. The lenticular space between grid and rim contains the inscription:

MARCVS PURMAN MONACHI FACIEBAT
ELEVATIO POLI. 48 GRAD.
ANNO 1602

FIGURE 3: Conical chalice by Purmann, 1602. Directional. Deutsches Museum, Munich, No. 1681. Height 125 mm, diameter 85 mm.

2.3.2 *GERMANISCHES NATIONALMUSEUM, NUREMBERG. 1590* (Fig. 4)

In this example of Purmann's work the inscription includes the date 1590, but otherwise the form of the object is similar to that described above. The equal hour calibration too is standard, but an unusual feature is another scale that becomes applicable only when the chalice is filled with water - or white wine![17,18] Refraction then moves the shadow of the tip of the gnomon further down towards the bottom of the vessel, and contracts the scale. A date of 1590 is well before Snel's enunciation of the Law of Refraction of 1621, so this calibration must have been made by experiment. Around the outside of the rim is engraved:

WAN ICH BIN EINGESCHENKET VOL
SO ZAIG ICH DIE STUNDT GER WOL;
BIN ABER LEHR:
SO DUE ISCHS NIT MER

This may be freely translated as:

When I am full
I show the hour,
But when I am empty
I do so no more.

Comparison of Fig. 4 with Figs. 3 or 5 will show that this chalice has unfortunately lost its original delicate ball-gnomon. Fig. 4 also includes an ugly screwclamp defacing the near side of the rim. This erroneous accretion is an insult to Purmann's fine craftsmanship, and should be removed.

FIGURE 4: Conical chalice by Purmann, 1590. Directional. Germanisches National Museum, Nuremberg, No. WI 14.

The related hemispherical 'scaphe' dials also lend themselves to being filled with water or wine, and the consequent incorporation of a 'refracted' calibration pattern. The first instrument of this nature - a 'Dial of Ahaz' - appears to have been made by Georg Hartmann of Nuremberg in 1547 (Ref. 9).

2.3.3 *MUSEUM OF THE HISTORY OF SCIENCE, OXFORD. 1599* (Fig. 5)

There are three scales within the bowl of this instrument. One set of equal hour lines numbered on the Italian system is inscribed HORARIVM SINE AQVA, and is for use when the cup is empty. The other set, numbered in the ordinary way, is marked HORARIVM EX PERSPECTIVA RADIOTRVM REFRACTORVM AQVAE, and compensates for refraction when the vessel is filled with water. Finally, opposite the hour lines, is a vertical scale for showing the sun's altitude.

This item was purchased by the museum in 1961, being formerly in the Rosenheim and Sir John Findlay Collections.

FIGURE 5: Conical chalice by Purmann, 1599. Directional. Museum of the History of Science, Oxford, No. 61-148.

2.3.4 *ADDITIONAL DIALS*

Further Purmann chalice dials listed by Zinner[11] include a specimen at the Landesmuseum, Zurich. This author also shows a 1608 engraving by Georg Brentel[19] (Fig. 6) explaining how the scales within chalice dials were initially plotted in polar coordinates on the flat sheet before it was engraved, bent-up, and soldered along the seam.

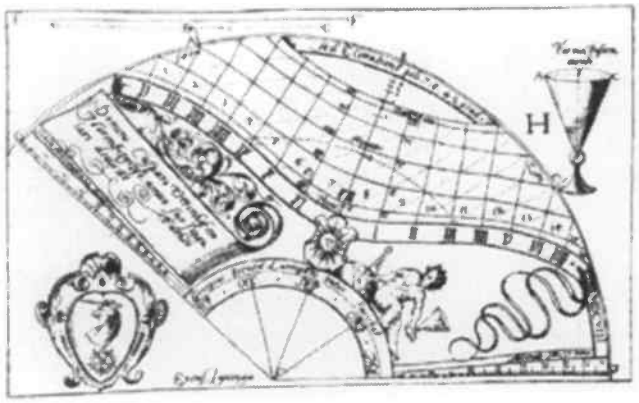


FIGURE 6: Engraving by Georg Brentel, dated 1608, showing how a conical chalice dial was initially laid-out and engraved in the flat. Germanisches National Museum, Nuremberg.

3. ALTITUDE TYPE

These sundials employ the altitude of the Sun above the horizon rather than its direction to tell the time. However, as the solar altitude also varies with its changing declination through the year, it is necessary to provide appropriately dated scales that compensate for this and leave only time of day as the variable. The presence of scales bearing dates (commonly marked at monthly intervals of the civil calendar, or with the zodiacal signs of the traditional astrological calendar) is therefore a good criterion by which altitude dials may be recognised.

Altitude dials employ only the tip of the gnomon as the shadow-casting index, so the support may point in any direction. However, with chalice dials it is convenient to use a vertical gnomon fixed along the axis of a symmetrical vessel, so that it is merely necessary to rotate the latter on its foot until the shadow falls upon the column of appropriate date. All known chalice dials of the altitude type are for this reason symmetrical about a vertical axis. It has already been seen that a vertical pin gnomon may also be used in directional dials, so this alone is not a reliable test.

Altitude dials do not require alignment with the celestial pole, so no magnetic compass is incorporated. However, they are still latitude-dependent. Also, as the calibration is symmetrical about noon, the user is expected to know whether it is morning or afternoon as well as the date.

3.1 BARTHOLOMEUS, 1554. BRITISH MUSEUM.

(Fig. 7)

This, the earliest extant chalice dial of all,[2,20,21] has inscribed in a cartouche within the bowl:

BARTHOLOMEVS
ABBAS ALDERS
PACENSIS
FACIEBAT
ANNO MDLIIII

That is, the dial was made by Bartholomew, Abbot of Aldersbach, in 1554. (Aldersbach is a small town in Germany, near Passau.) At the bottom of the cone (Fig. 8) is engraved HOROLOGIVM IN CRATERE AD ELEVA PO 48: *i.e.* a sundial in a cup for an elevation of the pole (latitude) of 48°.

The existing vertical gnomon is not original, but illustrates how the vessel is turned until the shadow falls upon the column of appropriate date, as indicated by its zodiacal sign. The position of the top of the shadow then indicates the time of day in equal hours. The cup may also be turned until the shadow falls upon a scale going from 0 - 65° downwards and labelled every 5°: This gives the instantaneous solar altitude.

FIGURE 7: Conical chalice by Bartholomeus, 1554. Altitude type. British Museum, No. 96 12-14 1. Height 142 mm, diameter 104 mm.

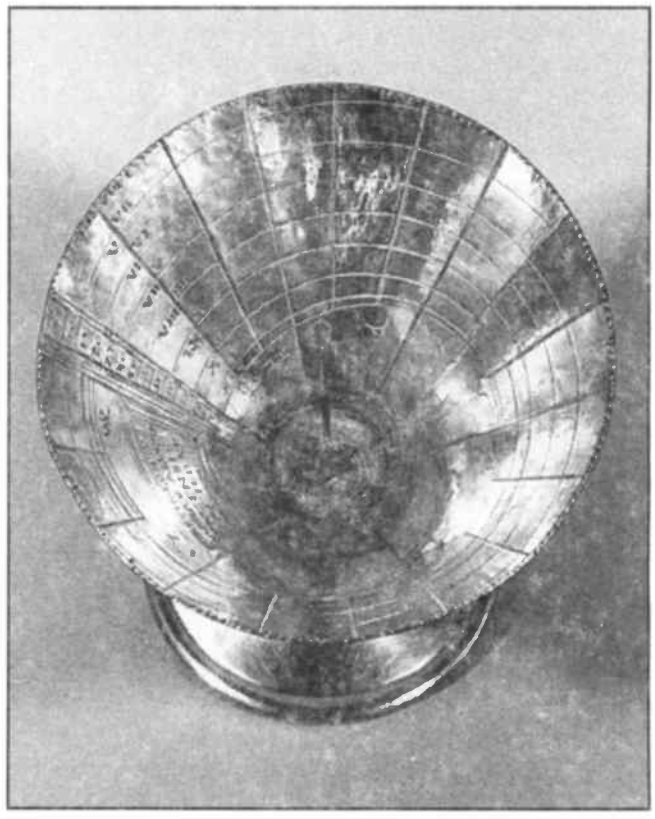


FIGURE 8: Interior of the chalice shown in figure 7

3.2 LINDEN, PRE-1589. ECOUEN (Fig. 9)

The Musée National de la Renaissance, at the Chateau d'Ecouen in France, holds[22] this fine chalice dial in silver-gilt. The original vertical axial gnomon has again been lost, but the columns dated both calendrically and zodiacally clearly indicate an altitude dial.

Closed curves crossing the dated columns, engraved as full lines and numbered in Arabic numerals, are the hour lines for equal hours. Another set of closed curves gives the seasonal hours: these are distinguished by closely spaced dotted lines and numbered in Roman numerals. Both sets are for use in air.

It is believed from hallmarks on the base that this object was made by Johann Anton Linden (Hanns Anthony Lind) of Heilbronn before 1589. Zinner[11] says that another example by this maker is in the Lindau Stadtmuseum, and is dated 1594 - by which time Linden had moved to Nuremberg. This last dial is for a latitude of 49°.

FIGURE 9: Conical chalice by Linden, pre-1589. Altitude type. Musée National de la Renaissance, Ecouen, No. E.C1.3297. Height 134 mm, diameter 85 mm.

3.3 ANON. 1598. SCIENCE MUSEUM, LONDON. (Fig. 10)

The Science Museum possesses only one chalice dial, but does have it on permanent display in the Timekeeping Gallery. Although quite small, it contains three scales for use in air:

Equal hours, standard numeration
Equal hours, Italian numeration
Seasonal hours

The object is made of silver, with only the outside gilded. The support, which includes a tiny plumb-bob, has been skilfully repaired at some time.[23,24] No maker's name is given, but there is a date of 1596 and the grid is designed for a latitude of 42° - that of Rome. It has therefore been suggested that this chalice dial may be of Italian rather than the expected South German origin.

FIGURE 10: Chalice dial by an anonymous maker, 1596. Altitude type. Science Museum, London, No. 1955-149. Height 110 mm, diameter 64 mm.

FIGURE 11: Paper label on the underside of the base of the chalice shown in figure 10.

The museum purchased this item in 1955, but its previous history and provenance are unknown. Intriguingly, the underside of the base bears a paper label (Fig. 11) claiming that it was once the property of Isaac Newton, being sold with his effects in 1727. Newton did indeed die in that year, but there are no records corroborating the inclusion of a little chalice dial in any sale and the attribution must be considered highly suspect. Nevertheless, Newton was interested in sundials all his life,[25] and in his later years as Master of the Mint would have been well able to afford such a piece. (His expensive pocket watch is kept by the Royal Society,[26] whilst an astronomical clock associated with him is in the Museum of the Clockmakers' Company at the Guildhall, London.[27])

3.4 STUART AND BENTELE, 1737. SALZBURG.

(Fig. 12)

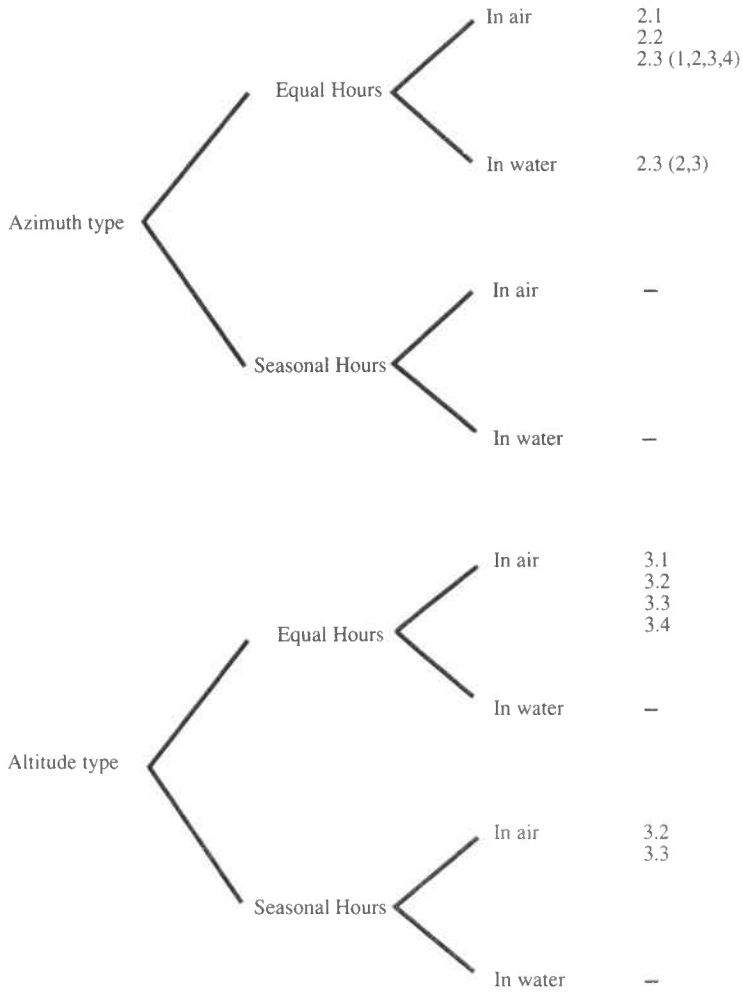
This is the only known chalice dial made of glass. It is mounted upon a wooden base. It is also unique in having no axial gnomon: the time is indicated by the edge of the shadow thrown by the yellow-enamelled rim of the vessel. It must be turned so that this shadow is received across a diameter by the appropriately dated scale, which is formed from black figures upon a white translucent glaze so that it may be read from the outside. The calibration is for equal hours, 5 - 12 - 7, in air.

A decorative band carries the legend:

FIGURE 12: Chalice dial by Stuart and Bentele, 1737. Altitude type. Museum Carolino Augusteum, Salzburg, No. K5729/49. Height 150 mm, diameter 77 mm.

De Hoc Cratere DeVs, Voveo, BeneDIXerit HaVstVs which embodies a chronogram for 1737 and may be translated 'I ask God to bless the contents of this chalice'. The object was acquired from the old Benedictine University.[28]

4. ANALYSIS OF VARIANTS



It will be seen that only 4 out of the possible 8 classes of chalice dials appear to have been constructed in the past.

5. CONSTRUCTION AND CALIBRATION OF CHALICE DIALS

The most practical method of calibration is a combined computational/graphical procedure based upon traditional methods for a vertical gnomon and horizontal dial. The gnomon is drawn full-size upon a sheet of paper, and rays defining the position of the shadow of its tip at various times of the day and year drawn towards the horizontal from its base, as represented in Fig. 13. The altitude angles α of these rays may be calculated from the standard equations of spherical astronomy,[4,5,6] modified according to Snel's law by the refractive index of any liquid to be contained within the finished vessel.[9,10] The outline of the latter is then superimposed full-size upon the diagram with its rim level with the top of the gnomon, intercepts marked and their positions transferred to the real vessel, and finally all joined by smooth curves.

A cone may alternatively be marked and engraved 'in the flat' as shown by Brentel, but the above method does

enable a finished vessel of any shape to be calibrated - although manual engraving of the interior may be awkward. However, a modern glass or transparent polycarbonate vessel intended to contain water or wine at the dining table may be utilised, and marked on the outside via an intermediate plaster cast of its interior. It is essential to matt the background surface (*e.g.* by fine grinding) to scatter the incident rays if the shadow cast by the gnomon is to be distinguished against the scales. An equal-hour altitude dial for latitude 51°N, bearing scales for use when empty or when filled with water was made to prove the technique: it is shown in Fig. 14.

ACKNOWLEDGEMENTS

I should like to thank the curators and staff of the various museums concerned for their help in providing photographs and information.

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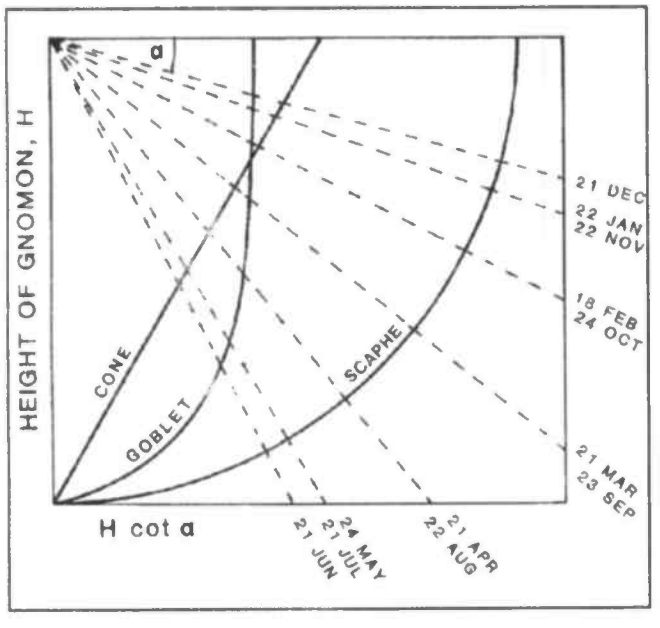

FIGURE 13: Construction of calibration pattern for conical, goblet and scaphe dials. In this abbreviated example, the points of intersection indicate local noon when the resulting instrument is positioned (empty) at lat. 51°N on the dates shown.

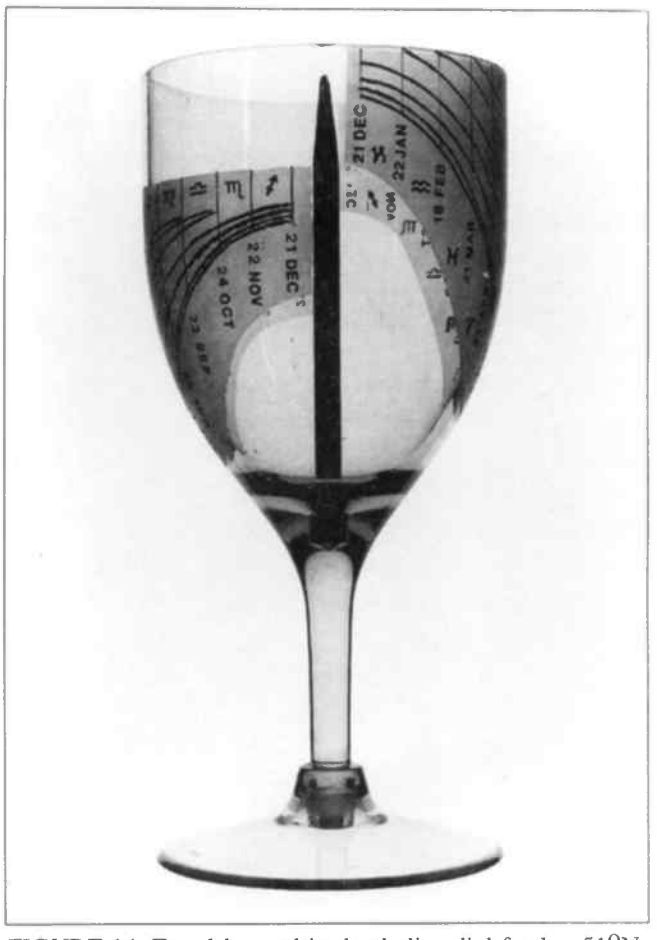

FIGURE 14: Equal-hour altitude chalice dial for lat. 51°N, bearing scales for use when empty (enamelled in black) and when filled with water (in red; the lower set of curves).

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YOU ONLY LIVE TWICE

R. VINCK (BELGIUM)

Although the emphasis of the article is on concept of time, it will surely be of interest to the diallist, who is always keen to read on this related subject.

Time is a measure of rotation of the Earth, which has an angular velocity of 360°/24 = 15° an hour.

For a change of each 15° of longitude, our clock will have to be altered 1 hour to keep track of local time.

Longitude and local time is measured East or West, from the Greenwich Meridian, by the rule:

LONGITUDE WEST, GREENWICH TIME BEST
LONGITUDE EAST, GREENWICH TIME LEAST

A place on the east side and close to the meridian of 180°, which lies diametrically opposite to the Greenwich meridian and is its lower branch, is 12 hours ahead on Greenwich time. While a place close to the first one, but on the west side of the meridian of 180°, is 12 hours slow on Greenwich time. Or in other words, the 180th meridian is the boundary between the -12 and the +12 time zones.

Consequently, the respective local times at two places close to the meridian of 180°, but on different sides, differ by 24 hours or one day.

This meridian of 180° is indeed the Date or Calendar line. Crossing this line in an easterly direction will give you two consecutive days, with the same date.

The survivors of F. Magellan's around-the-world expedition of 1519-1522 arrived home and found that they had somehow 'lost' a day, although their logkeeping was meticulous.

They recorded time by counting the sunrises, and going once around the world westward, they saw one less sunrise than their brother who stayed at home.

Ashore, and prior to the convention on the Meridian of Greenwich and any scientific findings, they blamed the "loss" on the rum!

Nowadays many traveller cross the "International Date line" in mid-Pacific, where they lose a day going West or have the same day over again going East.

Naturally, you haven't gained or lost anything of lifetime, because during your travelling you had to adjust your watch all the time, to keep in pace with local time.

The International Date or Calendar line is a modification of the 180th meridian, which is drawn in a way to include islands of any one group, i.e. on the same side of the line.

This line runs through the centre of the Bering Strait and East of the Fiji Islands and New Zealand.

East of this line the date is American and West of the line Australian.

When travelling East or West at higher latitudes you will have to shift your watch more frequently, due to the rapid convergence of the meridians.

One degree of longitude measured along the equator is 60 Nautical Miles, while measured at the parallel of 60° latitude it is only half of that or 30 Nautical Miles.

In fact the departure of the meridians varies by a factor equal to the cosine of the latitude. (The departure is the distance between two meridians at any given parallel of latitude.) This brings us to the hypothetical case of a man standing exactly at the North Pole, where all the meridians converge or meet into a single point. For this man there is no date, no time. He is standing at a fixed point, that doesn't rotate but is the centre of rotation itself. Any direction he faces, he is always looking due South. When he sees the sun, it is always South on the meridian, it is always noon.

Any direction he starts walking and keeping that direction he will always reach the South Pole by the shortest way. For him a day lasts a year, with half a day (six months) daylight or sunshine and half a day (six months) darkness.

A horizontal sundial, which in that position is an equatorial as well, will give an indication of the elapse of time, as the shadow of the gnomon moves across the dial and the hourlines at the same angular velocity of the Earth's rotation.

All these little facts may seem odd or strange at first sight, but it is nothing compared to the mysteries of the relativity of time, when you think about space travel at speeds approaching (or exceeding?) the speed of light.

A year on earth is not a year any more for such a space traveller, simultaneous events on earth won't be necessarily simultaneous to him because there is no absolute time throughout the universe by which absolute simultaneity can be measured. But this could be the subject for another article.

A LARGE TRANSLUCENT UNIVERSAL EQUATORIAL SUNDIAL (PART II)

BY MAURICE J. KENN

The essential features of the translucent, equatorial sundial described in the previous article are simplicity, readability, universality and novelty.[Ref. 4]

However, this sundial now also permits the ready determination of the date, the sun time, the local time and hence the standard time for any known location in the world.

For the prototype sundial, an empty, 1m high x 0.5m diameter, translucent, plastic container was suitably halved vertically, inscribed, mounted and provided with a 1m long x 1.25mm diameter "Gnomon". A 33mm diameter plastic-ball has now been mounted centrally on the gnomon and serves as the latter's "Date nodus" (Plate 7).

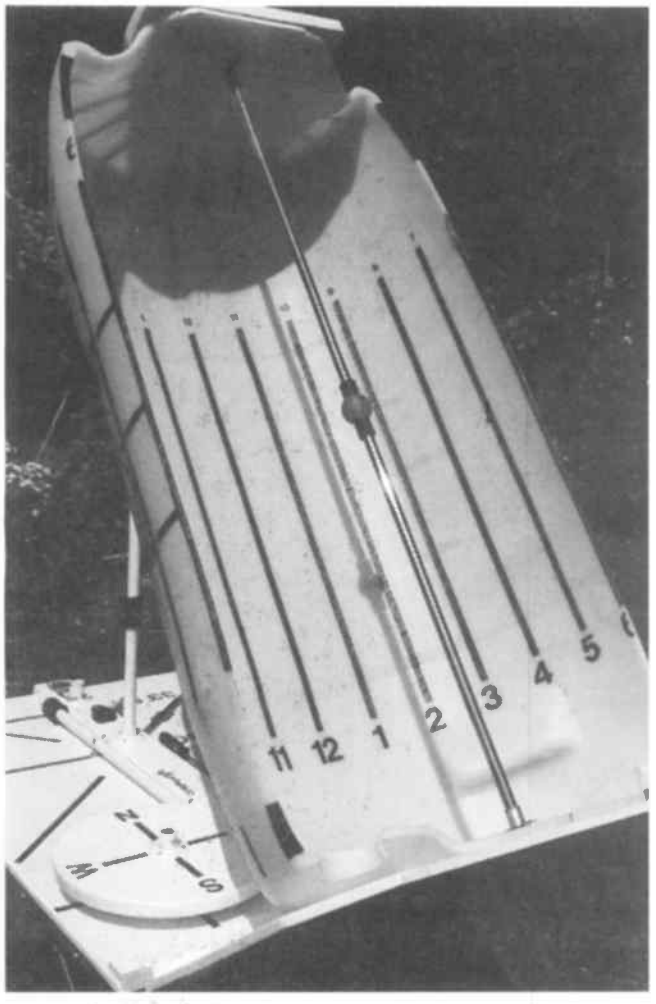


Plate 7

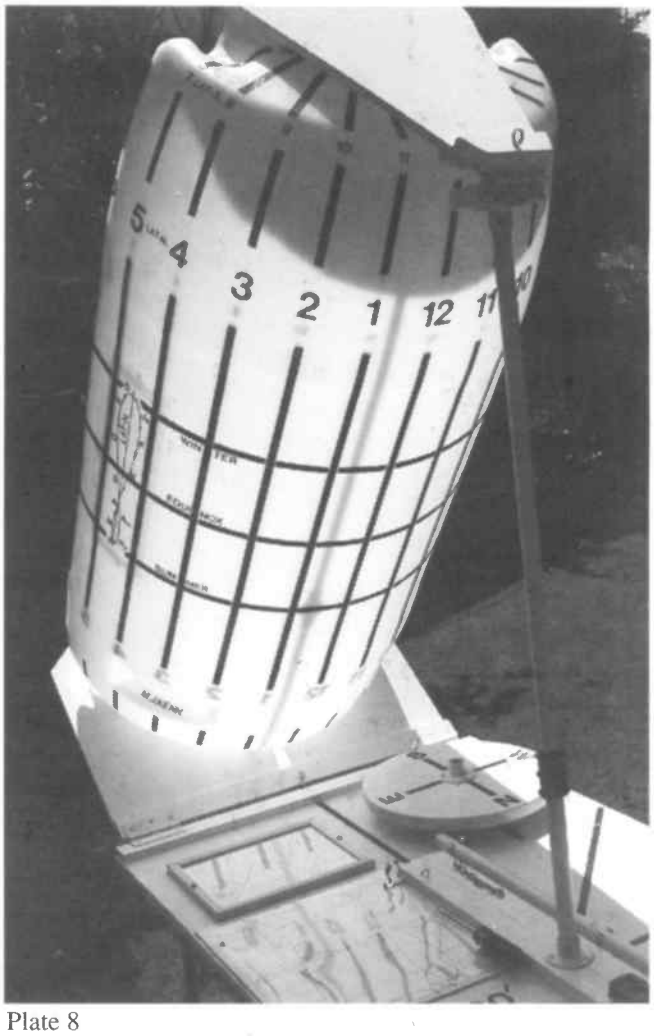
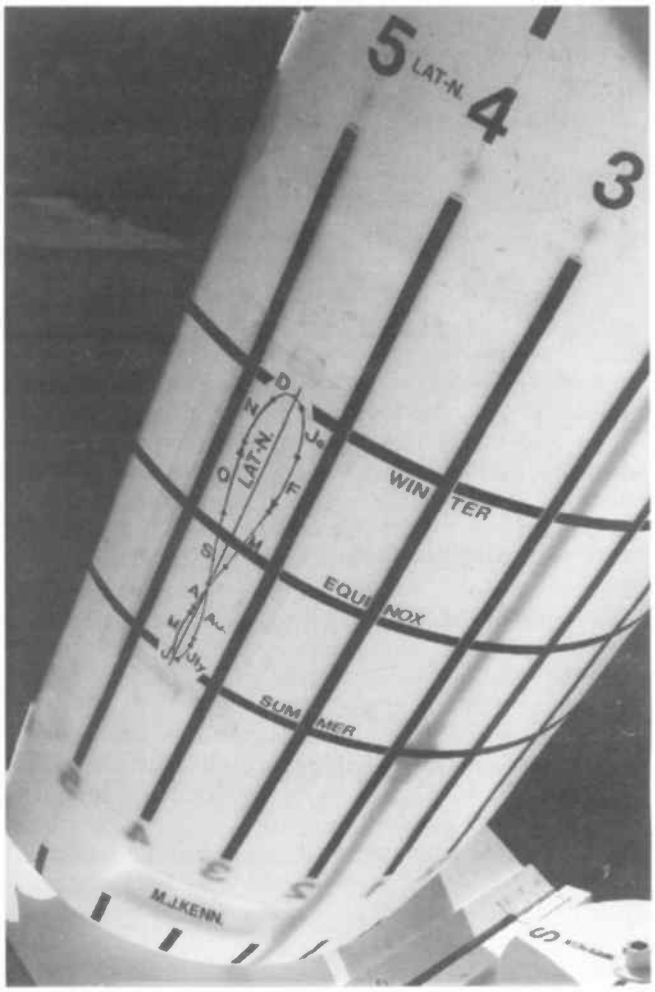


Plate 8

Plate 9



The hourly divisions on the sundials are evenly spaced at 15-degree intervals and are parallel to the gnomon. The gnomon's shadow is used to indicate the sun time on both the front and rear of the dial.

"Equatorial lines", used in conjunction with the shadow of the nodus, now indicate respectively the Solstices (Summer and Winter) and the Equinoxes (Autumn and Spring). The equatorial lines are, of course, at right angles to the gnomon and to the hour lines on both cylindrical faces (Plates 8, 9, 10 and 11).

Because the earth's orbit around the sun is elliptical, and because the earth's axis of rotation is tilted in relation to the orbit, "Sun time" varies on a daily basis throughout the year when measured relative to mean, or "Clock time". The variation of "Sun time" with "Clock time", or the so-called "Equation of Time", can be expressed graphically and on this sundial the "Equation of time" has been plotted to scale as a "Figure of Eight", between the "Equatorial

Plate 10

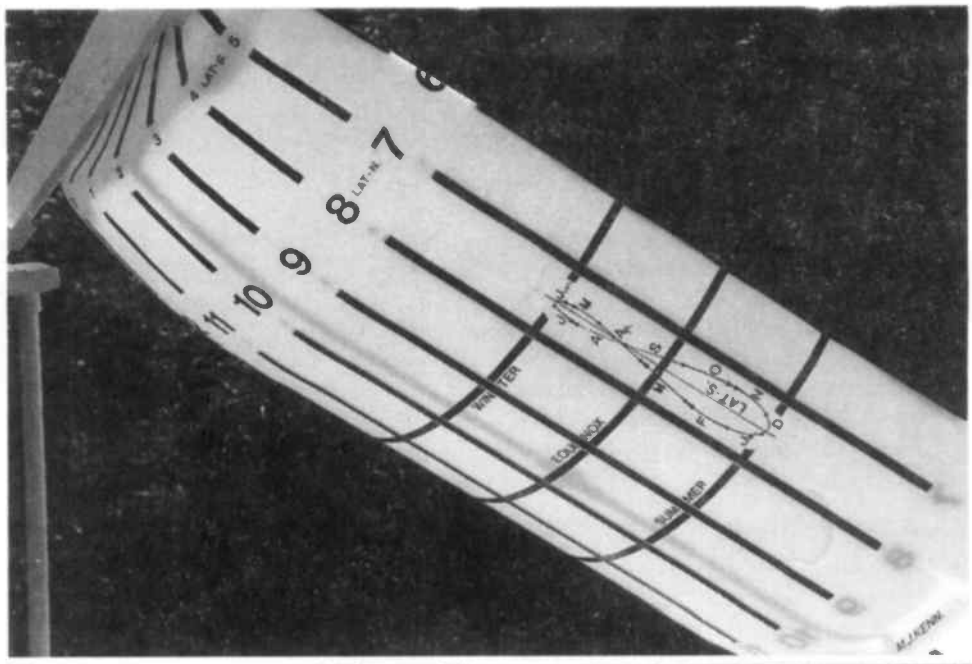
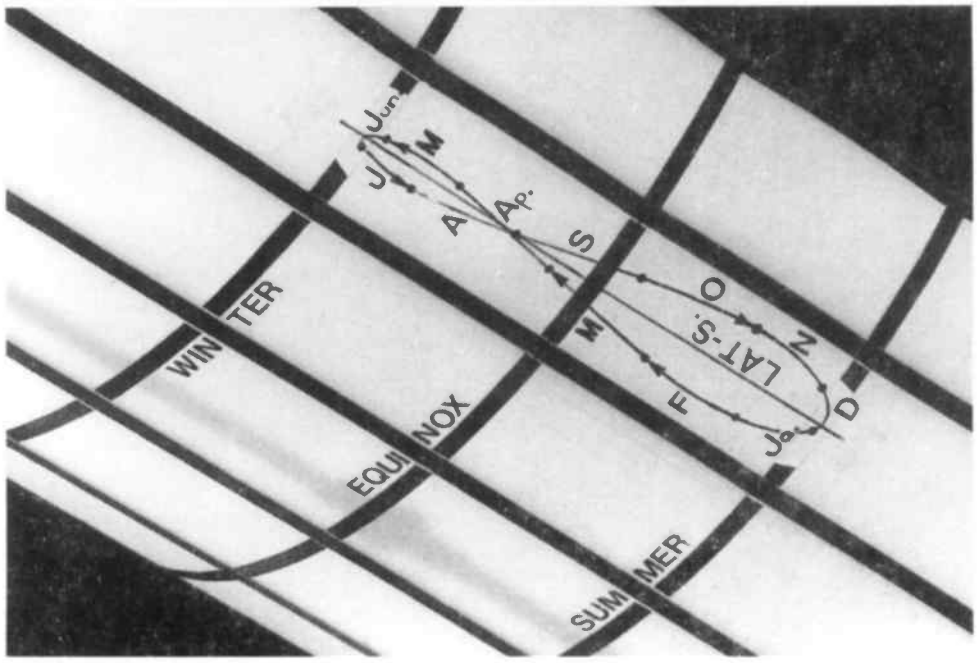


Plate 11



Solstice Lines", thus forming an "Analemma". This analemma can therefore be used directly with the nodus's shadow for the date determinations (Plates 8, 9, 10 and 11). Refs 5 & 6

Although, on this cylindrical sundial, the analemma must necessarily be located between the pair of Solstice Lines, the analemma can nevertheless be placed, or envisaged to be, at any radial position and measurements can accordingly be made at any time of the day.

In the Northern Hemisphere the gnomon on the sundial must be pointed up towards the North-Pole Star. The large numerals on the hour lines then permit sun time to be ascertained from the location of the gnomon's shadow

A "Northern-Hemisphere Analemma", (Plate 8 and 9) has been provided to enable the date to be ascertained from the position of the nodus's shadow, measured relative to the equatorial lines. The Analemma also then indicates the difference between local sun time and local mean time for the particular date.

When used in the Southern Hemisphere the *lower* end of the gnomon must effectively be pointed down towards the *North*-Pole Star (now "Downunder") and time measurements are made using the small, "Southern-Hemisphere" numerals provided on the hour lines (Plates 7, 8 and 10). These small numerals are necessarily arranged in reverse order to that of the larger, "North-Hemisphere" numerals (Plates 7, 8 and 10).

A Southern-Hemisphere "Analemma" has necessarily also been provided on the sundial for use in Southern Latitudes (Plates 10 and 11).

In Plates 7, 8 and 9 the sundial has been arranged to show the local sun time, from the front and from the rear, for Latitude 51° 30', for example in London, England, or at Stanley in the Falkland Islands. However, in Plates 10 and 11 the sundial has been re-arranged to show the local sun time, again from the front and from the rear, at Latitude 33° 55' for example in Sydney, Australia, or at Los Angeles, in California.

Simplicity, readability and universality have been achieved with this prototype sundial but, with minor design refinements, sufficient elegance could be achieved for this sundial to be used in any prestige location.

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THE ART OF DIALLING
THE 7th BOOK OF THE MARINER'S MAGAZINE

JOHN BRIGGS

INTRODUCTION

Captain Samuel Sturmy (see portrait - Figure 1) was a very remarkable man who was born in Gloucestershire in 1633 but who went to live in St. Georges, Bristol at an early age. It was here that he had "A House and Study". In the 1660's he prepared a treatise mainly for seamen, entitled *The Mariner's Magazine,* published in 1669, and in general devoted to navigation. This gallant gentleman, in pursuit of scientific knowledge, descended the old lead-ore mine known as Pen Park Hole in Gloucestershire, about three miles from Bristol, on 2nd July 1669. This place had a very bad reputation and Captain Sturmy intended to show it was quite unfounded. The miner with him, on his orders, entered an upper space in the mine and shortly afterwards returned affrighted by the sight of an evil spirit.

Four days after spending about five hours in the mine, Captain Sturmy was troubled by a violent headache, which he attributed to being in the vault. This developed into a fever, from which he unfortunately died. He had managed to write an account of his descent into the mine, this was sent to the Royal Society by Sir Robert Southend in January 1682-3. It had earlier been sent to the Royal Society and the King, by whom it is not known.

FIGURE 1: The true effigy of Captain Sturmy at the age of 36 years.

The verse on the pedestal reads:
What here you see is but a graven face,
Only the picture of that brittle case,
Whose soul's the magazine of all these Arts,
Which here most freely, he to all imparts.

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Most of Captain Sturmy's adult life was spent in command of commercial ships and he made many voyages to the West Indies, so his skill as a navigator is beyond question. His memorial tablet may be seen in St. George's Church, Easton-in-Gordano, near Bristol. This mentions the two dials he gave which were fixed to the church porch, and the copy of his treatise *The Mariner's Magazine* that he donated to the church which could be consulted by anyone desiring to read it, on deposit of £3. The dials and book have vanished, the first because the church was rebuilt in the last century, the loss of the book is not recorded.

It is clear from reading Captain Sturmy's treatise that he was a learned man of great literary skill and he was also a poet of some merit.

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THE DIALLING BOOK

Captain Sturmy had intended to end his treatise with a book on dialling, but like many authors of the period, he further embellished his book with Acts of Parliament for seamen, a Compendium of Fortification and Table of Logarithms to give as much information within one general treatise as possible. At the time of issue the book cost fourteen shillings (70p in modern currency, and about £140 in real value terms of today) see Figure 2.

The seventh book is on dialling and is entitled "The Art of Dialling by a Gnomonical Scale, and likewise by Calculation; Making all Sorts of Dials both without doors and within, upon any Wall, Ceiling, or Floor, be they never so Irregular, wheresoever the Direct of Reflect Beams of the Sun may come.

- + - + - + - + -

How to find the Hour of the Night by the Moon and Stars: And how to Colour, Guild and to Finish DIALS; and how to Fasten the Gnomon to Stone or Wood. Never before made so Plane . . .

This 7th book is dedicated "To My much Honoured Friend Isaac Morgan Esq.; Collector of his Majesties Customs in the Port of Bristol" because he was anxious "to inform the World how much I honour you and your Vertures, and by how many Obligations I stand engaged to you for the many signal Favours you have vouchsaved me since the time I came first into this Port" (Bristol).

He goes further to inform Morgan that he has chosen him "for the Patronage thereof (of the book), that it may gain the more Credit by your Protection. Only to all Favourers of the Art I am direct, erect, plain, as I am, Sir, to you". Captain Sturmy must have thought very highly of Morgan for in 1667 he presented him with a dial as a New

FIGURE 2: The engraved half-title page of *The Mariner's Magazine* or "Sturmy's Mathematicall and Practical Arts". It will be seen here that the work was intended to end with ". . .Dialling, performed Geometrically, Instrumentally and by Calculation", but squeezed under the date of publication 1669 is "and Fortification". The plate was engraved by Thomas Cross.

Year's gift. This is shown in Figure 3. The dial bears the date 1667 near the right hand gnomon.

Captain Sturmy writes of this dial thus:
I dedicate this Part of my Book, as the proper Part of the fruits of my spare time, in twenty-seven Dials, unto you presented as an unworthy New-years-gift; and that Dial-piece being the Subject of the whole Art of Dialling, I will now name the Dials, that I may charge you to Patronage no more than you had; viz Eight Verticals and Decliners, Eight Recliners and Incliners, a Globe with two Pole-Dials, and one Shadow-Dial, made on a Piece of Freezstone, as is seen in the Frontispiece the Gnomon or Stile fastened by me, and likewise Painted and Guilded.

On the dial are the Latin phrases:

Under the figure of Atlas - *Transit Hora Sine More* - "The Hour Passes Without Death".

Above the plane vertical dial: *Sic Transit Gloria Mundi An 1667* - "So Passes the Glory of the World 1667".

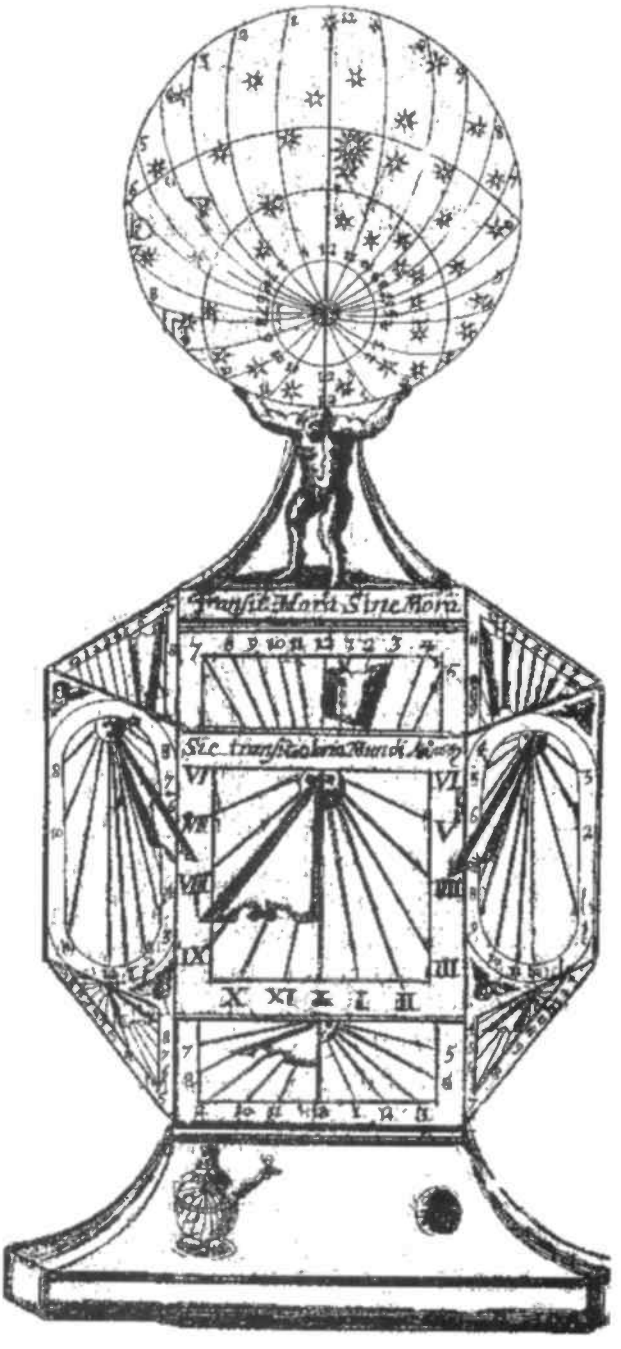

FIGURE 3: The frontispiece to the Seventh Book, the stone dial presented as a New-Years gift in 1667 to Isaac Morgan, Collector of His Majesties Customs in the Port of Bristol. It shows all the dials dealt with by Captain Sturmy in his treatise. In the actual work, this illustration is badly affected by the title page bleeding through.

Under the engraving is the wording: (Not shown in Fig 2) *Horalogium vitæ - Latus ad occasum nunquam rediturus ad ortum, Vivo hodie, moriar oras, heri natus eram.* "Life's Clock . . .

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The main south vertical dial is delineated with Roman numerals and its noon is shown as a Maltese Cross, whereas all the subsidiary dials are delineated with Arabic

Numerals. All the gnomons are furnished with a nodus.

On the pedestal of the polyhedral sundial, on the right, is an illustration of the earth, behind this a man is standing. His right hand rests on the top of the globe, his left hand holds aloft an instrument. On the left hand side is shown a crescent moon. It seems to illustrate a globe dial with the band around it acting as an hour scale, possibly it is intended as a moon dial.

On the whole this polyhedral sundial must be accounted a very handsome present, and it would not be unappreciated in present times.

EXTRACTS FROM THE TEXT

To Paint and Finish the Dials, ready to be set up in their Places.

For to fasten the Gnomon to the Plane, be it of Wood or Freestone, you must have a small thin Chisel, or Googe, or Gimblet, as is fit for the Stile, be it round as a Rod of Iron, or a piece of Brass, let in with a Foot an inch and half, or more or less, as you will; and in the Wood make such little Mortices as just the breadth and length of the Foot of the Stile; and if comes thorow to clinch it on the other side, then it is fast.

If it is in Freestone, your Dial first drawn in Paper, lay it upon Plane as it should be; then cut out the Substyle line as neer to its breadth as you can, and only leave so much as will just hold it together. The Paper laid as before on the Plane, with a Black-lead Pensil, or such like, draw the Substile line where it stood in the Paper, and with a small Chisel make such Mortises in that Line as are answerable to the Foot of the Stile; and crook his Foot, and put it into its place, with a small Ladle and some Lead melted, put the Stile perpendicular with the Plane, and pour in the Lead into the Mortise until it is full; and when it is cold, then with a Blunt Chisel harden the Lead in one inch side of the Stile or Gnomon: And if the Mortise should be too wide, or broken, and not even with the Plane, then wet some Flower of Alabaster, as you may have fit for the purpose at any Masons, and as soon as 'tis wet make a Plaster, and so smooth it, and spread it even and plain with the Plane; it is presently dry. Now have you the Stile or Gnomon as fast as if it grew there.

TO PAINT THEM

To paint them, you must first Prime them: The Prime is made thus. Take an equal quantity of Bol Armoniack and Red Lead, well ground together with Linseed Oyl, and well rubb'd in with a Brush or Pensil into the Plane; thus being dry, for the outside Colour, it is White Lead or Ceruse well ground with Linseed Oyl. How to know the best. Buy the White Lead, and grind it to a Powder, and put it into Water until it becomes as thick as Pap, and let it dry; then it is fit for your use.

For the Hour Lines a Vermillion, and a part Red Lead, well ground together with Linseed Oyl, with a small quantity of Oyl of Spike, or Turpentine that will dure, and make the Lines shine.

With a Gold Border, Rub the Border well with the white Ceruse Paint; be sure it is very thick in the Border. Then with Blew Smalts strew very thick the Border while it is wet; and when it is dry, wing that which is loose off, and save it in a Paper; and for the rest that clings, it is fast enough.

Take Red Lead and White Lead, and as much Red Lead again as White, or Yellow Oker, well ground with Oyl of Spike or Turpentine; this is the Sise: Then draw with that the Figure you would have in Gold, and when it is so dry that it will not come off on your Fingers by a slight touch, lay on the Gold; and when it is thorowly dry, wing it off.

How to make a good Black, to shadow or make Figures. Grind well with Linseed Oyl Lam-Black with some Verdigrease, and that is a firm Black. The like you may do with all other Colours, as you fancy for such Work.

A RECEIPT FOR RED INK

First, Steep one penny-worth of Brazeel Wood all night in Piss or Urine, then boil it well and strain it: then bruise two penny-worth of Cochineel, and boil it, and put in it the bigness of a Hens Egg of Roch Allom. that brings it to a colour, and then it is for your turn.

To Paint Freestone, wash the Stone with Oil, and it will last; and then all the Colours before may be used, as directed.

TO GRIND GOLD TO WRITE AND PAINT

Take as many Leaves of Gold as you please, Honey three or four drops; mix and grind these, and keep it in some Bone Vessel. If you will write with it, add some Gum-water, and it will be Excellent.

TO CLEANSE A GOLD BORDER

Wash it with Beer, and Dry it, and then cleanse it with Linseed Oyl. Masticious is a fine Yellow, ground with some Oil of Spike or Turpentine. Bice is a good Blew Colouring, to be ground with Linseed Oyl and Red Lead. And Spanish Brown will make a lasting Colour for Course Work.

HOW TO CLEANSE A PICTURE (OR DIAL)

Take blew Smalts, temper it in water, and rub the Picture with it, and after wipe it with a Linnen Cloth, which Cloth should be dipp'd in Beer, or otherwise with a dry Cloth, and it is clean.

Captain Sturmy ends his dialling book with a poem as for his other books:

All things pass on: Those Creatures which are made,
Fail, and by Time's assiduate motion fade.
Much like the Running Stream, which cannot stay,
No more than the light Hours that poste away.
But as one Billow, hast'ning to the Shore,
Impels another, and still that before,
Is by the following driv'n; so we conclude
Of Time, it so flies, and is so pursu'd.
The Hours are always new; and what hath been
Is never more to be perceiv'd or seen:
That daily grows, which had before no ground;
And Minutes, past once, never more are found.

GLOSSARY

The text reproduced here from Captain Sturmy's treatise is given as he wrote it and some of the words he used may be obscure to a modern reader. The following list may be of some assistance in making the text clearer:

Alabaster (Flower of) - Powdered calcined gypsum like the Plaster of Paris of today. With water it sets to a hard cement.

Bice - A blue pigment made from smalt (q.v.).

Blew Smalts - Pulverised glass which is a deep blue by dissolved cobalt.

Bole Armoniack - Bole Armoniac or Armeniac, an earth brought from Armenia, a brownish, reddish or yellowish clay containing iron oxide.
Brazeel Wood - Brazil, a red-dye wood produced by the genus *Cæsaplinia,* which gave this name to the country Brazil.
Cerise - Another name for a white lead oxide.
Cochineel - Cochineal, a colouring made from female cochineal insects. It gives a bright scarlet or carmine colour.
Course - Coarse.
Crook - To bend a piece of metal.
Dure - To endure, to last.
Freestone - A stone which can be cut freely in any direction, particularly suitable for delineating sundials.
Googe - Gouge or chisel with a circular cutting edge.
Guilded - Gilded. Coated with gold leaf or gold paint.
Gimblet - Gimlet, a small boring tool with a pointed screw for piercing wood.
Gum-water - Gum from certain trees dissolved in water.
Lam-black - Lamp-black, soot formed by the impertect combustion of oil.
Leaves of Gold - These are the ultra-thin pages of gold leaf prepared by the gold-beater, used for gilding surfaces and making numerals and lines. It will last 25-50 years in outside conditions because gold does not oxidise or deteriorate.
Linseed Oyl - Oil extracted from the seeds of the flax plant. This oil gradually combines with the oxygen of the air to become solid and hard.
Masticious - Mastic or resin exuded from an evergreen tree, used as varnish.
Oyl of Spike - Oil from lavender plants which oxidiss to become hard.
Pap - This was milk with bread mixed in to the consistency of a thick paste.
Red Lead - This is an oxide of lead which is a bright red colour.
Roch Allom - Rock Alum, a double salt of aluminium and potassium, found as a mineral in the form of large crystals.
Spanish Brown - A cheap brown coloured pigment.
Sise - Size, to coat an absorbent surface in preparation for painting.
Temper - To mix with water to a fine paste.
Verdigrease - Verdigris, a green copper compound, copper acetate.
Vermillion - Vermilion. A brilliant red pigment - mercury sulphide.
Wing - To brush lightly as with a feather to remove excess or loose material.
Yellow Oker - Yellow Ochre, a native earth containing hydrated peroxide of iron with clay in various proportions.

- + - + - + - + -

This book on dialling is preceded by a book which commences with the names and characters of the twelve signs of the Zodiac and goes on to deal with the definitions of the Circles of the Spheres and the rudiments of Astronomy, with details of how to calculate the sun's true position, its rising and setting and other matters appertaining to the heavenly bodies.

This is accompanied by a poem from Captain Sturmy's pen which seems more apposite to be included with the book on dialling:

Reader, read this; for I dare this defend,
Thy posting Life of Dials doth depend.
Consider thou, how quick the Hour's gone;
Alive to day, tomorrow Life is done.
Then use thy time, and always bear in mind,
Time's forehead hairy is, but bald behind.
Here's that which will decline to thee, and show
How quick Time runs, how fast thy Life doth go.
Yet be ingenious, learn the Practick Part,
And so attain to Practice of this Art:
Whereby you shall be able to trace
Out such a path, where Sol shall run his Race;
And make the greater Cosmus to appear,
According to each Season of the Year.

The present writer salutes the memory of the erudite Captain Samuel Sturmy.

* * * * * * * *

BOOK REVIEW **(Continued from page 45)**

Some critics say it has all been done before, well so it has, there is nothing new under the Sun. However, the book is unusual in the way it has been done and as such is ideal for those who know nothing about sundials and do not want to study spherical trigonometry, computer programming, engraving and letter-cutting before even getting to the simplest dial. The book is the product of someone who has learnt through his own progress in the practical work and has enjoyed what he has been doing. It will not satisfy the pundits but the author did not have them in mind anyway, he has written his book for his own pleasure, and I for one am pleased that he has achieved what every writer desires - his own book.

Although expensive at £12.00, this is only the cost of the printing and binding, so the author will not become rich with the sales of his book. It is well recommended to all those teachers seeking practical projects.

NORTH DECLINING VERTICAL DIALS

PETER J. MEADOWS

Have you considered constructing a north declining vertical dial? Following the completion of a south declining vertical dial,[1] some thought has been given to the construction of a dial on a wall opposite this dial. The main considerations have been what will be the range of hour lines visible and how much dial furniture can be placed on the dial.

Any north declining dial will have a more limiting set of hour lines than a dial which declines south. A direct north dial, for example, will only have hour lines between sunrise and 6 am together with between 6 pm and sunset (all times given here are local). Also the dial will only be of use between the spring and autumn equinoxes. Even an eastward facing dial will only have hour lines between sunrise and noon, while for a direct west dial, hour lines will only be between noon and sunset.

What hour lines will be shown on a north vertical dial not declining towards the north, east and west compass points? The unshaded region shown in Figure 1 show the possible hour lines for a latitude of 51° 43' N (i.e. that of the author's garden). The dashed horizontal lines show the hour line limits at the solstices and equinoxes. As expected, the greatest range of hour lines will occur at the summer solstice - this is shown in Figure 1 by using the top and bottom dashed lines as the upper and lower hour line range. Conversely, at the winter solstice, the appropriate dashed lines show the range of declining angles for which any shadow will fall on a vertical dial. At the author's latitude, this occurs only if the north declining angle of the dial is greater than 39° 20' E or 39° 20' W.

The hour line range for the direct north, east and west dials described above can be confirmed using Figure 1. However, it should be remembered that Figure 1 shows the maximum possible range of hour lines. For east or west direct dials, the noon line will not appear on the dial as it lies at an infinite distance from the dial. Also, dials with high declining angles can have their range of hour lines restricted to avoid the problem having most of the lines appearing close together on the dial face.[2]

Using a north declining angle towards the east of 15° 42' for the author's northward facing wall, Figure 1 indicates that maximum range of hour lines, at the summer solstice, would be between 03h 47m (sunrise) and 06h 50m together with between 18h 50m and 20h 13m (sunset). This gives a maximum time of only 4h 26m when there could be a shadow from the style on the dial. This reduces to only 50m at the equinoxes. Figure 2 shows the hour and half hour lines for this dial. The sub-style line is also shown (long dashed lines) and it is assumed that the gnomon has zero width. As with all north declining dials in the northern hemisphere, the hour lines increase clockwise around the dial.

Any furniture on this north declining dial will be quite restrictive, as Figure 2 also shows. In this particular diagram, the nodus has been placed 30% along the sub-style length (as indicated by the cross). It is also assumed that the nodus is a point. Any shadow for the nodus will fall only within the two triangular regions enclosed, at the top by the 0° altitude line, towards the bottom by the slightly curved summer solstice declination line and finally by the dial edge. The 20° altitude line just appears between the 6am and 6.30am lines. Changing the nodus position further up the sub-style has the effect of moving the dial furniture towards the dial edges. Moving the nodus downwards obviously limits the dial furniture towards the bottom of the dial, even though it increases the dial furniture area.

In summary, examination of the possible hour lines for a north declining dial, with a declining angle of 15° 42' to the east, has shown that there will be a maximum of only 4h 26m per day when the style could cast a shadow on the dial face. This only occurs at the summer solstice; at the

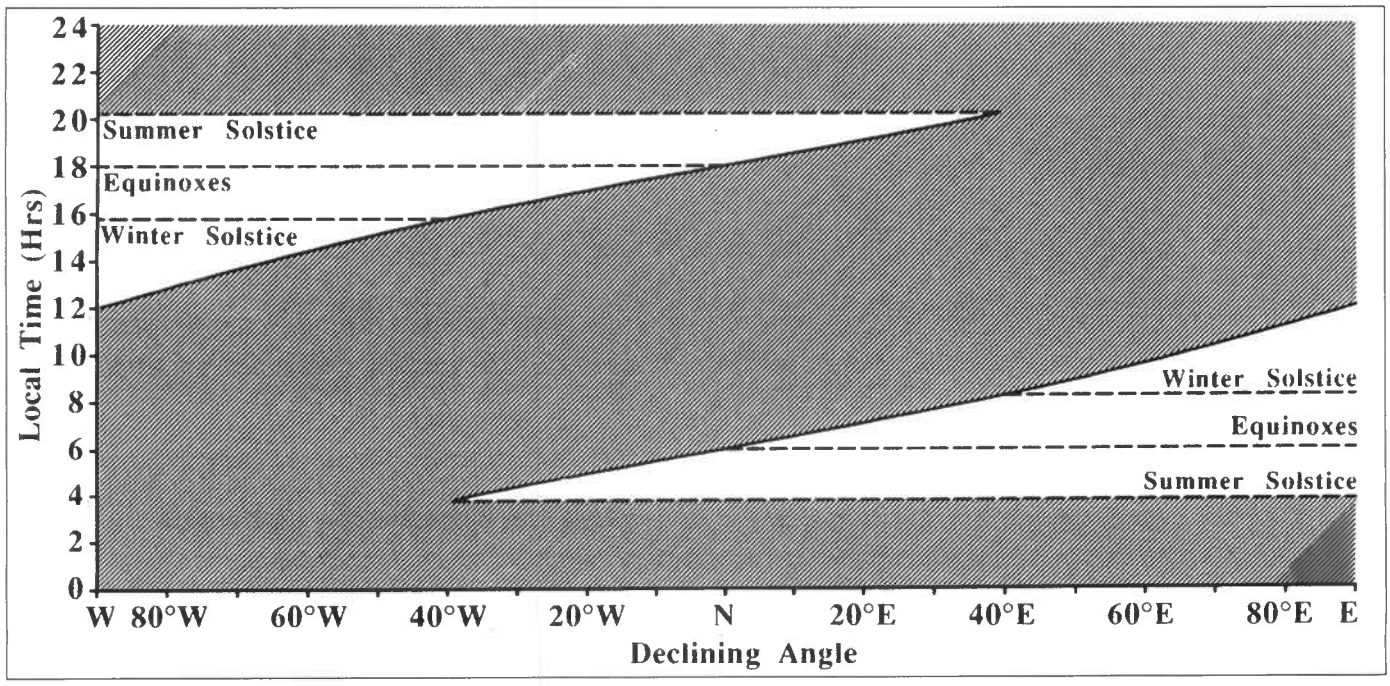
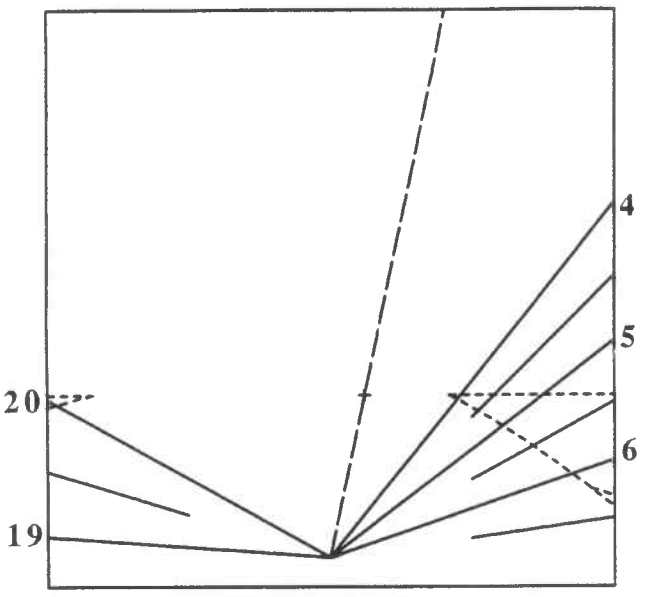


FIGURE 1: Hour line limits (unshaded portion) for north declining dials at a latitude of 51° 43' N. Sunrise and sunset limits at the solstices and equinoxes are indicated by the dashed lines.



equinoxes the dial would be of use for only 50m. In addition, any furniture is restricted to a very small portion of the dial face and would therefore not be worth including on such a dial.

REFERENCES

1. Meadows, Peter J., 'Vertical Dial Furniture', The British Sundial Society, Bulletin 94.3, p. 41, October 1994.
2. Mayall, R. N. & Mayall, M. W., 'Sundials: How to know, use and make them', Second Edition, Sky Publishing Corporation, 1973.

FIGURE 2: Dial face for a north declining angle of 15° 42' east at a latitude of 51° 43' N.

* * * * * * * *

READERS LETTERS (Continued from page 47)

satisfy the desire of enthusiasts in this century? The two points I make here speak against it.

i. In the early manuscripts, I have found nothing stated about vertical dials. Clear statements are only to be found about horizontal dials, others are ambiguous. Furthermore, the shadow schemes, and I have found about sixty in manuscripts of this period, appear to refer to horizontal dials exclusively.

ii. In your 1973 paper on the Bewcastle Cross you demonstrated that its dial, as with all others of that period, could not divide the day evenly with a horizontal gnomon. Without a polar inclined gnomon, the human stomach was a better timekeeper in these latitudes. Had the inclined gnomon been employed, there would probably have been many more dials at a time. Evidently they were so uncommon that the inscription on the Kirkdale dial makes sense, in effect it says "This is a sundial . . ." written to explain a work rarely found, even by those who could actually read the text.

So what were they really made for? As a help to the monks who needed to know the exact canonical hour for religious services? Or to demonstrate Eternity?

Finally I must confess that I have never been to Bewcastle, and with respect to you, who has, my arguments are based upon the London copy.

KARLHEINZ SCHALDACH
Germany

EDITOR: The Bewcastle Cross decorative features are not unique since the nearby Ruthwell Cross was from the same workshop and lacks only a sundial. In some respects the Ruthwell Cross is a finer piece of work. Regrettably there is no room in this Bulletin to reply to Mr. Schaldach's points in the detail required to give meaningful answers to the questions posed by him in his letter. I will reply to these points at a later date.

* * * * * * * *

BSS SUNDIAL COMPUTER PROGRAM

Mr. F. J. de Vries has kindly provided and extension to the dialling program which allows the results to be printed out on printers such as Canon, Epson, Fujitsu, HP, IBM, JRL, NEC, Toshiba (9 or 24 pin), Laser, etc. Mr. de Vries actually uses a Canon bubblejet printer in the Epson 24 pin mode and says he gets good results from this. If you have a colour printer, this can be used also.

Thanks to the kindness of Mr. J. McCrindle, the program is now available on two 3½ in discs. The price is still £8.50 for the program and despatch costs, those who purchased the original program may update for the price of £2.50 (to cover the cost of the discs and postage) on return of the old disc as proof of initial purchase. There is no objection to copying the original program for continued personal use.

The Editor, on behalf of the BSS members, thanks both Mr. de Vries and Mr. McCrindle for their assistance in providing the program for BSS members.

A program is available in MS PC/DOS 720K format on a 3½ in disc in respect of Professor Freeman's letter on page 47, the price is £1.00 to cover the cost of the disc and postage. It was intended to provide the program listing in the Bulletin but this causes great problems for our printer, and would have meant much work by individual members to enter it into a computer and eradicate the possible errors. If the actual listing is preferred this can be provided by the BSS Bulletin Editor at a cost of 50p (includes postage).

Members are reminded that the American publication "Compendium" is available on a 3½ in disc and is a very impressive presentation. An IBM compatible computer is necessary to be able to make use of this method. The Editor is prepared to loan a sample disc to allow members to evaluate this method for themselves once he has secured permission from the American Sundial Society for this proposal.

FUNDIALS

JOHN LESTER

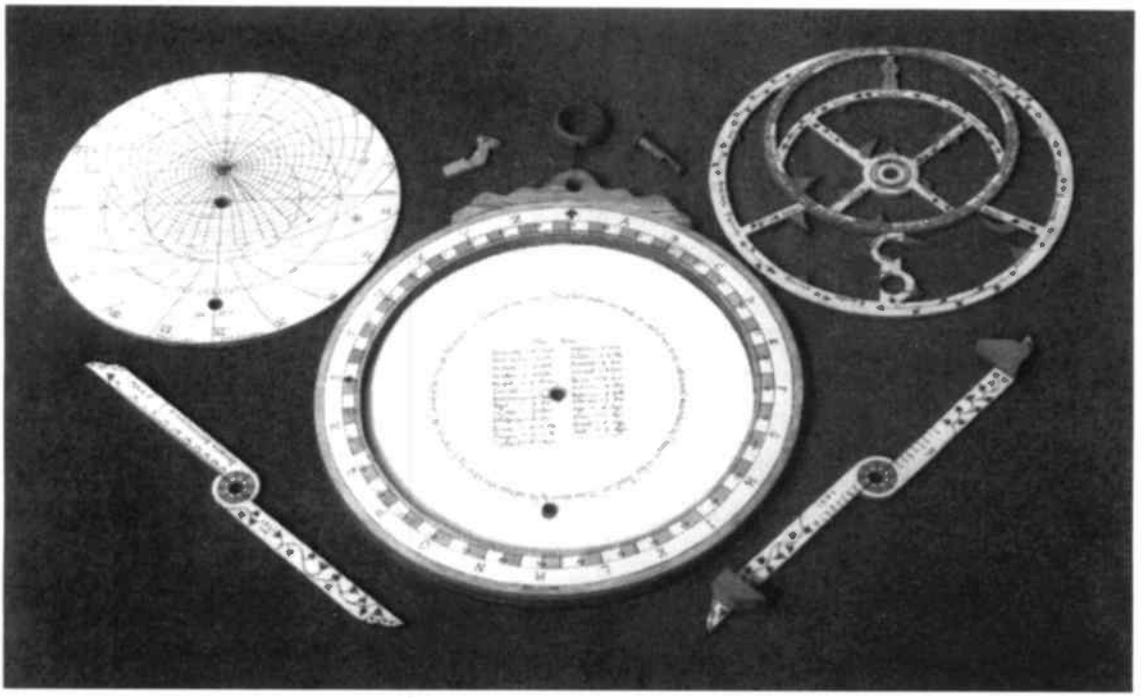


Figure 1: Components of Astrolabe

An interest in astronomy excited my curiosity about sundials and that same interest led to my involvement with The Astronomy Centre, an organisation aiming to establish an observatory with a large telescope on moorland between Bacup and Todmorden. Funds were, and still are, badly needed so for some years now I have run a stall at their biannual Star Parties in an effort to raise funds for the Centre. It began as a bring-and-buy stall to which members contributed unwanted astronomical equipment, books and magazines, but quite soon the idea occurred to me that I could make items to sell and swell the profits further.

Sundials seemed a possible product and reference to Waugh's 'Sundials, their Theory and Construction' showed that there was a wide range of portable dials which might attract buyers. Having only facilities for woodworking and turning was a bit limiting and meant that any dials I made would have varnished paper scales in order to keep prices low, but there are instruments in the Museum of the History of Science at Oxford made in this way which have survived for centuries. Over the years a variety of portable dials have appeared in batches, and what became known as the Fundials stall achieved a steady rate of sales. There were horizontal dials of various designs (with built-in compasses), combined horizontal and analemmatic dials (with lunar volvelle), Capuchin dials, cylinder dials (Oh, the calculations!), equatorial dials, floating horizontal dials (with built-in magnets) and even a heliochronometer. The dials, when not universal, were drawn for the latitude of the Astronomy Centre (53°43'N) though buyers came from all parts of Britain and even from abroad. A batch of nocturnals also found purchasers but in order to keep sales going it was always necessary to produce a new design for each Star Party. Using only wood and paper a high level of accuracy is not easy to achieve but these instruments at least serve to illustrate principles and have value for that reason.

Inspiration ran low from time to time but it was when I was struggling to understand Chaucer's 'Treatise on the Astrolabe' that I realised an astrolabe in the hand was worth two dozen in the museum. I found three articles by Eisner entitled "Building Chaucer's Astrolabe"[1] and they triggered a phase of astrolabe making, see Figures 1, 2 and 3. Like the sundials, I have lost count of how many I have made and sold, but the buckets of sawdust and shavings recycled on the compost heap bear witness to a considerable output.

Figure 2: Astrolabe assembled, front view

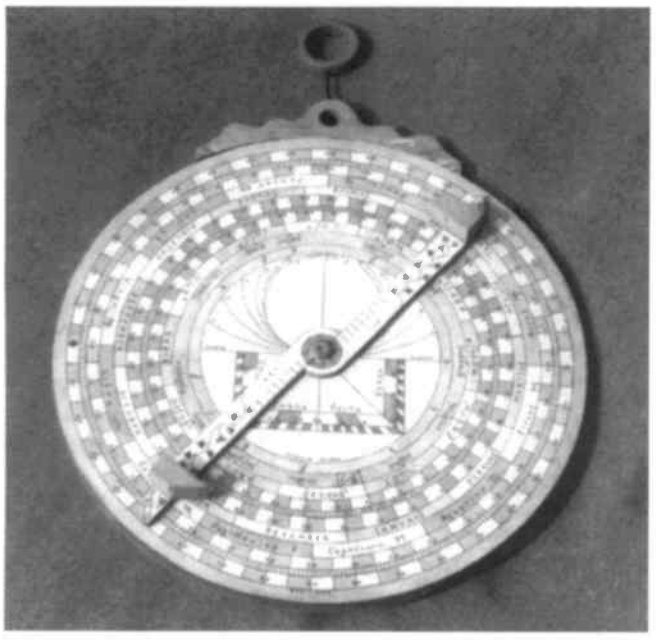


Figure 3: Rear side of Astrolabe

Figure 4: Horizontal dials with built-in compass

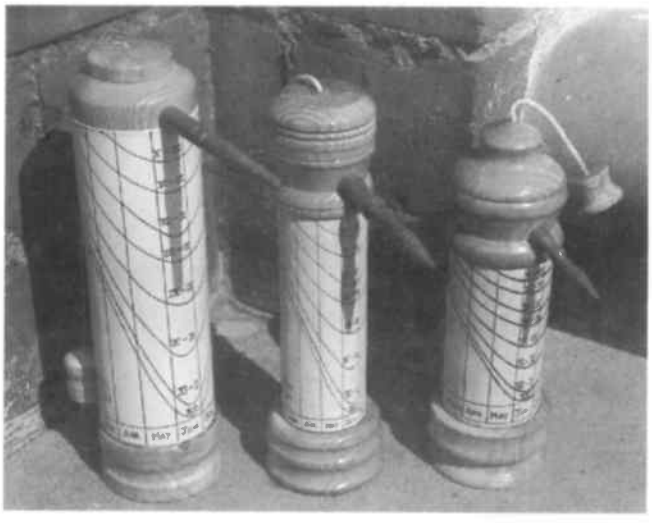


Figure 5: Group of Column dials

Other money-raising ventures included hand-coloured reproductions of an 18th century celestial chart and the publication of articles in "Woodworker"[2] and "Astronomy Now".[3] Once again, I am running out of ideas and the next Star Party is getting uncomfortable near. A batch of polar dials may save me this time but after that I shall need fresh inspiration. The B.B.S. Bulletin seems a likely source.

* * * * *

1. Journal of the British Astronomical Association. 86. 1975 pp. 18-19, 1976 pp. 125-132 and pp. 219-227.
2. Woodworker. Vol 92. No 10 Oct 1988. 'Time stands still' (Instructions for turning a cylinder dial).
3. Astronomy Now. Vol 5 No 7 July 1991. 'The Astronomer's Tale' (Encouraging a young person's interest in astronomy - an example from the XIV century).

KEEPING TRACK OF THE SUN

H.R. MILLS

It may be of interest to some members to consider, and make use of the Sun's Azimuth (compass bearing) for telling the time. Unfortunately, these bearings are related to the Sun's Hour Angle by a complicated formula, see Figure 1 below, which can be used to determine the position of the style on the meridian to give the Sun Time, as is done on analemmatic dials, or the playground dial which uses the observer as a gnomon.

A small simple "window-sill" dial that uses the Sun's azimuth, can be made which consists of a small compass rose with a small vertical style such as a matchstick or small plastic knitting needle at its centre. This will not of course show directly the Sun Time but will give the Sun's azimuth by its shadow angle which is Azimuth - 180°. This Azimuth can readily be converted graphically into the Sun's Hour Angle by the graphs shown in Figure 2 or by means of the nomogram mentioned in the British Sundial Society Bulletin 95/1 p.46.

For readers familiar with scientific calculators, the set of graphs shown in Figure 2 are derived from the so-called four-part formula, which involves the Azimuth, Az., the Hour Angle, HA., the Declination δ (dates) and the latitude Ø.

$$\text{Tan HA} = \frac{\text{Sin HA}}{\text{Cos HA sin Ø - cos Ø Tan δ}}$$

The three graphs shown are for declinations, 20°, 0°, and -20° but by interpolation intermediate values can be found. These values are shown in the table Figure 2. This table incidentally exposes the false azimuths that are given by the hour hand of a watch held horizontally but which are, at times, advocated by unscientific youth leaders, and can lead hikers 20° off course.

* * * * *

RISINGS AND SETTINGS OF THE SUN

The Azimuth of any celestial body at rising or setting can readily be found from the spherical triangle formula sin δ = sin ø sin alt + cos ø cos alt cos A_Z putting alt = 0 giving cos A_Z = sin δ / cos ø.

Azimuths of the Sun in degrees compared with bearings by the Watch method. Latitude 51°N, Bearings from N towards E.

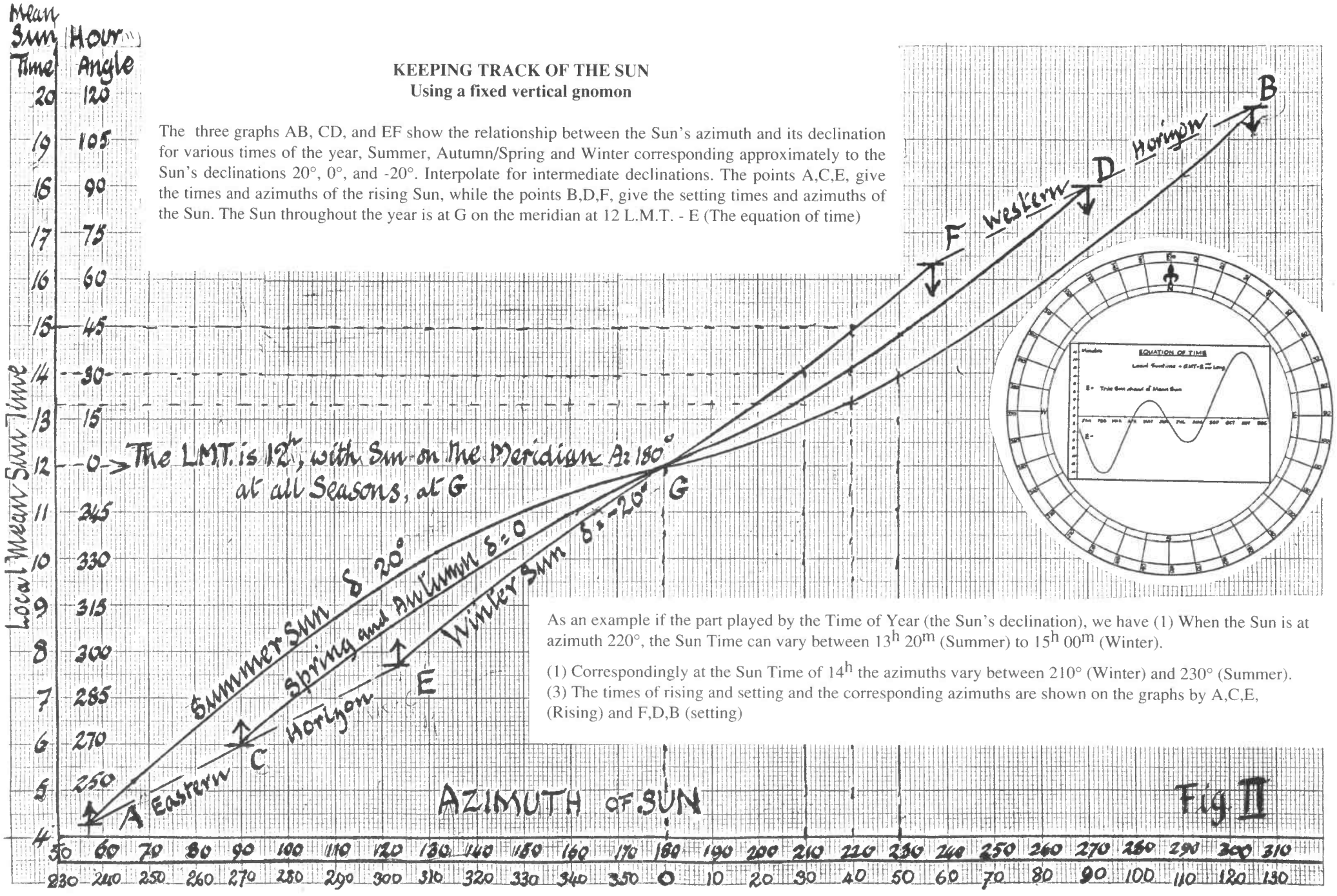
Local Sun Time	June +23°	May July +20°	April Aug +10°	Mar Sept 0°	Feb Oct -10°	Jan Nov -20°	Dec -23°	Watch Result
4	53							60°
5	64	66						75°
6	75		84	90				90°
7	86	88	95	102	108			105°
8	95	100	108	114	120	125	127	120°
9	112	114	122	128	133	138	139	135°
10	129	132	138	143	147	151	152	150°
11	152	154	158	161	163	165	166	165°
12	180	180	180	180	180	180	180	180°
13	208	206	202	199	197	195	194	195°
14	231	229	222	217	213	209	208	210°
15	248	246	238	232	227	220	221	225°
18	285	283	276	270				270°
19	296	294						285°
20	307							300°

Figure 1

The right-hand column shows the azimuth indicated if the 'Watch' setting is relied upon. Errors are a few degrees in mid-winter, but over 20° in the summer when the Sun is most likely to be used by travellers!

KEEPING TRACK OF THE SUN
Using a fixed vertical gnomon

The three graphs AB, CD, and EF show the relationship between the Sun's azimuth and its declination for various times of the year, Summer, Autumn/Spring and Winter corresponding approximately to the Sun's declinations 20°, 0°, and -20°. Interpolate for intermediate declinations. The points A,C,E, give the times and azimuths of the rising Sun, while the points B,D,F, give the setting times and azimuths of the Sun. The Sun throughout the year is at G on the meridian at 12 L.M.T. - E (The equation of time)



As an example if the part played by the Time of Year (the Sun's declination), we have (1) When the Sun is at azimuth 220°, the Sun Time can vary between $13^h\ 20^m$ (Summer) to $15^h\ 00^m$ (Winter).

(1) Correspondingly at the Sun Time of 14^h the azimuths vary between 210° (Winter) and 230° (Summer).
(3) The times of rising and setting and the corresponding azimuths are shown on the graphs by A,C,E, (Rising) and F,D,B (setting)

THE LIFE AND TIMES OF A HARDY SUNDIAL

BY JOHN MOIR

About a year ago I was comparing obsessions with a new acquaintance and inevitably I declared my own interest in sundials. She replied that she had a rather special one in her garden which had once belonged to Captain Thomas Masterman Hardy, who had served on Nelson's Flag-Captain at the Battle of Trafalgar. Her account of how the dial came to be in her garden was so fascinating that I persuaded her to write it down and her story reads as follows:-

"My cousin, Dr. J. W. Thornton, lived in Captain Hardy's house in Portisham, Dorset, until he emigrated to Australia with his family at the beginning of the National Health Service in 1948.

For some reason he took from the garden the sundial and the top stone of its plinth. These must have travelled around Australia quite a lot before finally ending up in Perth, because my cousin lived and worked in various parts of the Red Centre and Western Australia during his medical career.

After his death in 1977 his family felt the sundial should be returned to its original place and one winter some years ago his son brought it back to England, carrying it Cabin Baggage on the aircraft; a considerable effort because of its weight!

He stayed with me in North London and the idea was, after conducting his business in London, to hire a car and drive down to Portisham and return the sundial to the present owners of the house.

Unfortunately, England was suddenly swept with heavy snow storms and the West Country was practically cut off, so the journey from London became impossible in the time he had available.

The sun dial was put 'pro tem' in my garden, positioned to read the correct time and there it remains to this day.

The stone work has crumbled a bit more because of bad weather conditions some winters ago but otherwise it is in good order and much appreciated - if not in the right place, at least in the right country!"

Signed Anthea Gray

With such a history attached to it, I could scarcely wait to see this dial and a visit was soon arranged. I was particularly struck by the crispness of the engraving on slate, as if it were done yesterday, and the beautiful scroll design of the bronze gnomon (Figure 1). Sadly time and travel had taken their toll- some splitting and flaking of the dial plate having occurred, but most of the engraving was easily readable, thus:-

1. Distance of Meridian from London 0.11
2. Joseph .....y Esq
3. Kingston Ru .....at 50 degrees 45 minutes
4. Fu..... uge
5. 17.....
6. G.Aislabie Delin
7. C.Nepecker Sculp

Interpreting and filling in the gaps was not too difficult:-

1. Presumably this indicated that the time difference from London was 11 minutes, i.e. Longitude 2 degrees 45 minutes W.
2. Joseph Hardy - this could have been either Captain Hardy's father or grandfather, both named Joseph.
3. This had to be Kingston Russell, Dorset, which lies within a few miles of Lat. 50 degrees 45 minutes N and Long. 2 degrees 45 minutes W.
4. Fugio Fuge - Motto, "As I fly - fly thou", which of course refers to the transience of life. (David Young kindly winkled this out of Mrs. Gatty's book). (See David Young's article on page 41.)
5. 17..... Here I drew a blank.

6/7 Jill Wilson, who compiles the B.S.S. list of dial makers had not met with these names before, and suggests they could be local clockmakers/schoolmasters who had the necessary dialling skills.

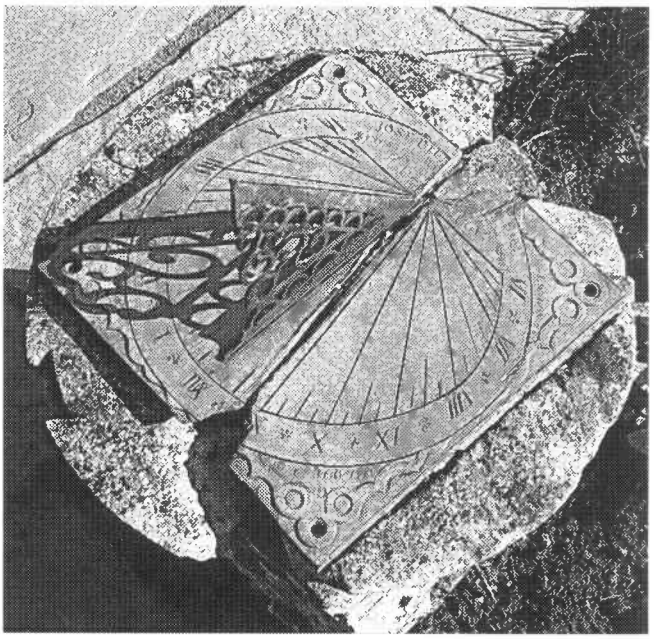


FIGURE 1: Captain Hardy's Sundial in 1994..

At this stage I was prepared to call it a day, admitting defeat on the question of date but otherwise quite satisfied, when I chanced upon a book published in 1909 entitled "Nelson's Hardy, his life, letters and friends", by Broadley and Bartelot. This book confirmed that Joseph Hardy, the younger, did indeed live in Kingston Russell House, which was the ancestral home of the Duke of Bedford (family name Russell) and it was here that Joseph's famous son, Thomas Masterman Hardy was born in 1769, and (more importantly!) where the dial began *its* life.

As a boy, T.M. often scrambled the four miles over the downs to visit his grandfather, also named Joseph, who lived in Portisham House, though the young T.M. always referred to the village as "Possum". This house is depicted in a photograph which, although of poor quality, is worth reproducing here (Figure 2) simply because, quite prominent in the left foreground stands the Hardy sundial. It is also worth quoting the passage from the book that refers to this photograph, as it neatly brings together this part of the story:-

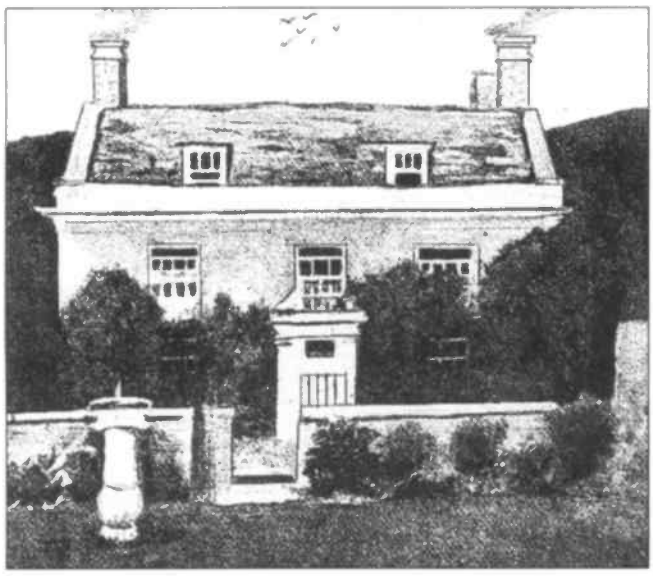


FIGURE 2: Captain Hardy's home at Portisham from an old photograph 1909

"Opposite the entrance of Portisham House to which Thomas Masterman Hardy's father and mother removed in 1778, on the death of Joseph Hardy the elder, stands a weather-worn sundial, which they must have brought with them from Kingston Russell. It bears the following inscription:-

'Joseph Hardy Esq., Kingston Russell, 1767.
Lat. 50 degrees - Fugio Fuge'".

Although the inscribed latitude is incompletely quoted as 50 degrees instead of 50 degrees 45 minutes, the date seems reliable enough, and is substantiated by this extract from a report I have recently discovered of a Dorset Field Club visit to Portisham House in 1920:- ".....In the garden is a picturesque sundial dated 1767 bearing the name of Joseph Hardy".

This would indicate that the inscriptions on the dial face were quite readable and undamaged in 1920, so that the "weather-worn" state referred to in the 1909 book probably refers to the plinth stone rather than the dial plate.

The following table summarises this intriguing dial's globe-trotting career.

1767-1778	11 years	Kingston Russell House, Dorset.
1778-1948	170 years	Portisham House, Dorset.
1948-1978	30 years	Australia/Perth.
1978-1995	17 years	North London.

When Dr. Thornton transferred the dial from the young Hardy's "Possum" to the land of the Possum, it is worthwhile considering how he could have used it to any good effect.

Assuming that his travels centred on an average latitude of 30 degrees S, the dial would have required wedging by about 21 degrees to maintain the gnomon on a N - S axis (see Waugh p.47). Such wedging would effectively have changed the dial from a horizontal to a reclining type, resulting in some loss of range at sunrise and sunset.

Furthermore, because of the reversed orientation of the dial, 2 p.m. and 3 p.m., for example, would have stood for 10 a.m. and 9 a.m. respectively, and even trickier, 1.15 p.m. would have indicated 10.45 a.m. These conversions are analogous to reading a clock seen in a mirror - not easy at the best of times. Finally, there still remained equation of time and longitude adjustments, the latter depending upon locality.

On balance, I think Dr. Thornton probably sported a watch, but the dial provided the reassurance of an old friend in his somewhat unfamiliar surroundings. He may have been pushing the definition of a portable dial to the extreme but in doing so he has provided us with a remarkable story and I am grateful to Anthea Gray for having given me the opportunity to delve into it more deeply.

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GEORGE HIGGS MEMORIAL FUND

A REMINDER

The death of George Higgs was heard by the assembled Annual General Meeting at Urchfont Manor with considerable sadness. The meeting decided that a Memorial Fund should be set up to commemorate his name and his particular achievements in dialling, and that the George Higgs Memorial Fund would be used to award a special prize with the inaugural Award Scheme announced in BSS Bulletin 94.2. page 45.

It was thought that this prize should be awarded to an entrant who had not been engaged in sundial making prior to the formation of the British Sundial Society in May 1989.

Please send your contributions to the BSS Treasurer:

Mr. R. A. Nicholls
45 Hound Street
SHERBORNE
Dorset DT9 3AB

Cheques to be made out to the BSS George Higgs Memorial Fund. The Treasurer will be pleased to acknowledge receipt of your contribution.

* * * * *

Please also look again at page 1 of Bulletin 92.2 at the message from our Patron, the Rt. Hon. The Earl of Perth, PC for an alternative means of making a contribution to the memory of a truly remarkable man. The proposal of fitting a glass window dial, designed and delineated by our member David Gulland, has been accepted by the Council at Kircudbright and is being brought to fruition as a result of the efforts made by our Patron.

Contributions to the above address please, clearly marked for the "George Higgs Memorial Sundial Appeal".

MRS. GATTY AND HER BOOK OF SUNDIALS

DAVID YOUNG

Mrs. Alfred Gatty's volume on sundials is a classic book well known to most sundialists, although not everyone is lucky enough to own a copy. Who was this Mrs. Gatty? Why did she write a book about Sundials? My own curiosity was to some extent satisfied when our member Frank Evans told me he had found a book about her life, published just after the last war by one of her grandchildren, Christabel Maxwell. Here then is a thumbnail sketch of her life, largely taken from this book but added to from some other minor sources.

Margaret Gatty

Mrs. Gatty was born Margaret Scott in 1809. Her father, Dr. Alexander Scott who had been chaplain to Lord Nelson, was in consequence well travelled and was an expert linguist. After the death of Nelson who died in his arms, he obtained the living at Southminster, Essex and married Mary Francis Ryder. They had three children, Horatia, the eldest, Margaret and a son who died in infancy. Mrs. Scott herself died just over two years after the marriage, so the two girls were brought up by their father with winters spent with their grandmother in London. A few years later Dr. Scott was appointed to a new living at Catterick, Yorkshire and eight year old Margaret with Horatia moved to the large Vicarage there which Dr. Scott had filled with books of many languages and mementos of his travels. Margaret was particularly interested in literature, she sketched in pencil and became a pianist of some skill. She kept close to her sister Horatia and they went everywhere together, having many interests in common.

In 1828 a number of friends and she formed what they called "The Black Bag Club". Stories and poems they wrote were put into a black bag and every so often they would all come together and read their masterpieces out aloud. Margaret also started to write poems and stories for children which started to be published in magazines of the period.

In about 1835 her interest in sundials began, chiefly in the collection of mottos of dials seen in the locality (there were several listed in her book) including the one over the porch of Catterick Church. Others further afield were sent to her by friends.

Visitors were always coming to the vicarage but one day a young curate who had only recently been ordained at Ripon was invited by Dr. Scott to stay for a few days. He was of good education and charming manners but had little money. He met Margaret and was instantly attracted to the girl of twenty eight with wonderful corn-coloured hair. She was very conscious of her lack of real beauty but failed to appreciate her charm of manner - not so the young man who after some acquaintance plucked up courage to declare his affection, and was not repulsed. Dr. Scott, at first forbade all thought of engagement to a curate with little prospect and a stipend of £57 a year.

Eventually after pleading with her father he did give his consent and they were married in St. Giles in the Field, London on July 8th, 1839. Margaret Scott had become Mrs. Alfred Gatty. On honeymoon in Scotland she wrote to her sister, Horatia ". . . I was in such a fuss in London. As we went to Blackwell to embark on the steamer I saw a dial in Leadenhall Street 'Non sine Lumine'. I have found none here . . .'

On return to Yorkshire Margaret learned that the living at Ecclesfield was vacant. It was in the gift of her Uncle Edward Ryder following the death of his brother and he was pleased to offer it to Alfred Gatty. So the newly married Gatty's settled in to the spacious vicarage at Ecclesfield where they lived for the rest of their lives.

During the next fifteen years she bore ten children, six boys, Alfred Alexander, Reginald, Alfred Scott, Stephen, Charles and Horatio, and four girls, Margaret, Juliana, Horatia and Undine. It seems hardly creditable that during this time as well as all her activities struggling to make ends meet with her ever growing family and with her social responsibilities as a parson's wife she nevertheless found time to write more stories, continue with her sundial collection and to write a book in conjunction with her husband on the life of her father which was published 1842.

After the birth of her seventh child she became ill and on the suggestion of her doctor went to stay at Hastings for five months to recover in the warmer climate of the south. Here she started a completely new interest. She met a local doctor there who was interested in the study of seaweeds. He introduced her to a book written by Dr. William Harvey, Professor of Botany at Dublin University and she spent hours collecting specimens and using her undoubted drawing skills to sketch them. From that time on her interest in the subject never wavered and on her return to Ecclesfield she studied all she could find on the subject, collecting specimens wherever she went and encouraged her friends to do the same. She started a communication with Dr. Harvey which developed into a friendship which lasted the rest of his life. The few years after her last child was born (he died in infancy) were her most crowded and probably her happiest. In 1851 she achieved her first

BOOK OF SUN-DIALS.

COLLECTED BY

MRS. ALFRED GATTY,

AUTHOR OF "PARABLES FROM NATURE,"

ETC.

LONDON:

BELL AND DALDY, YORK STREET,

COVENT GARDEN

1872.

THE BOOK OF SUN-DIALS

ORIGINALLY COMPILED BY THE LATE

MRS. ALFRED GATTY

NOW ENLARGED AND RE-EDITED BY

H. K. F. EDEN AND ELEANOR LLOYD

LONDON: GEORGE BELL AND SONS

MDCCCC

success in the literary world when she had her story book "The Fairy Godmother" published - she asked the publishers to send her Dr. Johnson's book 'The Zoophytes' in lieu of payment! Five more books followed.

The family generally spent holidays at the seaside a typical diary entry was "Set off for Filey, Alfred, self, seven children, two nurses and the cook . . . went down to the sand and found seaweeds". No doubt she would have noted any dials seen on the way! The return to Ecclesfield must have sometimes presented a curious picture for bedside their personal luggage there was the inevitable bottles of sea-water, baskets of shells, seaweeds, chippings of rock and other treasures of the deep. A few years later with encouragement from Dr. Harvey she started writing about her seaweeds, illustrated with her meticulous drawings she finally published "The History of British Seaweeds" in two volumes in 1869. A remarkable achievement for an amateur considering it became a standard work in many botany departments and in some cases was in use by students for some eighty years after being written.

At this time Margaret's interests, apart from her sundials also included fungi, homeopathy, the use of the newly discovered Chloroform for the relief of pain, and astronomy. At the same time she was busy writing more books for children often helped by her daughters, particularly Juliana who became a best selling author of children's books in her own right. She had established a reputation as a writer for children and in 1865 became editor of a children's story magazine. She met and corresponded with many famous people, Professors of Botany including Dr. Harvey and Dr. Joseph Wolfe, Lord Tennyson, and Lewis Carol who wrote for her magazine. Unfortunately her health, which of latter years had been poor deteriorated further and she was often in pain and found difficulty in the use of her muscles particularly her right hand and she started writing rather laboriously with her left. She still published more books, a volume of poems, "Waifs and Strays of Natural History" in 1870 and at last in 1872 one of her most imposing volumes, her "Book of Sundials" which had been written a little while before and had been considered seriously by her publisher, Bell and Sons, since 1869. All her own collection of dials were listed plus many from abroad sent to her by a friend of the family, Miss Eleanor Lloyd. At this time she had lost use of all her limbs and was attended constantly by her two daughters remaining in the vicarage, Juliana and Undine. She remained remarkably cheerful until the end which came peaceably on 4th October, 1873.

This is, however not quite the end of the story of the book as it was reprinted and enlarged four times in the next thirty years. For this we have to thank her daughter Horatia (later Mrs. H. K. Eden) and her old friend Eleanor Lloyd. In the later editions an extra chapter on portable dials written by Lewis Evans was incorporated and the work expanded including many more dials researched by Eleanor Lloyd and others.

What is perhaps surprising is that since 1900 no other recording of sundials in this country has been published or, as far as is known seriously attempted, until the British Sundial Society was formed in 1989. I hope that those members who have or are thinking of contributing to our sundial register will feel inspired by Margaret Gatty's example, if she was alive today I am sure she would be urging us on to our first 10,000!

BIBLIOGRAPHY - BOOKS BY MRS. GATTY

1842 Life of Dr. A. J. Scott (written with her husband)
1851 The Fairy Godmother
1855 Parables from Nature (1st series)
1856 Worlds not Realised
1857 Parables from Nature (2nd series)
1857 Proverbs Illustrated
1858 The Poor Incumbent
1858 Legendry Tales
1859 Aunt Judy's Tales
1859 The Human Face Divine
1861 Parables from Nature (3rd series)
1861 Old Folks at Home (written with her husband)
1862 Aunt Judy's Letters
1863 History of British Seaweeds
1864 Parables from Nature (4th series)
1864 The History of a Bit of Bread
1865 Domestic Pictures and Tales
1866 Aunt Judy's Magazine
1870 Waifs and Strays of Natural History
1871 Parables from Nature (5th series)
1872 The Mother's Poetry Book
1872 The Book of Emblems
1872 The Book of Sundials

EDITORS NOTE:

Will BSS members please note that more material is now required to be able to produce future issues. Illustrations preferably in black and white photographs or line diagrams. Good colour prints are acceptable but transparencies rarely give the standard of reproduction required for the Bulletin. Photocopied material must be of good quality for the same reason. Text is preferably double-spaced typed on one side of the sheets only but hand written work is quite acceptable. For the house style of BSS Bulletin, read through a few articles. Aim for a length of article of about six pages although for an important subject the article can be of any length, however, if too lengthy, it will have to be presented in two or more parts. The most important part of an article is the accuracy of its factual information.

BOOK REVIEWS

SONNENUHREN Deutschland und Schweiz. (Sundials - German and Swiss) Hugo Philipp, Daniel Roth and Willy Bachmann, pp. 751 (not paginated). 141 photographs, 68 line figures, paper covers, 24 x 17 cm. Published by the Deutsche Gesellschaft für Chronometrie, 1994. German text. ISBN 3-923-422-12-1. Price 96 DEM, including shipping. Best to obtain via the BSS booksellers but can be ordered direct (payment by Eurocheque).

It is sad but the first-named and main author, Dr.-Ing Hugo Philipp, as reported in BSS Bulletin 95.2 for June 1995 and amplified in this issue, died on 29th January 1995 without knowing the success of the published results of his work over many years.

Why Germany and Switzerland sundials together in one book? It was planned many years ago to include the sundials of all the German-speaking countries, Austria, Germany and Switzerland in one catalogue. The Austrians however produced a catalogue of their own, leaving just Germany and Switzerland to be catalogued.

The catalogue is a massive tome weighing over 2½ pounds, about 1.2 kilos, containing the details of about 6050 sundials in Germany and about 2200 in Switzerland. Each dial is given a catalogue number, place name and exact location in latitude and longitude, described in brief detail, with mention of condition and recent restorations, and whether the gnomon is present or not. A few illustrations are included, generally of one-column width, all in black and white and rather lacking in "sparkle" because of the reproduction method. This huge list is the main thrust of the book but is preceded by thirty-four pages of introductory text.

This preliminary section is commenced by an introduction by the doyen of dialling, our Vice-President René R.-J. Rohr, (see page 2/3 of BSS Bulletin for an English translation of this by E. J. Tyler). The reviewer finds the extract from Heinrich Heines poem "Atto Troll" about a neglected sundial particularly apt and appealing, when all over the world neglected sundials are crying out for attention and care. Next a section entitled "The Quartz Clock and the Sundial" by Heinz Schumacher, with a poem: followed by a foreword written in collaboration by the three authors.

A considerable section follows, with details of the main sundial types mainly presented in line diagram format and the catalogue listing of an actual example. It is supplemented with pages of the principles of dialling, very clearly laid out, concluding with an explanation of the Equation of Time and the Analemma. This section also has two poems by Hans Schumacher. Four pages set out the details of the composition of the catalogue listing, essential information before consulting the list itself on a systematic basis.

At this point the listing of German sundials begins. At a rough guess this occupies about two thirds of the book and ends with the well known quote from St. Augustine's 'Confessions' - "What then is Time . . .", which no one has improved upon in the millennia following. Thus onwards to the Swiss catalogue of sundials in the same fashion but interspersed with verses and sayings which succinctly summarise Man's involvement with Time and the Sun.

Sources and acknowledgements cover three pages - an indication of the number of participants involved in the preparation of this monumental listing. The locations of the dials are given in alphabetical order, separately for German and Swiss sundials, which seems quite logical.

A final section includes a sample recording page used by those who gathered the data. It is rather more complicated than the BSS recording form, possibly because the reviewer is unaccustomed to the German language. Details of articles in literature, particularly the Arbeitskreis Sonnenuhren in Deutschen Gessellschaft für Chronometrie are included. This is only natural since this is the Society which has published this massive work.

The paper cover carries an illustration of a modern vertical sundial with the motto "Umbra Demonstrat Lucem" - The Shadow shows the Light, but it would be an unclear dial to most with its 24-hour system numbering and the zodiacal symbols merely painted on it as decoration without utility. But it looks "nice", it carries the date 1976.

The reviewer can only express the admiration for the compiling of such a huge listing of sundials - the kind of work which one day the British Sundial Society may be able to emulate. It would be difficult to set the details out more clearly and this book will be the Vade Mecum, albeit a bulky one, for all those searching out sundials in the German speaking regions in Europe (apart from Austria, separately catalogued). It is a monumental achievement of the first order and every sundial enthusiast should have a personal copy.

DIALS IN THE HERMITAGE MUSEUM COLLECTION. V. Iu. Matveyev, pp. 166, 150 Illustrations, of which 100 are in colour, 230 x 240mm, hard bound. Published 1995. Text in Russian, English and German. Price not known, other details of publication still to be obtained.

Permission to reproduce a full review of this catalogue is being sought, a synopsis of the contents translated by R. Smirnov is given below.

The content of this book and its pictorial material can be summed up in such terms as Cosmos and the Sun, Man and the Earth and human awareness of Time confined within these limits.

This palpably demonstrates humanity's age-old urge to curb time by recording it. The dials illustrated in the book epitomise ideas evolved in different parts of the world and their materialisation. To illustrate this process the writer has made use of paintings, frescoes, and engravings by European and Oriental artists who turned their talent and aspirations from Earth to Heaven. Throughout the text there are sketches of timepieces, whose designs underwent a virtual heuristic evolution over the millennia.

The backbone of the book is formed by the collection of sundials and moondials from the Heritage Museum, which includes fragments of *scasis,* standing marble dials from Olbia (second-third centuries BC), bronze dials from Egypt (fourth-seventh centuries AD), as well as articles made by the illustrious Klieber masters in Augsburg (mid-sixteenth century) or dials made in France, England, Venice, Amsterdam, in addition to these, it presents the collection from Peter I's study made by turners from his workshop.

Individual items in the collection come from places spread over a vast geographical area - from Archangel to Alexandria and from London to Babylon. Central to the book is the idea that dials show the history of crafts in their development, and form an indispensable part of human civilisation and culture.

There are more than fifty sundials and nocturnals, and ten astrolabes in the Hermitage, making it one of the most important in Russia.

The full title of the catalogue is given by Patricia H. Atwood (of the Time Museum, Rockford, Illinois, USA) as: ***Western European Sundials and Nocturnals in the Hermitage Collection from the Middle of the XVI to the Beginning of the XVII Centuries.*** She has translated Matveyev's book, published Moscow 1981, (Russian text).

* * * * *

SUNDIALS FOR FUN, Colin McVean, pp. 182, 107 Illustrations, 26 Plates. A4 format, perfect binding with thin card covers. Privately published by Time Tellers. Fairford, Gloucester, 1995 ISBN 09526550-0-4. Price £12.

The Introduction outlines the purpose of the book, hinted at in its title.

The first plate in the book shows how art and science can be gracefully combined in the Henry Moore Dial at the Chicago Planetarium, the second shows the large Equatorial Dial at Jaipur, India. These lead one into the "Historical Note", commencing with sun indicators preceding the sundial and going on to an illustrated listing of the various dials. A Glossary briefly lists the terms used in the art of Gnomonics and Time Measurement.

Chapter 1 covers the structure of the Celestial Sphere, the Zodiacal journey of the sun, and the true motion of the earth. As indicated in Chapter 2, diallers still work to the Ptolemaic principle, merely because it is much more convenient to do, practical ease is preferable to scientific accuracy. Here too the outline of how to derive the various times required from the strictly local solar time of a sundial situate in various locations.

Chapter 3 moves on to a more practical theme with the construction of a combined Equatorial and Polar Dial, preceding to that of an horizontal dial - the most popular sundial for a garden.

In similar fashion, Chapters 4 to 15 deal with the following:

Direct Vertical Dials, Vertical Declining Dials, Cross and Armillary Dials, Cylinder and Globe Dials, Time by the Moon, the Stars, Tides, the Nocturnal, the Heliochronometer, Dials on Buildings, Dial Furniture, the Cruiserfix, Ceiling and Floor Dials, and finally Electronic Dials.

The sections which conclude the book include Sundial Mottoes, Tools and Materials, Bibliography. Four Appendixes give tables for Hour Angles for Horizontal and Direct South Vertical Dials, Equation of Time, Declination of the Sun, and the Height of the Sun above the Horizon.

The author mentions in his Introduction about A.P.H. Herbert's book *Sundials Old and New. Sundials for Fun* is modelled on this book but more scientifically and with more constructional detail than Herbert. The latter wrote with his tongue in his cheek most of the time, in fact he was well known for his APHorisms and eccentric behaviour such as swimming in the River Thames when it had been deserted by every other living creature.

Because of the means of producing the book, the photographic illustrations are not very good, there are a fair number of typographical errors. One wonders too how long the "perfect" binding will last when the book is consulted frequently. Astrolux covers would have been much better for the thin card covers will not stand up to much wear and tear, they need plastic covers if they are to survive for long. Reading typewritten text is also much more tiring than that set by a printer, the reader's eye wearies in having to travel the whole width of the A4 pages and then locate the start of the next line.

Within the restrictions of time, finance and effort, the author has succeeded in meeting his intended goal of presenting sundials in a more practical way than in the standard textbooks. His book will be more useful to teachers who are guiding pupils in how to combine theory and practice with "hands-on" experience in using simple tools and easily obtainable materials. With the author's instructions, sundials can be quickly made, a vital condition when those engaged on such projects cannot gain pleasure from doing the work without a reasonably rapid result. And the use of easily obtainable materials considerably reduces the cost. The use of the traditional brass plate is far too expensive today to waste it on beginners.

Continued on page 32

READERS LETTERS

THE ROYAL MAIL POST CODE AS AN AID IN DIALLING

To design a sundial plate and set the gnomon angle the first step is to ascertain the latitude and longitude of the location. In the United Kingdom the Ordnance Survey national grid coordinates for any address may be obtained from the Post Code and thus its geographical location. The Post Code is made up of four elements: The Post Code Area, The Post Code District, The Post Code Sector and the Post Code Unit. In the Post Code PO1 3AX, the first half PO1 is the outward code which is divided into two parts. Beginning with two letters which define one of the 120 Post Code Areas in the UK. The letters are based on letters from a city, town or district in the area. In the example given PO signifies Portsmouth. The second part of the outward code is a number, either one or two digits which indicate a Post Code District within the Post Code Area, except in London which because of its size uses a combination of numbers and letters (e.g. SW1A). There are approximately 2800 Post Code Districts in the UK.

The second part of Post Code is the inward code which is used by the sorting office nearest to the point of delivery. In our example PO1 3AX the figure 3 a single digit denotes the Post Code Sector and each Post Code digit has up to ten Post Code Sectors with some 9000 in the UK.

The second part of the inward code AX is made up of two letters, AX in our example. This denotes the Post Code Unit which average some fifteen addresses. There are approximately 1.8 million Post Code Units in the UK covering 25 million addresses or delivery points.

The 25 million addresses are contained in the Post Code Address File (PAF). It is the most complete and up-to-date address data base in the UK. For the commercial diallist this information on a (IBM compatible) PC makes an address check and OS grid reference immediately obtainable. Again by computer the transformation to latitude is simple. JOHN N. FINLAY

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MELVILLE DIALS

The puzzling instructions for finding the time at the places listed on the Richard Melville dials, described by R.A. Nicholls in BSS Bulletin 95.2, can be readily interpreted. The times on the main dial calibration adjacent to the place names are the local times at those places when it is noon at Greenwich, subject to the errors (sometimes large errors) noted by Nicholls. For example, when it is noon at Greenwich it is said to be 7.15 a.m. at Philadelphia.

The instructions, 'add the time past the meridian' implies that if the main dial indicates an afternoon time, the interval from noon is to be added to the time adjacent to a name to obtain the time at that particular place. Similarly, if the dial shows a morning time, subtract the interval before noon ('the time wanting') from the adjacent time. If the instructions had read '<u>or</u> subtract the time wanting' instead of '<u>and</u> subtract . . .' matters would have been clearer.

Again taking Philadelphia as an example, if the dial shows the Greenwich time to be 2 p.m., 2 hours are to be added to 7.15 a.m., giving the Philadelphia time as 9.15 a.m. If the Greenwich time is 10.30 a.m., then $1^h\ 30^m$ is to be subtracted and the Philadelphia time is 5.45 a.m.

The dial maker having gone to the trouble of providing a potentially accurate method of indicating the times at other places, it is indeed a pity that the locations and their times corresponding to Greenwich noon were not more accurately delineated. Accuracy appears to have been sacrificed for the sake of a uniform spacing of the place-names. C.M. LOWNE
East Sussex

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SPHERICAL TRIGONOMETRY

There was much of interest and enjoyment in the latest Bulletin (95.1), but I wonder if some of the authors should not be writing for the Bulletin of Spherical Trigonometry?

Speaking as someone who finds difficulty in understanding 3-dimensional ideas when drawn in 2-dimensions, the diagrams do not cater for this failing. No doubt many readers can cope, but I cannot, and I know of others. Can we not have isometric drawings (Frank W. Cousins' book is a model), or alternatively use the engineering conventions of plan, elevations, etc.

There is also a general lack of definition of symbols. They appear and re-appear in the text like currants in spotted dick, but unexplained. Scientific journals tabulate symbols and their meaning. If those used are standard terminology, may we please be pointed to the standard work of definition? R.A. NICHOLLS

EDITOR: Mr. Nicholls is, of course, the BSS Treasurer, to whom the Society is most indebted for the excellent way in which he deals with BSS finances.

Illustrations are a most thorny problem, the Editor spends much time in "improving" photographs and rescuing illustrations from very poor photocopies and quite frankly, some of the prints sent to him are almost useless for the intended purposes. Coloured transparencies usually give the worst results and what appears reasonable in the original slide can result in a muddy illustration. Mr. Partridge has helped the Editor on occasion with diagrams, but in general we do not have facilities to produce the quality of illustration which the BSS Bulletin so richly deserves. Given a good original, the result in the BSS Bulletin is a sparkling illustration, but none of us can make silk purses out of sow's ears.

Dialling terminology has also been a thorny problem with a history as long as dialling itself. The BSS should be in a position to issue a booklet containing the major and most significant dialling terms, with definitions, and their appropriate symbols. La Busca de Paper is producing such a vocabulary but it is going to take years to publish in full.

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THREE SHADOW LENGTHS

I will endeavour to answer the question posed by C.D. Lack in Bulletin 95.1, page 45, which concerned my article "A method of determining the North and Latitude" published in the Mathematical Gazette in 1975 (see Reference 2 at the foot of page 23 of Bulletin 93.3). This article has since been reproduced, with permission, in Bulletin 94.1, page 8. His question asked what sort of accuracy could be obtained by the method used in that article.

My article described a classroom experiment the aim of which was to introduce pupils to stereographic projection; it was published in the Mathematical Gazette some years before pocket calculators had become available, so I described a method which involved no calculation, results being obtained by drawing only.

To answer his question I performed the experiment, observing shadows at intervals of about two hours, and obtained values for the latitude and declination of the sun by the method described in the article. I also obtained these values by calculation applied to the same shadows instead of drawing. My results were as follows:-

	Latitude	Declination
Values obtained by drawing	52°.0	11°.5
Values obtained by calculation	53°.9	12°.1
Actual values	53°.8	11°.8

Considering the simplicity of the apparatus used - as shown in Figure 2(a) the results were surprisingly accurate.

The method of applying calculation to the stereographic projection

Letters refer to the diagrams in Bulletin 94.1, page 8.

(i) Measure lengths of OB_1, OB_2, OB_3, B_1B_2 and B_3B_2.

(ii) Denote lengths of OS_i' ($i = {}_{1,2,3}$) by r_i.

Calculate r_i from the formula, derived from Figure 3(a).

$$r_i = k \tan (45° - a_i/2)$$

where the sun's altitude a_i = arc tan (OA/OB_i) and k is the length chosen for OV.

(iii) Denote angles B_1OB_2 and B_3OB_2 by α and β respectively.

Calculate α and β from

$$\cos \alpha = \frac{(OB_1)^2 + (OB_2)^2 - (B_1B_2)^2}{2(OB_1)(OB_2)}$$

with a similar formula for cos β.

(iv) Take rectangular co-ordinate axes Ox and Oy, with Ox along OB_2. Calculate co-ordinates (x_i,y_i) of S_i' from

$$x_1 = r_1 \cos \alpha \qquad y_1 = - r_1 \sin \alpha$$
$$x_2 = r_2 \qquad y_2 = O$$
$$x_3 = r_3 \cos \beta \qquad y_3 = + r_3 \sin \beta$$

y_1 and y_3 having opposite signs since the points s_1' and S_3' are on opposite sides of the x-axis.

(v) Determine the co-ordinates (X,Y) of D, the centre of the circle through S_1', S_2' and S_3' as follows:
since $(DS_1')^2 = (DS_2')^2$

$$(X - x_1)^2 + (Y - y_1)^2 = (X - x_2)^2 + (Y - y_2)^2$$

which becomes, on simplifying

$$2X (x_2 - x_1) + 2Y(y_2 - y_1) = r^2_2 - r^2_1$$

Similarly $2X(x_2 - x_3) + 2Y(y_2 - y_3) = r^2_2 - r^2_3$

Solve these two equations to obtain X and Y.

(vi) Calculate R, the radius of the circle through S_1', S_2' and S_3' from $R^2 = (X - x_2)^2 + (Y - y_2)^2$

and OD from $(OD)^2 = X^2 + Y^2$.

The lengths of DS'_s and DS'_n are now known since each equals R.

Calculate OS'_s and OS'_n which are equal to DS'_s - OD and DS'_n + OD respectively.

(vii) Calculate the sun's altitude a_s and a_n when the sun is due south and due north (the second of these being negative) from

$OS'_s = k \tan (45° - a_s/2)$ and $OS'_n = k \tan (45° - a_n/2)$.

(viii) The latitude ϕ and the sun's declination δ are calculated from

$$\phi = 90° - (a_s - a_n)/2 \text{ and } \delta = (a_s + a_n)/2.$$

From, the north direction is given by OD, which makes an angle arc tan Y/X with OB_2.

A computer program to effect the above calculation is available from the Editor, price £1.00 including postage and packing. This program was written by my grandson Andrew M. Freeman, to whom I wish to express my thanks.

J. G. FREEMAN

* * * * *

BEWCASTLE CROSS

First may I draw your attention to page 52 of Bulletin 95.2. The quadrant shown in Fig 1 is dated 1438, whilst the ivory Column Sundial (now in the Bayerisches Nationalmuseum in Munich) is dated 1455. Secondly I would like to comment on your very instructive article in the same issue (Part 1) on the subject of the "Bewcastle Cross".

The Bewcastle Cross is unique, not only because of the sundial, but also by reason of its decoration. This includes Byzantine elements and one finds similar instances in the ornamentation of the throne of Bishop Maximinium in Ravenna.

In my view the scrolls are of less importance when compared to the squirrels and the birds . . . these is nothing less than a scene of Paradise.

Technically, because the Byzantine sundials (as they are to be seen in Armenia, Turkey, Greece and Italy) all show the twelve seasonal hours, I have no difficulty in accepting the duodecimal semicircle of the Bewcastle Cross. You have a "gut feeling" that the dial was added later, question its high position, and its dissimilarity to the rest of the shaft decoration.

Here again I must take a different view, if you look at sundials in the context of History, they never projected the concept of time-telling alone.

The oldest example of this is an illustration of the sundial in the room of the Cenotaph of Seti I in Abydos (circa 1310 BC) - a funerary decoration, which leads on to the Roman Empire where many sundials were found in cemeteries, and continues into the Christian Era with the tombstone dial of the 8th century in Cesena. Similarly, we have the dial of Orchomenos which is decorated with two peacocks . . . a symbol of Paradise.

To a greater or lesser extent, sundials often were concerned with the life-death-eternity trinity (I spoke about this and gave further examples in my lecture in London last year).

Was it not by the collective Christian desire to provide for the welfare of the Soul in Eternity, by regular prayers and devotions that timekeeping took hold of men's minds? I see also in the "soaring" sundial of Bewcastle, that it is not only of this world, but also in the midst of Paradise, reachable only by those who live by the Law of God.

There is a problem in all this to which I cannot find a convincing answer. Have the vertical dials, north of the Alps, and from the seventh until the eleventh century ever been used as time-tellers? Are there any real indications to

Continued on page 34

COMMENTS UPON THE CANTERBURY PENDANT

P.I. DRINKWATER

I was intrigued to read Mr. Mills' long and sumptuously illustrated Article on "The Canterbury pendant: a saxon seasonal-hour altitude dial". Some years ago I investigated the markings on this Instrument in an attempt to discover their logic. There are several more, and more plausible, theoretical origins for these than the two which Mr. Mills mentions (empirical and numerical calculation), for example: 1) that they represent readings of altitude taken when these hours were indicated on an ordinary "Scratch Dial". 2) that they are derived arithmetically from one of the curious horizontal scales of mere numerical progression (see my Article on p.31 of issue 91:3 of the Bulletin). 3) that they are calculated by some form of geometrical construction. 4) that they were calculated by means of the "Instrumentum Horarum" (see again the Article mentioned above). All of these are possible for the period: neither of Mr. Mills' really is, calucated Trigonometry had only just identified the Sine function at that time, and the Torquetum (which can't handle Temporal Hours anyway) had yet to be invented! The Astrolabe was another (remote) possibility.

None of these methods however will give results which make any real contact with the markings on "The Canterbury pendant". I suddenly realized that I, like Mr. Mills, was approaching the matter with far too much sophistication.

The "Canterbury pendant" is a work of Art, of intuition; made by eye and hand, not by brain and slide rule. It is also very little and consequently rather rough and imprecise, and there is in addition one glaring slip caused by the mis-phasing of the columns on one side.

The maker was not primarily a mathematician or an astronomer but a Religious. He/she inherits from the (then well known) Shadow tables the practice of phasing the monts in pairs, but cannot convert the horizontal values into vertical ones. Therefore He/she begins with the assumption that the noon shadow at the Equinox of Spring ("March") falls at 45° so that the Shadow then equals the length of the Gnomon. Crude logic suggests that if the shadow is that long then, then it will be twice as long a noon at the Summer Solstice ("June/July"). Again if the Shadow is as long as the Gnomon at the Equinox, when it is "half way up" *at* noon, then it will be the same length when it is "half way up" *to* (or half way down *from*) noon at the Summer Solstice. Thus at noon at the Equinox the Shadow is taken as one Gnomon's length; and at noon at the Summer Solstice the Shadow is taken as two Gnomon's lengths, whilst at the third and ninth hours at the Summer Solstice the shadow is taken as again being one Gnomon's length. All of the rest of the markings are found by mere extrapolation:

Taking the Gnomon as 3 points the intended Noon marks would appear to be: for Jan/Dec, one point; for Feb/Nov, two points; for Mar/Oct, three points; for Apr/Sep, four points; for Aug/Mai, five points; for Jun/Jul, six points.

The marks for the Third and Ninth hours would appear to be intended to lie half way between the noon mark and the Gnomon hole.

The actualities are much less precise: even the Gnomon holes are not in a straight line (and who knows how much the drill which made them has crept from the original lay-out mark?); whilst a slip in phasing the columns has led to the mark for the Third and Ninth Hours in Mai/Aug being made (and left) the same length from the Gnomon as in Jun/Jul (which should logically have been in that column). The Apr/Sept Noon mark seems deliberately half a point short.

I compose this letter in some trepidation, feeling that:

a) it will not be published at all. or
b) if published it will be so afflicted with missprints and ommissions as to read like pure nonsense. or
c) If published it will upset the Author of the Article discussed.

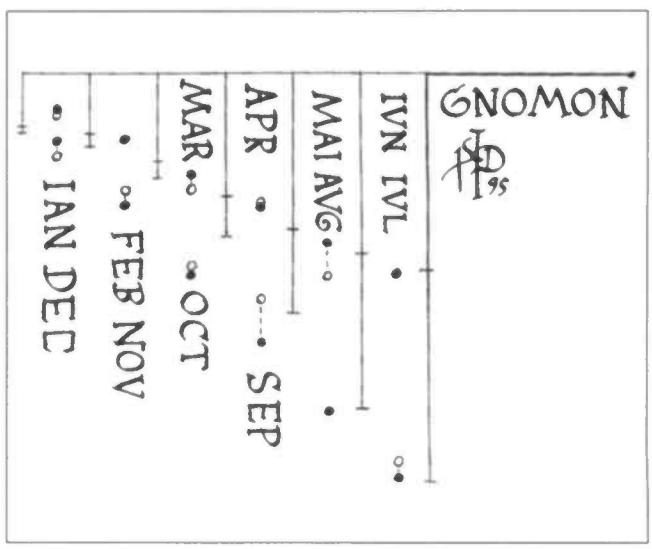
I can do nothing about a and b, which lie entirely under the shadow of the Editor and his proof readers; but to forstall c I can only say that I have not actually contradicted or belittled any statement made in the Article, I merely propose an answer to the problem that is there stated and discussed.

It might also be thought that I am rubbishing the ancient Instrument, and this I am certainly not doing; any more than I would seek to rubbish the Scratchdial or any other Instrument constructed according to the lights of its time. I would, in this context, point out that it is no sense an impractical device. The Gnomon, although theoretically and actually of the length stated, is in fact fully adjustable in length within these limits in practice and would certainly need to be adjusted to match the Noon mark (by eye according to observation) within the time span of each column. I do not believe that the maker had any conception of fixed Latitude; and has anticipated the need to adjust (by sliding in and out) according to both day and place.

With this understanding the Instrument does what it supposed to: it enables the user to locate, with regularity, and according to pattern, the required times for those Hours of Christian Prayer not marked by obvious natural events like Sunrise, Sunset, or the beginning of morning and the ending of evening twilight. I would imagine that it was made by one person as a gift to another: the two inscriptions would suggest this.

NOTE: On the Diagramme the Black Dots represent the points of the Shadow calculated as described above: the white dots indicating the points actually cut on the Instrument, where they differ from the calculated values. The horizontal marks on the lines which divide the columns indicate the Hour points at the cusps of the Zodiacal Signs as they would be determined by observations taken at noon, and at the times of the third and ninth hours as shewn by a Scratchdial at Latitude 51°. The whole is proportionate to the length of the Gnomon as indicated by the thick horizontal line so labled.

EDITOR: Literatim et Verbatim



HENSLOW'S SKETCHES

M. COWHAM

I have been fortunate enough to come across some very exciting sketches of sundials. These are in pen and ink, 94 in total, contained in a very dirty and dilapidated album. It is leather bound, 25" x 17" in size and weighs an incredible 10kg. It originally contained 100 drawings plus a missing frontispiece. On the front cover is the title, **Sundial Etchings, Vol. 1**.

When I first saw its pictures, I recognised the drawings from my copy of Gatty, (actually the edition by Eden and Lloyd, 1900). On closer inspection, I noticed some small differences and then some not so small differences, although the dial details are remarkably similar, and the views were always from the same direction. A picture of the Tower of the Winds in Athens is identical in Eden & Lloyd, even down to individual pen strokes, but in these newly found drawings, there is extra detail seen in the foreground and background, see Figure 1 and 1a.

Further investigation revealed that the dials were not always so identical and that they always had additional 'scenery' added. Also, only about a dozen of these 94 drawings actually appear in the book by Eden & Lloyd.

It then dawned on me that these were the drawings used by T.G.W. Henslow for 'Ye Sundial Booke' published by him in 1914. Checking through Henslow, I identified 93 out of the 94 and these are definitely the ones used by the publisher to produce this volume.

Henslow used a friend, Miss D. Hartley, as the artist, and in his book the majority of the 360+ drawings are signed, and sometimes dated. In these newly discovered sketches, none are signed, although one has the initials and date, DH -11. It therefore appears that the signed drawings have already been separated from these and have possibly suffered the fate of being framed. Perhaps these were in Volumes 2, 3 or 4? BSS members should keep a look out for these missing volumes. All drawings in Geoffrey Henslow's book that were dated were 1911 to 1913, and the book was published in 1914. For those who do not know Henslow's book, it contains one drawing per page, and underneath each are a few lines of verse by Henslow. In his Introduction, he does apologise for his work, and from reading some of these verses I can understand why.

Having studied these drawings it became obvious that Miss Hartley had copied directly from the Eden & Lloyd book, and possibly from other sources, and has added extra fictitious scenery to make the scene look more interesting. In my opinion this has somewhat detracted from the scene and could be misleading. However, I must admit that the extra embellishments do add extra interest.

The drawing of the dial at Badminton shows a stately home in the background, see Figures 2 and 2a. Was it actually like this? I doubt it. The early dial at North Stoke in Oxfordshire that is mounted high up on the south face of the nave has now, in Miss Hartley's work, appeared over and archway! This is an amazing transposition, see Figures 3 and 3a.

Some of the drawings are taken from the earlier pictures by Warrington Hogg. In fact, Eden & Lloyd used some of his pictures in their 1900 edition. Compare the picture of the dial in the Rochester Deanery garden. Here, Miss Hartley has copied the Warrington Hogg drawing exactly, even down to the ivy around its base, but then added the details of the gardens behind, see Figure 4 and 4a.

I enclose a selection of these pictures and some copies of their equivalents as shown in Eden & Lloyd. I also enclose a small clip from the Introduction to Henslow's book.

The only drawing that does not seem to appear in the Henslow book is the one with the oval dial on a church tower, see Figure 5a. Perhaps some member will be able to tell me of its location? From its style, I would guess that it is one from Rye in Sussex, but was it really mounted up a tower? It could even be the one on the Grammar School, see Figure 5. The image of the smiling sun in the corner is perhaps the reason that Henslow did not include this picture in his book. It seems very inappropriate.

This collection of drawings deserve further study and I will prepare a more lengthy article for a future edition of the Bulletin discussing them and the relationship between Mrs. Alfred Gatty, her daughter Horatia Eden and Eleanor Lloyd. Their relationship with Warrington Hogg is also of interest, and if any member can throw any light on this subject I will be pleased to hear from them.

Extract from the Introduction to
Ye Sundial Booke

by T. Geoffrey W. Henslow, MA. 1914

He would, indeed, be a mean man who, having received considerable assistance in any undertaking, failed to acknowledge such on the first opportunity; and I have the greatest pleasure in here testifying to the untiring efforts of my artist, Miss D. Hartley, who has contributed so largely to my work; indeed, I am sure that, without her talent, I should receive but poor commendation from the general public.

All the sundials that figure in this work are dials that actually exist, and although the settings are new, yet it is to be hoped that this will no wise detract from the value of the book. So many ancient dials are today continually changing hands and being placed in new surroundings, that although cognisant of the fact that it would be far more interesting to illustrate my work with sketches showing the dial in its original position, yet in the majority of cases I have proved this to be impossible. I have, therefore, decided, whilst representing faithfully the actual dials, to adopt quite new lines, and to illustrate my work with a series of sketches in keeping with the age of each horologe, and also supplying a series of pictures calculated to suit the style and nature of my book.

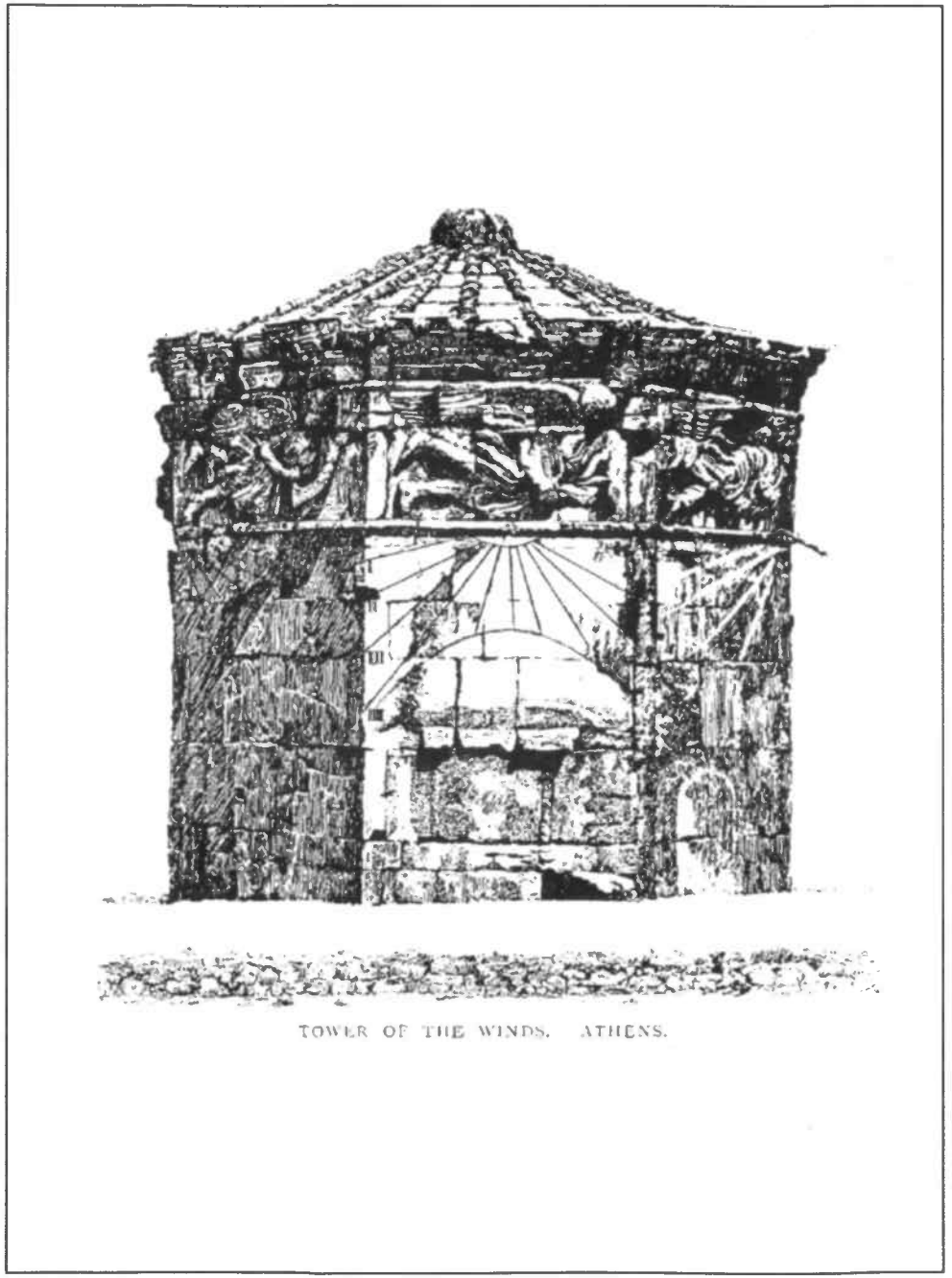


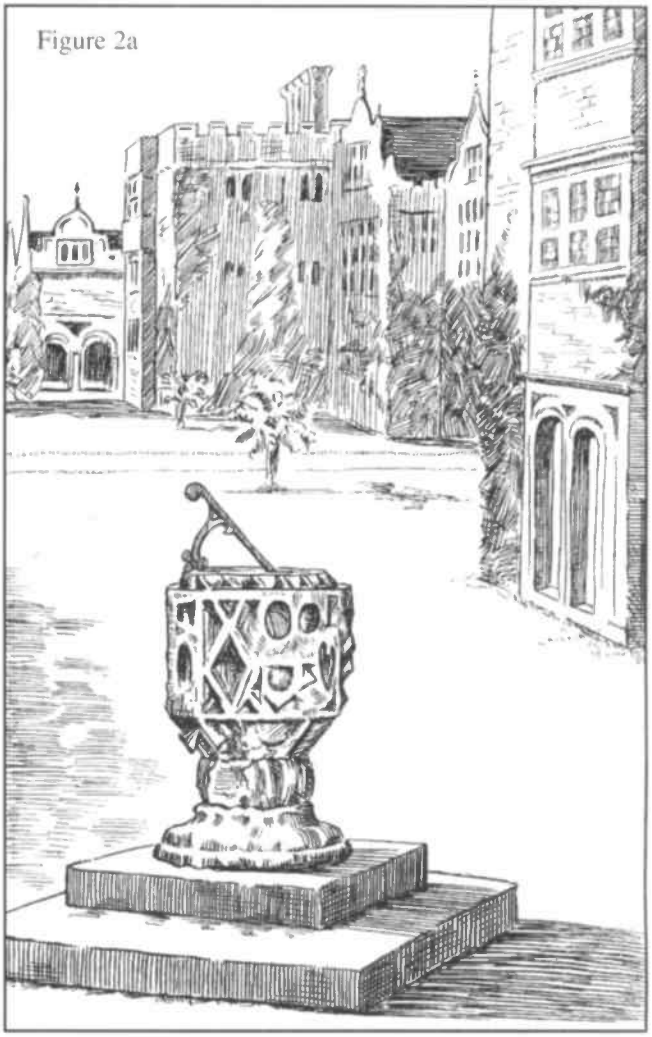
Figure 1 Eden & Lloyd

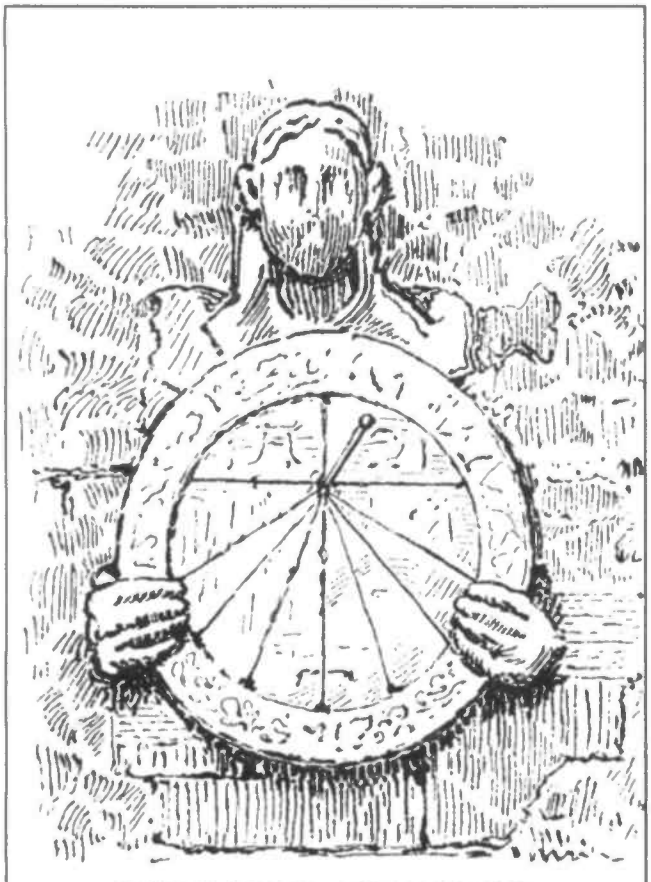
Figure 1a Henslow

Figure 2

BADMINTON HOUSE.

Figure 2a

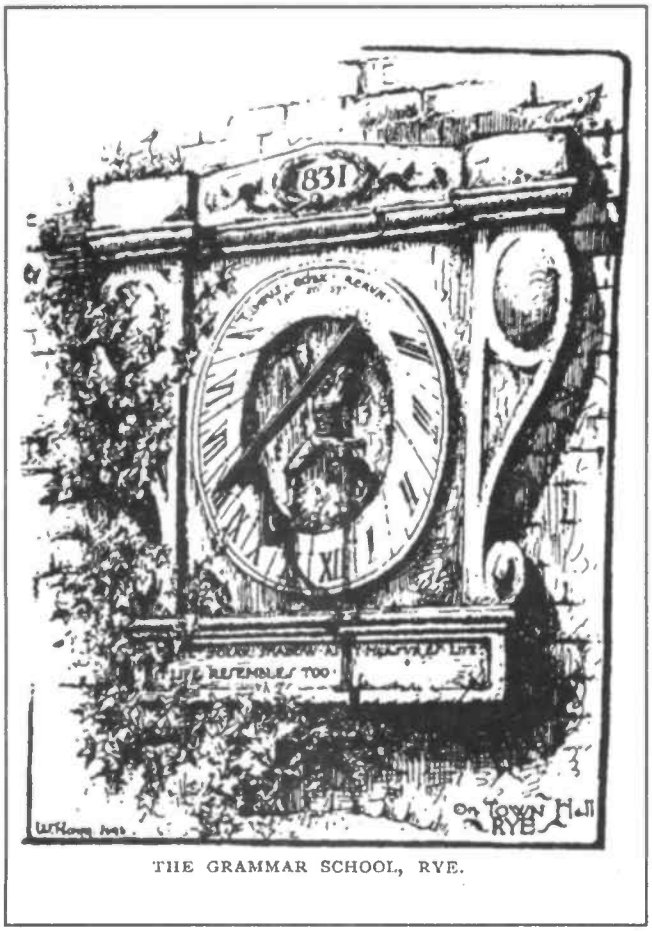




NORTH STOKE, OXFORDSHIRE.

Figure 3 Eden & Lloyd

Figure 3a Henslow



THE GRAMMAR SCHOOL, RYE.

Figure 5 Eden & Lloyd

Figure 5a Henslow

USEFUL ADDRESSES

Mr. Charles K. Aked
54 Swan Road
WEST DRAYTON
Middlesex UB7 7JZ
[Editor]
Tel: 01895 445332

Mr. C. St. J.H. Daniel
57 Gossage Road
PLUMSTEAD COMMON
London SE18 1NQ
[Chairman]
Tel: 0181 3178779

Mr. E.R. Martin
West Lodge
Thicknall Lane
CLENT
Nr. Stourbridge
Worcs DY9 0HJ
[Mass Dials]
Tel: 01562 882709

Mr. R.A. Nicholls
45 Hound Street
SHERBORNE
Dorset DT9 3AB
[Treasurer]
Tel: 01935 812544

Mr. P. Nicholson
9 Lynwood Avenue
EPSOM
Surrey KT17 4LQ
[Sponsorship]
Tel: 0137 27 25742

Mr. Alan Smith
21 Parr Fold Avenue
WORSLEY
Manchester M28 7HD
[Northern Liaison]
Tel: 0161 790 3391

Mrs. Anne Somerville
Mendota
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HIGHER POYNTON
Cheshire SK12 1TX
[Library, Archival Records & Sales]
Tel: 01625 872943

Mr. Graham Stapleton
50 Woodberry Avenue
NORTH HARROW
Middlesex HA2 6AX
[Council Member]

Mr. Robert B. Sylvester
Barncroft
Grizebeck
KIRKBY-IN-FURNESS
Cumbria LA17 7XJ
[Membership]
Tel: 01229 889716

Mrs. Jane Walker
31 Longdown Road
Little Sandhurst
CAMBERLEY
Surrey GU17 8QG
[Education]
Tel: 01344 772569

Miss R. J. Wilson
Hart Croft
14 Pear Tree Close
CHIPPING CAMPDEN
Gloucestershire GL55 6DB
[Council Member]
Tel: 01386 841007

Dr. I.D.P. Wootton
Cariad Cottage
Cleeve Road
GORING-ON-THAMES
Oxon RG8 9BD
[Registrar]
Tel: 01491 873050

Mr. D.A. Young
Brook Cottage
112 Whitehall Road
CHINGFORD
London E4 6DW
[Secretary]
Tel: 0181 529 4880

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